London School of Economics and Political Science

The Plague and the State in Early Modern England 1538-1667

Charles Warrington Udale[1]

A thesis submitted to the Department of Economic History of the London School of Economics and Political Science for the degree of Doctor of Philosophy.
Rutland, September 2023.

[1] Any correspondence with the author should be addressed to charlieudale@live.co.uk.

Abstract

This thesis examines the impact of and state responses to plague in early modern England – a period I define as beginning in 1538 with the emergence of parish burial registers and ending with the disappearance of epidemic plague in c.1667. The main focus is 8 national outbreaks that occurred in 1544-6, 1563-5, 1577-9, 1592-4, 1603-5, 1624-6, 1636-7, 1665-7. The aim is to build on existing studies of plague in early modern Europe by combining detailed, micro history and big data historical epidemiology to answer four key questions:

1. What were the dynamics of national plague outbreaks in the early modern period? 2. How widely were plague quarantine regulations (mandated nationally from 1578) enforced? 3. What was the demographic impact of enforcement? 4. How did English plague responses (the core policy being household quarantine) compare with those on the continent, particularly France and Italy?

The results suggest whilst plague was more limited in its diffusion than previously thought, state responses were more comprehensive, sophisticated, and charitable. Plague was a highly urban disease and one that affected a relatively limited number of smaller regional and market towns in any given outbreak. It travelled predominantly by boat, along navigable rivers and sea routes. So, its diffusion patterns in England are best understood as part of a complex, European (possibly Eurasian) disease environment. Within towns, it affected poorer parishes and households most.

Whilst there is little to suggest quarantine measures radically altered the severity of epidemics or the ability of plague to spread to new settlements between 1538 and 1667, there is very strong evidence the regulations were enforced with considerable intensity. There was also variation between parishes. Household quarantine policies were enforced most strongly in wealthy, well-resourced parishes. Within them they were enforced across most households regardless of affluence.

Yet even as they began to roll out household quarantine, city governments were establishing supplementary pesthouses for the isolation of people who could not expect help if isolated at home – a policy which added previously unnoticed levels of care and support to existing isolation policies in England. The measures developed and implemented in response to plague would inspire public health responses up to the present day.

Declaration

I certify that the thesis I have presented for examination for the PhD degree of the London School of Economics and Political Science is solely my own work.

I warrant that this authorisation does not, to the best of my belief, infringe the rights of any third party. I declare that my thesis consists of 52647 words, including footnotes but excluding footnote-references, appendices, and bibliography.

Acknowledgements

I was inspired to write this thesis by the exciting and deeply formative seminars on 'Human Health in History' organised by Patrick Wallis and Eric Schneider whilst I was a master's student at the LSE. The seminars combined Patrick's interest in the history of medicine with Eric's interest in demographic history. Like that module, this thesis combines both disciplines both substantially and methodologically.

This is particularly unsurprising given Patrick and Eric became my supervisors. I would like to express my gratitude to them for their generosity, charity, good humour, enthusiasm, patience, and guidance. I have attempted to soak up everything I can from them, and I am still left astounded by the depth of their intellects and breadth of their learning in comparison to my own. They are the cleverest people I know, and two of the kindest. This thesis is dedicated to them.

I would also like to thank my mother and late father for their generosity and enduring support – even if they were never entirely sure what I was doing or, indeed, why I was doing it. The same cannot be said for three other people: Zane Jennings, Henry Yeomans, and Beshara Sheehan.

Zane and I met on the MSc and became life-time friends. I would like to thank him for endlessly fascinating, often highly energetic debates about every element of this thesis, his thesis, and every other area of economic history we encounter. I feel very fortunate to have met someone as excited about the 17th century as I am.

I will also be forever grateful to my dear friend Henry Yeomans who, despite having no academic interest in economic history has shaped this thesis more than the law of copyright will allow me to reveal. Thanks, Hen!

Most importantly, I would like to thank Beshara Sheehan. Aside from the countless contributions she made to the research by challenging my thinking with her truly rigorous, subtle, and scientific mind, she also supported me through four years of personal loss, disruption, and upheaval. I hope she knows how grateful I am because mere words are incapable of expressing it.

I would also like to thank several academics who have inspired, encouraged, assisted, and guided me through this research: Romola Davenport, Paul Slack, Neil Murphy, and Evan Jones. Finally, I thank my examiners Guido Alfani and Vannessa Harding for reading the whole thesis so carefully and attentively – perhaps the first and last people ever to do so.

To anyone beginning a PhD thesis: remember, reality is far more complex, fascinating, and enlightening than whatever preconceptions you bring to your research. Enjoy discovering you are wrong. I certainly have.

Charles Udale,
Rutland,
06.06.2024.

Contents

List of Figures

List of Tables

Chapter 1. Introduction

Bubonic plague is a highly lethal and uniquely enigmatic disease. Its name inspires terror and dread; its legacy includes the destruction of people, families, communities, and social systems. Since the Bronze Age, plague has dogged humanity in a series of global pandemics with its local manifestations capable of killing more than half a settlement's population.[2] The early modern quarantines and associated policies developed in response were feared almost as much as the disease itself. They were immensely costly and disruptive, and they trampled on traditional charitable and neighbourly assumptions.[3] Whilst remaining controversial, they have also inspired later and often more successful measures to control and limit infectious disease – from smallpox to covid-19.[4] This thesis analyses an early phase in the history of the human struggle against lethal microbes. Its focus is the period from 1538 to 1667 when the English state adopted quarantine policies of unprecedented ambition entailing considerable expansions in the responsibilities of local authorities to fight plague. It is therefore concerned with one of the most dramatic episodes in history – an early engagement in the ceaseless battle between humans and our microbial adversaries.[5]

Using a combination of big-data and micro-historical approaches, this thesis reveals the dynamics of plague and the scale of human resistance in early modern England with rare precision and geographical breadth. It demonstrates how the behaviour of plague was shaped as much by its environment - human and natural - as by its biology. It nuances the most apocalyptic images of plague as an indiscriminate, omnipotent, and omnipresent killer. But in describing the complex dynamics of plague, it only serves to make its impact more imaginable and therefore more terrifying and insidious. Likewise, by unveiling – in new depth – the vigour and complexity of local government responses this thesis displays the intensity with which human societies can struggle, with poor information and limited resources, to protect themselves and their communities from external threats. This thesis is much more than a policy analysis concerned with whether state objectives relating to plague quarantines were met. This is a dynamic portrayal of a society's struggle to overcome one of the greatest threats in human history: bubonic plague.

It is essential to contextualise and explain the dynamics of the plague if we are to understand and evaluate state interventions. Early modern life was chronically unstable, with constant threats from political unrest, economic crisis, as well as the circulation of infectious diseases. It is important to situate plague within this context of instability, drawing out the

---

[2] Spyrou, M. A. *et al.* Analysis of 3800-year-old Yersinia pestis genomes suggests Bronze Age origin for bubonic plague. *Nat. Commun.* 9, 2234 (2018); Valtueña, A. A. *et al.* The Stone Age Plague and Its Persistence in Eurasia. *Curr. Biol.* 27, 3683-3691.e8 (2017); Alfani, G. & Murphy, T. E. Plague and Lethal Epidemics in the Pre-Industrial World. *J Econ Hist* 77, 314–343 (2017)

[3] Slack, P. Responses to plague in early modern Europe: the implications of public health. *Soc Res* 55, 433–53 (1988)

[4] E.g Tognotti, E. Lessons from the History of Quarantine, from Plague to Influenza A. *Emerg Infect Dis* 19, 254–259 (2013); For smallpox: Davenport, R. J., Satchell, M. & Shaw-Taylor, L. M. W. The geography of smallpox in England before vaccination: A conundrum resolved. *Soc Sci Med* 206, 75–85 (2018)

[5] Harper, K. 2021. Plagues Upon the Earth: Disease and the Course of Human History. Princeton University Press

commonalities with other sources of crisis as well as those features which are unique to plagues. Whilst remaining alive to contemporary perspectives, I aim to show how these dynamics help to explain the particularities of plague policies and the vast resources dedicated to implementing them. Plague was one of the most persistent and extreme sources of instability in early modern life; the responses reflect the degree of the threat. In recent years, historians have developed new, high-resolution datasets describing administrative, geographical, and economic features of early modern England. These can be exploited to determine the relative vulnerabilities of settlements to experiencing plague epidemics. Doing so improves our understanding of the patterns of policy adoption as well as the possibility that these interventions could have changed disease dynamics.

This investigation of plague and plague responses combines two central themes of economic and social history: the epidemiological transition and the development of the modern state. Beginning in the early modern period, the proportion of deaths due to infectious disease began to recede in European populations. In 17th century London, c.75% of deaths were due to infectious diseases, malnutrition, or complications in childbirth.[6] Today, the same causes represent around 6% of total deaths in Europe, with degenerative diseases and life-style related illnesses contributing the overwhelming majority.[7] The decline of infectious disease has been accompanied by a substantial rise life expectancy at birth from 20-40 years in the early modern period to 75-85 years today.[8] The exact contribution of nutritional improvement, public health interventions, and advances in medical theory and practice are disputed.[9] Nevertheless, it is clear active state involvement has significantly limited the burden of infectious disease. The earliest example is the introduction of systematic poor relief which already by the mid-17th century had significantly weakened the relationship between harvest failure and mortality crises in England.[10] Beginning in the 18th century, the breadth and scale of interventions increased sufficiently to reduce the burden of mortality from disease such as smallpox, cholera, and typhoid by 1900.[11] This thesis illuminates a key moment in the assumption of responsibility for population heath by the state and the interventions that responsibility implied.

The broadening of states' interventions in everyday life that responses to plague involved were also an important stage in the emergence of the modern state, for which improving

[6] Omran, A. R. The Epidemiologic Transition: A Theory of the Epidemiology of Population Change. *Milbank Q* 83, 731–757 (2005), 740

[7] https://data.worldbank.org/indicator/SH.DTH.COMM.ZS?locations=EU

[8] Omran, *The Epidemiologic Transition*, 737; https://data.worldbank.org/indicator/SP.DYN.LE00.MA.IN?locations=EU

[9] See, for instance, Szreter, S. The Importance of Social Intervention in Britain's Mortality Decline c.1850–1914: a Re-interpretation of the Role of Public Health. *Soc Hist Med* 1, 1–38 (1988)

[10] Kelly, M. & Gráda, C. Ó. Living standards and mortality since the middle ages. *Econ Hist Rev* 67, 358–381 (2013)

[11] Harper, *Plagues Upon the Earth*, 469-475; Szreter, *The Importance of Social Intervention*, 26; Porter argues we should not overlook the earlier 18th century public health interventions that set the stage for the sanitary movement of the 19th: Porter, R. Cleaning up the Great Wen: public health in eighteenth-century London. *Med Hist* 35, 61–75 (1991); Davenport et al, *The geography of smallpox*, 75–85; Gallardo-Albarrán, D. Sanitary infrastructures and the decline of mortality in Germany, 1877–1913†. *Econ. Hist. Rev.* 73, 730–757 (2020).

health outcomes is a fundamental objective. The central functions of medieval states were restricted to extracting land and customs taxes to pay for war and provide essential legal services; local authorities were concerned with economic regulation and basic sanitary initiatives.[12] During the early modern period states became more bureaucratic, complex, and capable of extracting greater levels of economic rents from populations.[13] They also began to gather and share information on a much greater scale.[14] By the 16th century, the English state was increasing its interventions in everyday life, with new initiatives emerging at the centre and in the localities.[15] It became increasingly involved in raising and distributing new forms of taxation to support the 'worthy', 'respectable', or 'impotent' poor.[16] The state also became concerned to regulate food prices in times of dearth and, of course, with attempts to mitigate and limit the spread of plague.[17] In short, the 16th century saw the expansion, even the birth, of English social policy.[18] These attempts to intervene in everyday life led to the creation of institutions – such as the overseers of the poor or bills of mortality – and the elaboration of existing institutions like the wider offices of the parish, borough, and county.[19] To evaluate the implementation of English plague interventions is therefore to illuminate the capacity of the early modern state to achieve its emerging and expanding social objectives in the critical area of public health.

Two important themes I develop in the chapters on household quarantines and pesthouses are resistance against plague and the extension of power entailed by state responses. The significance of plague, power, and resistance is evident from the two great philosophical treatments of plague and plague responses in the 20th century. These are Camus' *La Peste* and Foucault's *Discipline and Punish: The Birth of the Prison*. For Camus, plague represents inevitable and painful death as a fundamental human truth; plague responses – including quarantine – represent part of the necessary but ultimately futile struggle all humans must engage in if they are to generate moral value in the world.[20] In Foucault, the unique qualities of the disease and the agency of individuals are pushed to the background whilst at the centre is the development of bureaucratic, analytical, and invasive system of power, control, and discipline. Agency is given to powerful elites who instrumentalise the threat caused by plague: 'In order to see perfect disciplines functioning, rulers dreamt of the state of plague.'[21]

---

[12] Tilly, Charles. *Coercion, Capital, and European States, AD 990-1990*. Cambridge, Mass., USA: B. Blackwell, 1990; Gunn, S. J. (Steven J.), David Grummitt, and Hans. Cools. *War, State, and Society in England and the Netherlands 1477-1559*. Oxford: Oxford University Press, 2007; Rawcliffe, C., Urban bodies: communal health in late medieval towns and cities (Woodbridge, 2013)

[13] Braddick, M. J., State formation in early modern England, c. 1550–1700 (Cambridge, 2000), 22; 25; chapter 6

[14] Slack, P. Government and Information in Seventeenth-Century England. *Past Present* 184, 33–68 (2004)

[15] Kent, J. R. The centre and the localities: state formation and parish government in England, circa 1640–1740. *Hist J* 38, 363–404 (1995).

[16] Slack, Paul. *Poverty and Policy in Tudor and Stuart England*. London: Longman, 1988.

[17] Braddick, *State formation*, chapter 3.

[18] Slack, P. Books of Orders: the Making of English Social Policy, 1577–1631. *T Roy Hist Soc* 30, 1–22 (1980)

[19] Braddick, *State formation*, chapter 3; Hindle, S., *The State and Social Change in Early Modern England, c.1550-1640* (Basingstoke, 1999), chapter 6

[20] Weiser, Peg Brand, 'Modern Death, Decent Death, and Heroic Solidarity in *The Plague*', in Peg Brand Weiser (ed.), *Camus's The Plague: Philosophical Perspectives* (New York, 2023; online edn, Oxford Academic, 15 Dec. 2022)

[21] Michel Foucault, in Discipline and Punish: The Birth of the Prison (New York, 1979), 199

These conceptions, especially that of Foucault, influence the perspectives many historians have brought to the study of plague and plague responses.[22] Consequently, they are engaged with throughout this thesis through questions about the relative importance of elites and the wider public in contributing to the enforcement of quarantines and the identification of the quarantined.

Whilst the significance of plague in the history of Europe is paralleled only by wars and reformations, it has received far less scholarly attention than either. Consequently, fundamental questions remain about its epidemiology and the nature of responses. This thesis addresses three: 1. How substantial was plague's impact on mortality? 2. What was the relative importance of direct human interventions, passive economic and social systems, and the natural environment in shaping mortality? 3. How vigorous and comprehensive were the public health responses and which measures were prioritised, why, by, and for whom? These questions connect the often-distinct history of medicine and public health with the history of human health and disease. In doing so, this thesis intends to demonstrate how both sub-disciplines would benefit from closer theoretical and methodological integration.

The remainder of this introduction sets out the literature on plague and plague responses during the Second Pandemic, outlining the relatively limited number of accepted propositions about the disease and the much more numerous areas of contention. This will highlight the key themes taken up in subsequent chapters. The final section of the introduction relates these themes more closely to those chapters, setting out the stages of analysis through which I will study the plague and the state in early modern England.

The Epidemiological Context and Consequences

What is Plague?

This thesis investigates epidemics and the responses mounted against them during the Second Plague Pandemic which began in Europe in 1347 and ended with three widely separated outbreaks: Marseilles in 1720-23, Messina in 1743, and Moscow in 1771-2.[23] The Second Pandemic was characterised by repeated surges of plague activity – with many outbreaks occurring almost simultaneously across wide areas of Europe. As its name suggests, the Second Pandemic was preceded by an earlier documented plague pandemic which began in the mid-sixth century with the 'Plague of Justinian' and continued until the mid-eighth century.[24] It is now clear from the analysis of ancient DNA that there were also earlier plague pandemics prior to recorded history – the earliest so far discovered dating to the Bronze

---

[22] This is often implicit but Newman states this clearly: Newman, K., 'Shutt Up: Bubonic Plague and Quarantine in Early Modern England', *Journal of Social History*, 45 (2012), 829.
[23] Alfani and Murphy, *Plague and Lethal Epidemics*, 316; Cohn, S K. The Black Death Transformed: Disease and Culture in Early Renaissance Europe. (London, 2002), 8
[24] Keller, M. *et al.* Ancient Yersinia pestis genomes from across Western Europe reveal early diversification during the First Pandemic (541–750). *Proc National Acad Sci* 116, 12363–12372 (2019).

Age.[25] The Third Plague Pandemic began in Yunnan in China in 1855 and was only declared over in 1960 when cases dropped below 200 per year.[26] The most recent pandemic had a relatively limited effect on European populations with the major mortality occurring in India and China.[27] In contrast, the Second Pandemic was a persistent and preeminent source of instability and crisis mortality for Europeans. It is vital to understand its impact, potential and realised, if we are to appreciate why early modern Europeans elected to target plague and to evaluate the outcomes of their responses.

Plague has broad and narrow definitions. For decades historians have debated whether the three pandemics were only plagues in the broad sense – mass mortalities – or whether they also shared an underlying causative agent. At least since Alexandre Yersin discovered the bacillus responsible for the Third Pandemic in 1894, the three pandemics have been thought to share a causative biological agent, later named *Yersinia pestis*.[28] This is in large part due to one shared symptom: the bubo – a swelling in the lymph nodes found in the armpits, groin, or neck.[29] This is the key feature of modern plague in its most common, bubonic, form (less frequently it takes a pneumonic or septicaemic form if it infects the lungs or blood).

However, a long list of historical epidemiologists dispute this, pointing to the many differences in characteristics of plague epidemics between the Second and Third Pandemics.[30] For example, plague spread a lot more quickly and had much higher mortality rates in the earlier pandemic. These important discrepancies led to a range of alternative suggested protagonists of major mortality crises during the Second Pandemic including anthrax, smallpox, and 'haemorrhagic plague.'[31] One of the most sophisticated 'plague deniers', Samuel Cohen, refuses to make an alternative suggestion. Instead asserting in the first line of his book the 'Black Death… was any disease other than… the bubonic plague (now known as *Yersinia pestis*).'[32] Yet, beginning in 1998 and with a series of articles in 2010 and 2011, analyses of ancient DNA extracted from the dental pulp of plague victims from the Second Pandemic has shown the plague bacillus was indeed *Yersinia pestis* – seemingly ending the controversy.[33]

---

[25] Valtueña, et al. *The Stone Age Plague*; Spyrou *et al, Analysis of 3800-year-old Yersinia pestis*

[26] Høiby, N. Pandemics: past, present, future. *APMIS* 129, 359-360 (2021)

[27] Bramanti, B., Dean, K. R., Walløe, L. & Stenseth, N. C. The Third Plague Pandemic in Europe. *Proc Royal Soc B Biological Sci* 286, 20182429 (2019); Høiby, *Pandemics*, 359-360

[28] Cohen, *Black Death Transformed*, 8

[29] Cohen discusses the historiography of plague buboes here: Cohen, *Black Death Transformed*, 57-58. But he is sceptical that the medieval plagues produced buboes in the same way as bubonic plague of the Third Pandemic.

[30] For a particularly comprehensive exposition see: Cohen, *Black Death Transformed*

[31] Benedictow, What Disease Was Plague? On the Controversy over the Microbiological Identity of Plague Epidemics of the Past (Leiden, 2010).

[32] Cohen, *Black Death Transformed*, 1

[33] Didier Raoult, et al., 'Detection of 400-year-old Yersinia pestis DNA in Human Dental Pulp: An Approach to the Diagnosis of Ancient Septicemia', Proceedings of the National Academy of Sciences of the USA, xcv (1998), 12637–40; Stephanie Haensch et al., 'Distinct Clones of Yersinia pestis Caused the Black Death', PLoS Pathogens, vi (2010), 1–8; and Giovanna Morelli, et al., 'Yersinia pestis Genome Sequencing Identifies Patterns of Global Phylogenetic Diversity', Nature Genetics, xlii (2010), 1140–3; V.J. Schuenemann, et al., 'Targeted Enrichment of Ancient Pathogens Yielding the pPCP1 Plasmid of Yersinia pestis from Victims of the Black Death', PNAS, cviii (38) (2011), E746–52 ; and K.I. Bos, et al., 'A Draft Genome of Yersinia pestis from Victims of the Black Death', Nature, cccclxxviii (2011), 506–10. For excellent overviews of this debate see:

Plague and Other Sources of Instability

Plague distinguished itself among the myriad sources of mortality crisis in early modern Europe. Plague epidemics across Europe could kill 50% - 60% of a town's population in a single outbreak.[34] That said, mortality between 10% and 12% was more typical in England and the Low Countries.[35] Yet other diseases could cause comparable death rates. In early modern England, influenza, not plague, caused the highest single year of crisis mortality in 1558-9 when the national crude death rate rose by 124%.[36] It was also responsible for the 5th most catastrophic mortality crisis which occurred in 1638-9, beating most of the major early modern plague epidemics.[37] One characteristic that distinguished plague among highly lethal diseases was the frequency with which it returned. In England, between these two major influenza outbreaks of the early modern period, there had been at least 5 nationally significant plague surges. For major towns, plague could cause a major outbreak killing 20% of the population once every ten years.[38] And plague epidemics were also peculiarly long. Epidemics caused by other major diseases such as influenza, dysentery, and the mysterious 'sweating sickness' tended to last for a month or two; plague epidemics regularly lasted four months, and sometimes multiple summers (with a lull in mortality over the winter).[39] Plague produced epidemics with a highly unusual combination of frequency, lethality, and duration.

In terms of length, the most comparable mortality crises were famines caused by harvest failure. These were mixed crises where direct starvation was only a minor contributor to total mortality. More important were gastrointestinal diseases caused by eating and drinking contaminated food and drink, respiratory and other diseases that are sensitive to low nutritional levels, and louse-borne typhus which thrives in crowded environments caused by

---

Cohen, S. The Historian and the Laboratory: The Black Death Disease. in *The Fifteenth Century XII: Society in an Age of Plague* (eds. Clark, L. & Rawcliffe, C.) (2013), 196-7; Little, L. K. Plague Historians in Lab Coats*. Past Present 213 (2011), 274-282

[34] In England: Newcastle in 1636 or Colchester in 1665; For Italy: Verona in 1629-1630 and Naples in 1656-57 Alfani, G. Plague in seventeenth-century Europe and the decline of Italy: an epidemiological hypothesis. *Eur Rev Econ Hist* 17, 408–430 (2013), 417; For central Europe: Eckert, E., *The Structure of Plagues and Pestilences in Early modern Europe: Central Europe, 1560-1640* (Basel, 1996), 28-34

[35] Slack, P. The Impact of Plague in Tudor and Stuart England. (London, 1985), 66; Curtis, D. R. Was Plague an Exclusively Urban Phenomenon? Plague Mortality in the Seventeenth-Century Low Countries. *J Interdiscipl Hist* 47, 164; Alfani's dataset shows similar levels of mortality across a range of settlements in 17th century Italy, though Alfani and Henderson quote much higher rates of between 30% and 40% for major towns. See: Henderson, J. 'The invisible enemy: Fighting the plague in early modern Italy', *Centaurus* 62, (2020), 265; Alfani, *Plague in Seventeenth Century Europe*, 417

[36] Wrigley, E A, Schofield R, Lee R D, and Oeppen J. The Population History of England, 1541-1871: a Reconstruction. (Cambridge, 1989), 333

[37] Wrigley and Schofield, *Population History*, 333

[38] See chapter 3.

[39] For plague, see chapter 2. For dysentery in historical populations see: Eckert, *Structure*, 52-53; For Sweating sickness: Dyer, A. The English Sweating Sickness of 1551: An Epidemic Anatomized. *Med Hist* 41, 362–384 (1997); Slack, *Impact*, 70; Heyman, P., Simons, L. & Cochez, C. Were the English Sweating Sickness and the Picardy Sweat Caused by Hantaviruses? *Viruses* 6, 151–171 (2014); Wrigley and Schofield note mortality crises of more than 2 months cannot be sustained in villages and market towns by airborne diseases. See Wrigley and Schofield, *Population History*, 663

dislocation.[40] There were at least three famines triggered by major harvest failures in early modern England 1586-7, 1596-7, and 1622-3 and they regularly lasted for many months, often until the next successful harvest.[41] Plague aside, harvest failures were the only other crisis in which the early modern English state tried to intervene. In this case by manipulating the grain market to ensure domestic supplies could reach the most vulnerable.[42] This suggests the state saw the comparably lengthy crises due to plague and harvest failure as providing enough time to institute an effective mitigation response. I will analyse the patterns of mortality due to harvest failures in several chapters to understand whether there are other features which disposed the state to act in these instances but not in the face of other mortality crises.[43]

Epidemiology and the Effectiveness of Interventions

Patterns of mortality reveal more than the nature of the problems early modern states were attempting to tackle. They also help to reveal how far those interventions succeeded in their objectives to limit crises and control disease. Contemporaries often believed their adoption of quarantine measures were successful. As proof, they invariably cited the failure of plague to arrive in their town or the failure of a few cases to cause a major epidemic when the victims had been isolated.[44] In other words, their evaluations were based on the patterns of infection and mortality that did or did not materialise. Historians sometimes adopt the same approach. Jillings argues the preventative measures adopted in 16th and 17th century Aberdeen kept the city free from plague for 98 years between 1550 to 1647.[45] Likewise, Wrightson suggests the relative freedom of the hinterlands of Newcastle from plague in the years surrounding the 1636 epidemic may be due to the measures adopted in that city.[46] Also using patterns of mortality, others have reached positive evaluations of *cordon sanitare* in 17th century Italy and 18th century Finland, France, and Austria.[47] One study even claims to have found that in Rome in the 1650s, *cordons sanitaire* imposed on some quarters ensured the city's mortality

[40] Burns, J. N., Acuna-Soto, R. & Stahle, D. W. Drought and Epidemic Typhus, Central Mexico, 1655–1918 - Volume 20, Number 3—March 2014 - Emerging Infectious Diseases journal - CDC. *Emerg. Infect. Dis.* 20, 442–447 (2014); Alfani, Guido, and Cormac Ó Gráda, eds. *Famine in European History*. Cambridge, United Kingdom: Cambridge University Press, 2017; Mokyr, J. & Grada, C. O. What do people die of during famines: the Great Irish Famine in comparative perspective. *Eur. Rev. Econ. Hist.* 6, 351 (2002); Eckert, *Structure*, 36
[41] Appleby, A. B. Disease or Famine? Mortality in Cumberland and Westmorland 1580-1640. *The Economic History Review* (1973), 408; Slack, *Impact*, 73
[42] Good overview in Braddick, *State Formation*, 119
[43] There were also local efforts to control smallpox from the 17th century, though these were not supported by national regulations. See: Slack, *Impact*, 241; Davenport et al, *The geography of smallpox*, 75–85
[44] E.g Slack, *Impact*, 213
[45] Jillings, K. An Urban History of the Plague: Socio-Economic, Political and Medical Impacts in a Scottish Community, 1500–1650 (Abingdon, 2018), 119
[46] Wrightson, K., *Ralph Tailor's Summer: A Scrivener, His City and the Plague* (New Haven, 2011), 52
[47] Kallioinen, M., 'Plagues and governments: the prevention of plague epidemics in early modern Finland', *Scandinavian Journal of History*, 31 (2006); Rothenberg, G. E. The Austrian Sanitary Cordon and the Control of the Bubonic Plague: 1710–1871. *J Hist Med All Sci* XXVIII, 15–23 (1973), 22-23; Alfani, *Plague in Seventeenth Century Europe*, 418-419

rate was 8% whilst mortality in cities nearby reached 30-40%.[48] Using data from c.850 parish burial registers, Eckert identifies a shift in the 'structure' of plague surges in central Europe around 1640, with surges affecting fewer settlements.[49] Eckert describes this as the retreat of plague before its disappearance after 1720 and argues more strident human interventions may have been responsible.[50] Though, as he points out, 'A critical question is the extent of the disparity between official regulations and the actual enforcement of quarantine.'[51]

A Priori Arguments Rest on Two Disputed Propositions

Claims that interventions were effective rely on implicit assumptions about the mode of plague transmission. Quarantine and isolation policies restricted human movement. For these to be effective, the movement of plague must be dependent on human movement as well. This dependency, and by extension the efficacy of quarantine, was debated by contemporaries who argued plague spread via 'miasma' or corrupted air and not principally by human-to-human contagion.[52] Historians such as Slack argue the connection between human and plague transmission is most certain over long distances, and especially transmission by ship.[53] However, ongoing disagreement about plagues' transmission mechanism undermines *a priori* claims about the spread of plague at more local levels such as between nearby settlements or between households. During the Third Pandemic, British Scientists in India argued human cases of plague are caused by rat-specific fleas jumping from infected black rats during rat epizootics.[54] Fleas must feed regularly on their hosts. When their rat host dies of plague, fleas jump to new hosts to survive. As the rat population declines, rat fleas increasingly jump to humans, thus passing on the bacillus to the human population. The rat-flea model underlies many histories of plague during the Second Pandemic.[55] Even so, many historians have pointed to stark contrasts between the Second and Third Pandemics in terms of the severity and speed of epidemics which may suggest plague spread by alternative means.[56]

---

[48] Sonnino, Eugenio. "Cronache della peste a Roma: Notizie dal Ghetto e lettere di Girolamo Gastaldi (1656–1657)." Roma Moderna e Contemporanea 14, no. 1-3 (2006): 35–74 – quoted in Alfani and Murphy, *Plague and Lethal Epidemics*, 329. I am grateful to Guido Alfani for bringing this paper to my attention.
[49] Eckert, E. A. The Retreat of Plague from Central Europe, 1640-1720: A Geomedical Approach. *B Hist Med* 74, 1–28 (2000), 21
[50] Eckert, *Retreat,* 1
[51] Eckert, *Retreat,* 25-26
[52] Henderson, J., *Florence under siege: Surviving plague in an early modern city* (New Haven, 2019), 132-133; Slack, *Impact,* 250-252
[53] Slack, *Impact,* 313-314
[54] Cohen, *The Historian*, 199; The classic exposition of the rat flea model can be found in: Pollitzer, R., 1954. Plague. World Health Organization, Geneva. Many 20th century French and German historians, notably Noel Biraben, did not subscribe to this transmission model. See: Flinn, M W. Plague in Europe and the Mediterranean Countries. Journal of European Economic History; Spring 1979; 8, 1, 133-135.
[55] Shrewsbury applies the rat theory more rigidly; For reviews see: Slack, P. A. Reviewed Work(s): A History of Bubonic Plague in the British Isles by J. F. D. Shrewsbury. *The English Historical Review* (1972); Cohen, *Black Death Transformed*, 43-47. Benedictow, O J. 1992. Plague in the Late Medieval Nordic Countries: Epidemiological Studies. Oslo, Norway: Middelalderforlaget; Benedictow, O J. 2004. The Black Death 1346-1353. The Complete History; In his characteristically subtle style, Slack also allows for other transmission models but emphasises the role of rats. See: Slack, *Impact,* 314
[56] Cohen, *Black Death Transformed*, part 1

There are two alternative theories of plague transmission in the Second Pandemic. One points to plague spreading directly between humans (through water droplets) after infecting the lungs and taking a pneumonic form. Since pneumonic plague has a case fatality rate of nearly 100% and a very short incubation period, it is probably incapable of causing a mass epidemic.[57] Victims would be incapacitated too quickly to spread the disease to additional people. The other possible explanation implicates alternative ectoparasites to the rat flea, *Xenopsylla cheopis*, and is more plausible. Researchers most often point either to the human flea, *Pulex irritans*, or the body louse, *Pediculus humanus humanus.* There is a growing literature arguing for human ectoparasite transmission by examining the relative efficiency of ectoparasite transmission in laboratory conditions, surveys of modern outbreaks, and comparing known epidemic patterns to models describing expected patterns given different vectors.[58] Yet, recent work has undermined the apparent efficiency of human ectoparasite transmission relative to rat-fleas and questioned the often implausible and unfounded assumptions used in statistical modelling.[59] Moreover, surveys finding high concentrations of human ectoparasites in areas with known plague cases invariably relate to very limited outbreaks, suggesting other factors explain the severity and speed of plague during the Second Pandemic.[60]

Whether rats or humans primarily carried ectoparasites between households has particularly important implications for the potential success of household quarantine policies. These were adopted widely against plague in early modern Europe and were the principal form of plague quarantine in England.[61] The standard policy was to lock up all members of an infected household as soon as one infected person was identified. Historians who emphasise rat-flea transmission argue this policy would have been at best ineffective and at worse actively harmful.[62] Confining healthy people close to infected rats would increase mortality within the household. Yet, rats would not be prevented from spreading disease between households. So, overall, more people would be exposed to plague and therefore mortality would be higher than if no quarantine had been imposed. Yet, if plague was spread by human fleas, household

---

[57] Dean, K. R. *et al.* Human ectoparasites and the spread of plague in Europe during the Second Pandemic. *Proc National Acad Sci* 115, 201715640 (2018); Earn, D. J. D., Ma, J., Poinar, H., Dushoff, J. & Bolker, B. M. Acceleration of plague outbreaks in the second pandemic. *Proc National Acad Sci* 117, 27703–27711 (2020), 27707

[58] Extensive discussions can be found in: Cohen, *The Historian,* 196-7; Little, *Plague Historians*, 274-282; Also see: Dean et al, *Human ectoparasites*; Whittles, L. K. & Didelot, X. Epidemiological analysis of the Eyam plague outbreak of 1665-1666. *Proc Biological Sci Royal Soc* 283, 20160618 (2016); Eisen, R. J., Dennis, D. T. & Gage, K. L. The Role of Early-Phase Transmission in the Spread of Yersinia pestis. *J Med Entomol* 52, 1183–1192 (2015)

[59] Benedictow, O. J. Epidemiology of Plague: Problems with the Use of Mathematical Epidemiological Models in Plague Research and the Question of Transmission by Human Fleas and Lice. *Can J Infect Dis Medical Microbiol* 2019, 1–20 (2019); Hinnebusch, B. J., Bland, D. M., Bosio, C. F. & Jarrett, C. O. Comparative Ability of Oropsylla montana and Xenopsylla cheopis Fleas to Transmit Yersinia pestis by Two Different Mechanisms. *PLoS Neglected Trop. Dis.* 11, e0005276 (2017)

[60] See: Dean, K. R., Krauer, F. & Schmid, B. V. Epidemiology of a bubonic plague outbreak in Glasgow, Scotland in 1900. *Roy Soc Open Sci* 6, 181695 (2019); Laudisoit, A. *et al.* Plague and the Human Flea, Tanzania. *Emerg Infect Dis* 13, 687–693 (2007)

[61] Slack, *Impact,* chapter 8

[62] Slack, *Impact,* 320; Cipolla, C., *Fighting the Plague in Seventeenth-century Italy* (Madison, 1980), 18

quarantine may have had a neutral or even positive effect. Whilst the healthy would still be at greater risk (having been confined with the infected and their fleas or lice), quarantine would limit the spread of plague between households. With either transmission mechanism, an increase in secondary infections within the household would be expected if household quarantine was enforced. But under the human ectoparasite scenario, fewer households should be infected. In chapters 3 and 4, I will test the impact of household quarantine on total mortality and interpret the results with reference to this debate.

The transmission mechanism is not the only debated proposition on which claims about the effectiveness of quarantine rest. A second is that surges in plague activity in Europe, as well as England specifically, required reimportation from outside. This is important for explanations of the 'retreat' and disappearance of plague from Europe (but not the Levant) in the later 17th and 18th centuries which emphasise the role of human interventions in preventing its arrival.[63] Since early historians of plague like Charles Creighton identified repeated surges in plague activity, many historians have supported a model of repeated re-introductions of plague to Europe from an external plague reservoir over the course of the Second Pandemic.[64] Slack neatly summarises this view that plague spread in 'broad tides of infection moving from the eastern Mediterranean across the whole of Europe.'[65] Yet macro studies of plague dynamics and phylogenetic analyses of *Yersinia pestis* most often conclude plague circulated within Europe for much of the Second Pandemic.[66] These studies sometimes claim plague continuously circulated among humans or within one or multiple rodent reservoirs.[67] Moreover, even those studies which identify multiple re-introductions find they are too infrequent to explain individual plague surges.[68] These results may undermine the hypothesis that quarantines prevented the importation of fresh waves of

[63] Eckert, *Retreat*, 23; Slack, P. The Disappearance of Plague: An Alternative View. Econ Hist Rev 34, 470 (1981).

[64] Creighton, C. 2013 [1891]. A History of Epidemics in Britain from A.D 664 to the Extinction of Plague. Volume 1. Project Gutenberg https://www.gutenberg.org/cache/epub/42686/pg42686-images.html; Flinn, *Plague in Europe and the Mediterranean Countries*, 132-133; Slack, *Impact*, 68; Shrewsbury, J F D. *A History of Bubonic Plague in the British Isles*. (Cambridge, 1970), 371

[65] Slack, *Impact*, 68

[66] Eckert, *Structure*, 1; Seifert, L. *et al.* Genotyping Yersinia pestis in Historical Plague: Evidence for Long-Term Persistence of Y. pestis in Europe from the 14th to the 17th Century. *Plos One* 11, e0145194 (2016); Spyrou, M. A. *et al.* Historical Y. pestis Genomes Reveal the European Black Death as the Source of Ancient and Modern Plague Pandemics. *Cell Host Microbe* 19, 874–881 (2016); Spyrou, M. A. et al. Phylogeography of the second plague pandemic revealed through analysis of historical Yersinia pestis genomes. Nat Commun 10, 1-13 (2019)

[67] Humans: Eckert, *Structure*, 1; Humans or rodents: Ell, S. R. Immunity as a Factor in the Epidemiology of Medieval Plague. *Clin. Infect. Dis.* 6, 869 (1984); Rodents: Carmichael, A. Plague Persistence in Western Europe: A Hypothesis in Green, M (ed). Pandemic Disease in the Medieval World: Rethinking the Black Death. 2014, 157-191; Keeling, M. J. & Gilligan, C. A. Metapopulation dynamics of bubonic plague. *Nature* 407, 903–906 (2000).

[68] Namouchi, A. et al. Integrative approach using Yersinia pestis genomes to revisit the historical landscape of plague during the Medieval Period. Proc National Acad Sci 115, 201812865 (2018); Guellil, M. et al. A genomic and historical synthesis of plague in 18th century Eurasia. Proc National Acad Sci 117, 28328–28335 (2020); Schmid, B. V. *et al.2015* Climate-driven introduction of the Black Death and successive plague reintroductions into Europe. *Proc National Acad Sci* 112, 3023

plague. Consequently, alternative hypotheses based on changes in the transmission vector or the plague bacillus might be more plausible.[69]

Particularly important for this thesis are the studies arguing on theoretical and empirical grounds that English plague surges were caused by fresh spill overs from the London rat population. Using the London Bills of Mortality, Keeling and Gilligan develop a 'metapopulation model' which demonstrates spill overs of plague to human populations could have depended on the underlying population dynamics of rats in large settlements.[70] Using a large database of parish register burials extracted from Anscetry.com, Cummins et al provide empirical support for the metapopulation model by showing major plague outbreaks in London rarely began in areas near the ports, suggesting it was not imported.[71] This research calls into question the ability for quarantines to effectively prevent plague surges in England and limit their spread once they have begun. They therefore challenge explanations of the disappearance of plague from England after 1667 and Europe in the 18th century which point to the implementation of ship quarantines. Chapter 2 tests this by mapping the origins and diffusion of major plague surges in early modern England.

Are Mortality Patterns Consistent with Successful Interventions?

Existing studies of plague's diffusion over successive outbreaks may suggest quarantine reduced the impact of plague in early modern England. To understand the dynamics of plague, early scholars complied chronologies of plague occurrences from a wide variety of sources without systematically accounting for changes in the availability of sources over time.[72] Improving on this, Slack conducted county studies of crisis mortality using parish registers in Devon and Essex.[73] Utilising a single source, Slack was able to account for changing availability to provide a much clearer sense of the proportion of parishes affected in each surge of plague. For Devon, he found plague generally became less pervasive over time, though with variation from outbreak to outbreak.[74] His results appear to correspond to Wrigley and Schofield's finding that mortality patterns in the early 16th century, represent 'the last throes of a late medieval regime of widespread epidemic mortality.'[75] The pattern of declining pervasiveness of plague after this date may suggest interventions increasingly constrained the spread of plague. This is a possibility raised by Slack when noting the particularly limited spread of plague among a sample of large towns in the final outbreak in

---

[69] Konkola, K. More Than a Coincidence? The Arrival of Arsenic and the Disappearance of Plague in Early Modern Europe. *J Hist Med All Sci* 47, 186–209 (1992); Appleby, A. B. The Disappearance of Plague: A Continuing Puzzle. Econ Hist Rev 33, 161–173 (1980); Susat, J. *et al.* Yersinia pestis strains from Latvia show depletion of the pla virulence gene at the end of the second plague pandemic. *Sci. Rep.* 10, 14628 (2020); Spyrou et al, *Phylogeography*
[70]Keeling and Gilligan, *Metapopulation dynamics*, 903–906
[71] Cummins, N., Kelly, M. & Gráda, C. Ó. Living standards and plague in London, 1560–1665. *Econ Hist Rev* 69. 2016, 19
[72] Creighton, *History*; Flinn, *Plague in Europe and the Mediterranean Countries*, 132-133; Shrewsbury, *History*
[73] Slack, *Impact*, chapter 4
[74] Slack, *Impact*, 104-105
[75] Wrigley and Schofield, *Population History*, 178-9

1665-7.[76] This might help explain how a disease capable of reducing the entire English population by 30% to 45% during the Black Death (1347-52) was, by the 17th century causing national crude mortality rates an order of magnitude lower.[77]

That said, Slack's data from the Essex registers show a contrasting pattern of rising pervasiveness over the early modern period.[78] The national experience of plague is therefore unclear and so it is currently difficult to know whether state responses led to a general decline in the extent of plague's diffusion across settlements. One possible explanation for these divergent trends is that the surviving registers are not equally representative of their counties. Whilst Slack accounts for the availability of registers to calculate the proportion of parishes affected, he does not adjust these estimates to account for representativeness. Slack also finds larger populations, and particularly towns, were more susceptible to outbreaks.[79] It is therefore important to weight the observations used to calculate the proportion of parishes affected so that the distribution of population sizes in the sample is like those in the total population of parishes. In chapter 2, I will test the pervasiveness of plague in early modern England using a weighted sample of c.4000 parish registers. This will help to understand the degree to which interventions reduced the spread of plague.

A comparison between levels of pervasiveness in England, Italy and the Low Countries appears to show England was far more effective at controlling plague. Alfani found that 82% of settlements in northern Italy were affected in a plague surge between 1629-1630.[80] Likewise, Curtis finds 82% of settlements were affected by plague in the Low Countries between 1635-1638.[81] Similarly, Slack finds 80% of parishes experienced a plague in Devon during the first measurable outbreak in Devon in the 1540s.[82] However, using a stable sample containing parishes from both counties over the whole period 1565 and 1666, Slack finds 24% of settlements experienced no major plague outbreak and a further 53% only experienced 1 major outbreak.[83] This period covers 5 of the most nationally significant plague surges in the early modern period. Unfortunately, Slack does not break his findings down by surge, but if he did it would show even more clearly that the level of dispersion was much lower in England than in 17th century Italy and the Low Countries. An important objective of this thesis is to test the seemingly anomalously low level of dispersion in England and then to understand the extent to which any differences were likely the result of interventions or whether they were due to differences in human or natural environment, or differences in the biology of plague.

---

[76] Slack, *Impact*, 319

[77] Hatcher, J. *Plague,* Population, and the English Economy, 1348-1530. (London: Macmillan, 1977), 25; Wrigley and Schofield, *Population History*, 333

[78] Slack, *Impact*, 104-105

[79] Slack, *Impact*, 110

[80] Alfani, *Plague in the Seventeenth Century*, 420

[81] *Curtis, Was Plague*, 161

[82] Slack, *Impact*, 84

[83] Slack, *Impact,* 109. For a further c.20%, the existence of plague did not lead to a major epidemic but is visible using measures other than extremity of burials.

The apparent association between the severity of crises and the degree of pervasiveness could also point towards a role for human interventions. Multiple studies have found that when plague spread to a greater number of settlements, it also killed more people within each settlement.[84] For England, Slack found that burials in plague years deviated further from trend in affected parishes in Devon than Essex, whilst Devon also experienced higher incidence.[85] If quarantining infected people prevented them from spreading plague to susceptible settlements, it may also have prevented them from spreading plague to their susceptible neighbours. In regions where quarantines were better enforced, we might therefore expect fewer settlements affected and lower mortality within those settlements that did experience outbreaks. Yet, here too, other factors could be responsible. Particularly important to understand is plagues complex relationship between trade, population density, and living conditions. Plague would likely spread most easily in regions with high levels of trade integration. Many such areas in early modern Europe were also highly urbanised. These towns attracted migrants, many of whom resided in extra-mural suburbs in cramped, insanitary conditions. If, as is often thought, plague caused the highest mortality in these areas, then the link between regional pervasiveness and settlement-level severity may be mediated by socio-economic factors and not the enforcement of quarantine.[86]

Yet consistent plague severity across large English towns in the 16th century suggests population density and insanitary conditions alone could not account for this association. Whilst socio-economic groups were not neatly segregated by parish, they still represent areas for which considerable differences of wealth and poverty existed. From the mid-16th century, sufficient registers survive to compare the severity of mortality across towns. Where this has been undertaken, a consistent pattern emerges. Plague mortality was high and relatively consistent across parishes in the 16th century but deviates in the 17th century as wealthy parishes experience less extreme surges in mortality.[87] This process is sometimes characterised as plague gaining an ‘increasing hold’ over poor suburban areas.[88] But, in fact, plague maintained its hold over the poorer suburbs and lost its grip on the wealthy inner city areas.

This distinction is important for evaluating possible explanations. Some historians point to the deterioration of suburban living conditions and increasing population density as cities became more populous in the 17th century.[89] This explanation does not fit the data: levels of severity do not increase in areas of increasing population density in large English towns. This is not wholly surprising. The absence of a clear association between population density and

[84] Slack finds this in a comparison of two English counties, Devon and Essex: Slack, Impact, 104; Alfani finds the same through international comparisons, particularly between England and Italy: Alfani, *Plague in Seventeenth Century Europe*, 417-420.
[85] Slack, *Impact*, 104-105
[86] Some examples of plague severity and insanitary conditions: Wrightson, *Ralph Tailor's*, 32-33; Litchfield, R. Burr. *Florence Ducal Capital, 1530-1630.* E-book, New York: ACLS Humanities E-Book, 2008, 327 https://hdl.handle.net/2027/heb90034.0001.001.
[87] Slack, *Impact*, 121, 135; Cummins et al, *Living Standards*, 14
[88] Slack, *Impact*, 161
[89] For instance, Slack argues ‘it is probable… the suburbs of larger English towns became increasingly populous, impoverished, dirty, and therefore unhealthy.’ Slack, Impact, 165

plague severity at the settlement level is one of the most striking features of plague epidemics across early modern England, France, Italy, and the Low Countries.[90] An alternative explanation for divergent patterns of mortality would be that wealthy parishes were best able to implement costly and administratively burdensome quarantine policies. This hypothesis is strengthened by the coincidence of quarantine adoption in England around 1578 and the divergence of mortality within towns. Chapter 3 addresses this possibility through a case study of household quarantine in Bristol between 1565 and 1604.

The Mechanisms for Plague Control

Historians have thus recovered several epidemiological patterns which help to contextualise plague among the sources of instability in early modern life and appreciate why plague was responded to by adopting novel interventions. They may also indicate human efforts to control plague began to impact patterns of mortality. Even so, the kind of epidemiological patterns we are capable of reconstructing from the sources are too partial to convincingly demonstrate that interventions had an effect. We must also analyse the interventions themselves, and particularly their implementation and enforcement. We know that quarantine measures across Europe were adopted on paper. Less clear is the extent to which those regulations were enacted on the ground. There are good reasons for doubt, given the relatively low capacity of early modern states to raise and distribute resources and monitor population behaviour. Addressing this requires shifting perspective from epidemiologist to historian of public health. Doing so, forces us to consider the social and political context of early modern plague responses and therefore the institutional structures through which they were adopted, implemented, and enforced. We must also consider the ways in which ordinary people contributed to and resisted these measures as well as the motivations of elites who were ultimately responsible for guiding policy. This fusion of epidemiology and social history provides the best opportunities for understanding the consequences of plague interventions, allowing us to contribute to debates over the early origins of the decline of highly lethal infectious diseases.[91]

Plague and Public Health

European states responded to the Second Pandemic by adopting measures of prevention and containment. Existing policies targeting environmental improvements were repurposed for fighting plague. Orders were published for cleaning streets and sewers, culling animals, purifying the air by burning substances like pitch, and dredging ditches to improve the flow of fresh water. These approaches had long been used, especially in towns, to prevent the

---

[90] Slack, *Impact*, 109; *Curtis, Was Plague*, 162-165; Alfani, *Plague in the Seventeenth Century*, 417; Benedictow, O. J. Morbidity in Historical Plague Epidemics. Popul Stud 41, 401–431 (1987), 419; Biraben, J. Certain demographic characteristics of the plague epidemic in France, 1720-22. *Daedalus* 97, 536–45 (1968), 543

[91] Davenport and Smith. The early history of public health from an evolutionary perspective. 2019. Online: https://www.openaccessgovernment.org/history-of-public-health/74610/

accumulation of miasmatic air that caused disease and threatened 'communal health.'[92] More novel policies were also adopted, targeting human behaviour. Some measures were aimed at broad reductions in human movement. For instance, the cancellation of public gatherings likes feasts, fairs, and markets along with the restriction of movement through ports or city gates.[93] Others specifically targeted infected individuals along with their close contacts.[94] Targeting the infected entailed the development of elaborate systems of implementation. The infected first had to be identified before they were kept – often forcibly and at the state's expense - in isolation either at home or in specialised facilities. States responded to the Second Pandemic with a new and highly sophisticated public health invention: quarantine.[95]

The adoption of plague interventions, and particularly quarantines represent an important turning point in the history of public health.[96] They may have eventually helped exclude plague from early modern Europe, thus beginning the 'mortality transition' (an issue we will return to below).[97] Quarantines were also used subsequently to prevent the arrival of yellow fever in Europe in the 18th century and cholera and plague in the 19th century.[98] Moreover, a recent study found the reason for the absence of small pox epidemics in early modern southern England was the isolation of victims in pesthouses.[99] The invention of plague quarantines has had a profound effect on the subsequent history of public health interventions – as we know only too well given recent responses to the covid-19 pandemic. Since their first use against plague, they have remained a highly intrusive, politically, and medically contentious public health response.[100]

Whilst all behavioural interventions were heavily resented given their disastrous economic consequences, quarantining the infected and their contacts was especially controversial. Many contemporaries saw this as profoundly illiberal, anti-Christian, and economically destructive.[101] Quarantined people are known to have smashed open their padlocked doors

---

[92] Geltner, G. The Path to Pistoia: Urban Hygiene Before the Black Death. *Past Present* 246, 3–33 (2019); Geltner, G. Public Health and the Pre-Modern City: A Research Agenda. *Hist Compass* 10, 231–245 (2012); Rawcliffe, *Urban bodies*

[93] The use of preventative measures deserved systematic research. Slack's discussion in *Impact* of this topic is could be seen as contradictory since he claims the authorities ignored the existence of plague (256) and then argues they were proactive in implementing measures to prevent epidemics (257).

[94] See below for references.

[95] Crawshaw, J. S. The Renaissance Invention of Quarantine. *The Fifteenth Century XII Society in an Age of Plague* (2013)

[96] Slack, *Responses to plague*, 433; Harper, *Plague*, 386; 405

[97] Useful summary in Harper, *Plague*, 364-67

[98] Harrison, M. Disease, diplomacy and international commerce: the origins of international sanitary regulation in the nineteenth century. *J Global Hist* 1, 197–217 (2006), 199

[99] Davenport et al, *The geography of smallpox*, 75–85

[100] Harrison, *Disease*, 199; Slack, P. Perceptions of plague in eighteenth-century Europe†. *Econ Hist Rev* (2021), 5-7; Slack, *Responses to plague*, 433–53

[101] Salomons pest-house, or tovvre-royall (1630). Early English Books Online, https://quod.lib.umich.edu/e/eebo2/ A69170.0001.001/1:1?rgn=div1;view=fulltext (accessed 28 Feb 2022), 62; Shutting up infected houses as it is practised in England soberly debated (London, 1665), Early English Books Online, https://quod.lib.umich.edu/cgi/t/text/text-idx?c=eebo;idno=A60176.0001.001 (accessed on 28 Feb 2022), 6, 19; Slack, *Impact*, 232; Henderson, *Florence under siege*, 132–3; Newman, *Shutt Up*, 817–18, 823.

and assaulted state officials in attempts to resist incarceration.[102] Others attempted to quietly evade the authorities or bribe them to be released. Some were caught; many others must have got away with it.[103] As well as costly and controversial, many thought quarantines were medically dubious. They created incentives for hiding infection, fleeing (and thus spreading disease), and crucially, they endangered healthy people when they were locked up alongside the sick.[104] An anonymous London pamphleteer was speaking for contemporaries across Europe when arguing in 1665 that isolating whole households was counterproductive. 'Infection may have killed its thousands, but shutting up hath killed its ten thousands.'[105] Given their outsized impact on contemporaries and long term significance for public health policy, this thesis concentrates on measures to identify and confine infected individuals, leaving it to future historians to conduct much needed research into the additional environmental and behavioural measures adopted against the plague during the Second Pandemic.

As plague battered the 17th century European population for what would be the last great plague surge, quarantine policies had become commonplace. Implementing them required the extension or development of state apparatus for monitoring, coordination, and enforcement. The most elaborate systems were those of the Italian city states where permanent medical police had been established that managed the response to plague when an epidemic broke out and otherwise gathered information on outbreaks elsewhere, to prevent suspected people entering their jurisdictions.[106] In England, plague responses were coordinated through existing state functionaries - the justices of the peace and parish-level officers.[107] To supplement donations by other towns and city elites, taxes to fund quarantine were raised using existing assessments from the lay subsidy returns.[108] Churchwardens or the justices themselves managed the funds, whilst constables and overseers ensured isolation was enforced.[109] Parish clerks recorded the burials in parish registers, in some cases distinguishing those from plague in the margins.[110] Parishes also employed additional staff for searching and burying bodies, nursing the sick, and watching the doors of infected households.[111] During an epidemic, ordinary parish officers (mostly volunteers from the local

---

102 Slack, *Impact*, 298; Tomic, Z. B., and Blazina, V., *Expelling the Plague: The Health Office and the Implementation of Quarantine in Dubrovnik, 1377–1533* (Montreal, 2015), 14.
103 Newman, *Shutt Up*, 821
104 *Shutting up infected houses*, 9–10.
105 *Shutting up infected houses*, 9–10.
106 Cliff, A. D., Smallman-Raynor, M. R. & Stevens, P. M. Controlling the geographical spread of infectious disease: plague in Italy, 1347-1851. *Acta Medico-historica Adriatica Amha* **7**, 197–236 (2009)
107 Slack, *Impact*, 212; 256-260
108 Slack, *Impact*, 279-283; Also see chapter 3 for use of subsidy assessments in Bristol in 1603-4.
109 Slack, *Impact*, 270-271; Newman, *Shutt Up*, 817-818
110 Harding, V. "And one more may be laid there": the Location of Burials in Early Modern London. *Lond J* **14**, 112–129 (2013), 117
111 Slack, *Impact*, 270-276; Munkhoff, R. Searchers of the Dead: Authority, Marginality, and the Interpretation of Plague in England, 1574–1665. *Gend Hist* **11**, 1–29 (1999); Munkhoff, R. Poor women and parish public health in sixteenth-century London. *Renaiss Stud* **28**, 579–596 (2014); Thorpe, L. 'At the mercy of a strange woman' Plague Nurses, Marginality, and Fear during the Great Plague of 1665. In Hopkins, L & Norrie, A, (eds) Women on the Edge in Early Modern Europe. (Amsterdam, 2022); Newman, *Shutt Up*, 820; Champion, J., *London's Dreaded Visitation: The Social Geography of the Great Plague in 1665* (London, 1995), 93-97.

community on annual tenures) were responsible for ensuring quarantine regulations – and their associated activities – were implemented.[112]

Isolation either took place at home or in specialised plague hospitals known as Lazarettos or pesthouses. Before an individual could be isolated, however, they had to be identified as a plague victim. This occurred either through incentives to self-report or inform on one's neighbours or through the work of paid officers (in England called 'searchers'). Household quarantine was either used for contacts of the infected, like in Florence in 1630.[113] Or for the sick and their contacts combined, as was the norm in early modern England. It was the English model of shutting up the sick with the healthy that provoked the greatest consternation. In either model, the state provided necessities to those households (almost always the majority) who could not support themselves without working and paid for it through general taxation.[114] Lazarettos were established widely in Italy, France, and many major European cities as places for the isolation and care of infected individuals.[115] In some cases, these were vast permanent structures capable of housing thousands of people. Whilst we know pesthouses were also a feature of English plague responses, their precise purpose has never been systematically investigated. Some historians have viewed them as 'fashionable schemes that never had any chance of success' because they appear to have been too small.[116] Yet, this interpretation is at odds with numerous contemporary evaluations claiming they were 'verie useful and beneficial' or 'right honorable and christian prouisiōn[s].'[117] The purpose of English pesthouses will be investigated for the first time in chapter 5.

National vs Local Policy Development

Quarantine policies were first developed in Ragusa (Dubrovnik) in 1377 and spread early to Venice and then other powerful Italian city states.[118] Following Venice in 1423, permanent Lazeretti were established in numerous Italian cities during the 15th century including Milan (1448), Naples (1464), and Genoa (1467).[119] Quarantine policies had also been adopted in France, Spain, and German cities by the mid-15th century at the latest given it is at this date

---

The history of plague would benefit from a systematic investigation into the background of watchmen, doorkeepers, and buriers of the dead.

112 Braddick, *State Formation,* 104; Archer, I W. *The Pursuit of Stability: Social Relations in Elizabethan London*. Cambridge: Cambridge University Press, 1991, 63-74

113 The same occurred in Venice: Crawshaw, J S., *Plague Hospitals: Public Health for the City in Early Modern Venice* (Farnham, 2012), 3

114 Palmer, R J. 'The Control of Plague in Venice and Northern Italy 1348–1600' (Univ. of Kent Ph.D. thesis, 1978), 35

115 See below for chronology.

116 Quoted from Slack, *Impact*, 277; Similar points in Wilson, F P. Plague in Shakespeare's London. (Oxford, 1927), 82-83 and Bell, The Great Plague in London in 1665. (London, 1924), 88-89

117 Bamford, J. A Short Dialogue Concerning the Plagues Infection. Published to preserve bloud, through the blessing of God (London, Richard Boyle, 1603). Early English Books Online, https://quod.lib.umich.edu/e/eebo/A03264.0001.001?view=toc (accessed on 26 Sep 2023)
, 29; McConaghey, R. M. S. Epidemiology in Devon*. *Brit Med J* 2, (1957), pp.1296-7

118 Tomić and Blažina, *Expelling the Plague,* 3

119 Crawshaw, *Renaissance Invention*, 163

we find the first evidence for the establishment of pesthouses.[120] For Switzerland, England, Denmark, Sweden, Finland, and the Low Countries, the earliest evidence for the use of quarantine dates to the 16th century.[121] By this time, the city states of the Mediterranean had developed sophisticated institutions to manage their quarantine systems. By the end of the 16th century, Ragusa, Venice, Milan, Genoa, and Florence had established permanent boards of health and medical police which coordinated a vast range of activities to prevent and manage the spread of plague.[122]

The character of quarantine adoption in different parts of Europe reflected internal balances of power and differing processes of state formation. In areas with high degrees of urban autonomy, like 15th century Spain, France, Germany, and above all Italy, quarantine measures were initiated by local authorities with little central government direction.[123] Only during the later 16th century did the Spanish monarchy begin to coordinate plague interventions and mediate between local authorities with competing interests.[124] By the mid-17th century the French and Spanish monarchies were intervening in the local plague responses – stipulating quarantine policy and evaluating local government implementation.[125] By the 18th century, newly powerful and bureaucratic central states in the Low Countries, Sweden, France, and Spain were assuming unprecedented responsibility for controlling plague in the localities, including sending troops to manage responses directly.[126] The process of state formation thus fundamentally altered the nature of plague responses in Europe by shifting management and coordination responsibilities away from local authorities and towards central authorities with wider jurisdictions.

England was a laggard in the adoption of quarantine policies, but a leader in their centralisation and nationalisation due its highly centralised state.[127] The first evidence of the use of quarantine in England dates to 1518 when the central government sought to ensure all

---

[120] Murphy, N. Plague Hospitals, Poverty and the Provision of Medical Care in France, c. 1450–c.1650. *J Soc Hist* (2021), 3; Huguet-Termes, T. 'Madrid hospitals and welfare in the context of the Habsburg empire' in Teresa Huguet-Termes, Jon Arrizabalaga and Harold J. Cook (eds), Health and medicine in Habsburg Spain: agents, practices, representations (London, 2009), p. 68; Risse, G B. Mending Bodies, Saving Souls: A History of Hospitals (Oxford, 1999), 203

[121] Waldis, V. 'Hospitalisation und Absonderung in Pestzeiten – die Schweiz im Vergleich zu Oberitalien', Gesnerus, 39 (1982), 71–8; Kinzelbach, A M. Hospitals, medicine and society: southern German imperial towns in the sixteenth century, Renaissance studies, 15:2 (2001), 217–28; Porter, R. (ed.), Cambridge illustrated history of medicine (Cambridge, 1996), 210; Claudia Stein, Negotiating the French pox in early modern Germany (Aldershot, 2008), p. 82; Slack, *Impact*, 202-204; Christensen, P. In these perilous times: plague and plague policies in early modern Denmark, Medical History, 47:4 (2003), p. 437; Kallioinen, *Plagues and Governments*; Van Andel, M. 'Plague regulations in the Netherlands', Janus, 21 (1916), 431.

[122] Cipolla, *Flighting Plague*, 5; Tomić and Blažina, *Expelling the Plague*, 3; Palmer, *Control*, ii.

[123] Christensen, *In These Perilous Times*, 433

[124] Wilson Bowers, K. Plague and Public Health in Early Modern Seville. (Rochester: University of Rochester Press and Woodbridge: Boydell and Brewer, 2013), 90

[125] Bowers, *Plague and Public Health*, 90; Murphy, *Plague Hospitals*, 5

[126] Ermus, C. The Spanish Plague That Never Was: Crisis and Exploitation in Cádiz During the Peste of Provence. *Eighteenth-cent Stud* 49, 169 (2016); Ermus, Cindy. "The Plague of Provence: Early Advances in the Centralization of Crisis Management." Environment & Society Portal, Arcadia (2015), no. 9. Rachel Carson Center for Environment and Society; Kallioinen, *Plagues and Governments*, 42-44; Christensen, *In These Perilous Times*, 433

[127] Christensen, *In These Perilous Times*, 433

infected Londoners were identified so they could be separated from the susceptible public.[128] In the same year, this policy was also adopted in Oxford and household quarantine was introduced in Windsor on the King's orders.[129] In 1578 the Privy Council issued Europe's first national plague regulations outside Italy.[130] These were supported by The Plague Act (1604) which provided for stricter punishments to aid enforcement and greater revenue raising powers.[131] Their central policy was a rigorous household quarantine for all household members once one person became sick. It would last until six weeks had passed since the final infected person had either recovered or died. Responsibility for implementation was given to Justices of the Peace in the counties and their urban counterparts. The early adoption of a national quarantine policy reflects England's precocious state development.

In contrast to much of Europe, English quarantine policies have thus been described by Slack as central government initiatives. Denmark is the only country for which the same pattern of late adoption, driven by central government has also been identified.[132] Though whilst in Denmark there is direct evidence of central government demanding local towns councils implement household quarantines from the 1580s, in England there is little evidence of central pressure for quarantine adoption prior to 1578, at least outside of London.[133] Slack suggests members of the central government (like Thomas More and William Cecil) influenced local government adoption through informal pressure, but more evidence is needed to confirm this, particularly in the case of English pesthouses.[134] Pesthouses were established in England from the 1530s, but they were not required as an alternative to household isolation in national regulations until the Plague Orders were substantially revised in 1666.[135] Moreover, Slack claims central government influence is discernible from the location of some early pesthouses in strategically important cities but does not mention the failure of the national government to suggest the establishment of a pesthouse to the London authorities until the end of the 16th century (when many far less important towns had long since established them).[136] Through investigations of household quarantine enforcement over time, and the chronology and geography of pesthouse establishment, this thesis will reassess the autonomy of English local authorities in responding to plague before and after the publication of the national plague orders in 1578.

---

[128] Slack, *Impact*, 201
[129] Slack, *Impact*, 201; Roger, E. C. 'To Be Shut Up': New Evidence for the Development of Quarantine Regulations in Early-Tudor England. *Soc Hist Med* 33, 1077–1096 (2019), 1085
[130] Orders, thought meete by Her Maiestie, and her priuie Councell, to be executed throughout the counties of this realme, in such townes, villages, and other places, as are, or may be hereafter infected with the plague, for the stay of further increase of the same (London, 1578?). https://wellcomecollection.org/works/c3h938yb (accessed 19 May 2022).
[131] Slack, *Impact*, 209-211. This was temporary legislation that was generally renewed with each parliament.
[132] Christensen, *In These Perilous Times*, 433
[133] Christensen, *In These Perilous Times*, 437
[134] Slack, *Impact*, 202-4
[135] Slack, *Impact*, 203-4, 223; Rules and orders to be observed by all justices of peace, mayors, bayliffs, and other officers, for prevention of the spreading of the infection of the plague: Published by His Majesties special command (London, 1666). https://wellcomecollection.org/works/pfrmrkyv (accessed 29 September 2023)
[136] Slack, *Impact*, 203-4

The Motivations for Policies Targeting the Infected

This thesis will also consider whether quarantine policies were motivated by the desire to improve public health or ensure order and extend control over populations. Beginning in the 1970s with the work of Pullan, historians argued urban elites and medical authorities, concerned with increasing levels of urban poverty, came to perceive the poor and marginal as a threat to social order and as the chief sources of plague epidemics.[137] The outcome of this association was the development of plague regulations, particularly household quarantine, which were 'designed with the poor in mind', in Slack's memorable phrase.[138] Carmichael went further, suggesting it was the desire to control 'the poor and the property-less' that led to the development of policies to control plague.[139] The relationship between scapegoating, hatred, and violence towards the 'other' has also become an important theme in the broader historiography of pandemics.[140] Several historians have argued plague strategies were not only developed to target the threat of the poor, marginal, and potentially disorderly, but were also enforced unevenly, in ways that reflected the desire to control and discipline these groups.[141] These explanations give credence to Michel Foucault's notion of 'plague as a form of disorder' and quarantine as a system of discipline, underpinned by invasion, surveillance, and threats of punishment.[142]

Foucault also argued the 'rituals of exclusion' developed around leprosy provided the model for later mass quarantines for plague victims.[143] Palmer repeats this connection, but associates it with contemporary understandings of disease, rather than the development of structures of power. He claims medieval understandings of 'contagion' in relation to leprosy were later applied to plague. The Italian states thus used 'the isolation of lepers [as] a model for the isolation of the plague stricken' to reduce transmissions between people.[144] From this perspective, plague quarantines were motivated by the desire to control infection, not people, per se, or ensure the maintenance of social order. Yet whilst disused leper houses in Italy were sometimes repurposed as isolation facilities in plague epidemics, the conceptual link between the contagiousness of plague victims and lepers may be undermined by Rawcliffe's

---

[137] Pullan, B., *Rich and Poor in Renaissance Venice* (Oxford, 1971); Pullan, B., 'Plague and Perceptions of the Poor in Early Modern Italy' in T. Ranger and P. Slack eds *Epidemics and Ideas* (Cambridge, 1992); Henderson, J., 'Historians and plagues in pre-industrial Italy over the longue durée', *History and Philosophy of the Life Sciences*, 25 (2003); Carmichael, A., *Plague and the Poor in Renaissance Florence* (Cambridge, 1986), 125; Slack, *Impact*, p. 306. Similarly, Newman argues the government had 'incorporated moral judgements about the poor and unsettled' into its quarantine policy. (Newman, *Shutt Up*, 828.) The relationship between scapegoating, hatred, and violence towards the 'other' is an important theme in the broader historiography of pandemics. (Sontag, S., *Illness as Metaphor* (London, 1979); Nelkin, D., and Gilman, S. L., 'Placing Blame for Devastating Disease', *Social Research* 55 (1988); Cohn, S. K., 'Pandemics: waves of disease, waves of hate from the Plague of Athens to A.I.D.S', *Bulletin of the Institute of Historical Research*, 85 (2012))

[138] Slack, *Impact*, 306

[139] Carmichael, *Plague and the Poor*, 125

[140] Sontag, *Illness as Metaphor*; Nelkin and Gilman, *Placing Blame*; Cohn, *Pandemics*

[141] Slack, *Impact*, 306–7; Carmichael, A., 'Plague Legislation in the Italian Renaissance', *Bulletin of the History of Medicine*, 4 (1983), 522–3; also, Henderson, *Historians and Plagues*

[142] Foucault, *Discipline and Punish*, 197-8; For a summary of this strand of argument see Watts, S. J. *Epidemics and History: Disease, Power, and Imperialism*. (New Haven, 1997), 2,16-17.

[143] Foucault, *Discipline and Punish*, 198

[144] Palmer, *Control*, 26

claim that 'contagion' in the context of medieval leprosy is often wrongly equated with the modern definition.[145] She argues 'contagion' was also used to describe hereditary and congenital transmission.[146] Moreover, lepers were apparently less isolated than has often been thought. Leper houses were located near city gates and on major thoroughfares and lepers themselves were allowed to maintain contact with their communities and attend mass.[147] So, the degree to which plague isolation should be seen as a development of earlier policies aimed at lepers requires further investigation.

Some historians have explained the emergence of plague quarantines as new expressions of Christian charity and as spaces for the extension of medical treatment.[148] In her study of early quarantine policies in Ragusa, Milan, and Venice, Crawshaw finds 'quarantine… evolved into a structure for providing, distributing, and demonstrating charity and for facilitating the practice of medicine' – particularly inside the lazaretti.[149] Similarly, where previous generations of historians characterised pesthouses as places for 'incarceration' of the poor, Murphy emphasises their function as sites for the provision of care. He suggests the poor were prioritised because they lived in crowded conditions with little prospect of at home medical support.[150] But whereas charity and care have been associated with continental plague responses, the literature on English responses has consistently taken a negative view, emphasising their harshness and their exclusionary character.[151] There are a couple of recent exceptions. Newman shows households of middling artisans and gentlemen were also quarantined in Westminster in 1636, yet since she does not have an independent measure of the number of households infected, she cannot establish whether there were biases in enforcement.[152] In a study of the use of pesthouses in London, Columbus provides some evidence to suggest English pesthouses may also have cared for their patients, though the extent to which this was the case remains to be investigated.[153] This thesis will systematically investigate the levels of medical care in English pesthouses for the first time. It will also develop a novel approach to measuring the degree and social distribution of household quarantine enforcement.

Implementation and Enforcement

The greatest barrier to understanding the degree to which plague regulations were enforced is the challenge of measuring changes in population behaviour. Several studies analyse enforcement using either laws and proclamations or official sources that were generated

---

[145] The claim that pesthouses were sometimes former leper houses can be found in: Risse, *Mending*, 190
[146] Rawcliffe, C. Leprosy in Medieval England (Woodbridge, 2006), 90
[147] Rawcliffe, *Leprosy in Medieval England*, 7
[148] Crawshaw, *Renaissance Invention*, 172–3; Newman, *Shutt Up*, 826; Murphy, *Plague Hospitals*, 2; Henderson, *Florence under siege*, 183–6, 226–8.
[149] Crawshaw, *Renaissance Invention*, 172
[150] Murphy, *Plague Hospitals*, 7
[151] Grell, O. P. Plague in Elizabethan and Stuart London: The Dutch response. *Med Hist* **34**, 424–439 (1990), 426; Wilson, *Plague in Shakespeare's*, 84; Slack, *Impact*, 277
[152] Newman, *Shutt Up*, 816–17, 824, 827
[153] Columbus, A. 'To Be Had for a Pesthouse for the Use of This Parish': Plague Pesthouses in Early Stuart London, c. 1600–1650. *Urban history* (2022), 6

through the enforcement process.[154] The wide adoption of quarantine regulations across Europe, especially by the 17th century, and the often-draconian punishments associated with infringement might suggest high levels of enforcement.[155] However, laws and proclamations only reflect the intentions of the authorities; they do not reflect what was achieved on the ground. The survival of detailed lists of disbursements to quarantined households allows scholars like Slack and Newman to investigate the degree of implementation more precisely. These studies reveal in impressive detail the broad use of quarantines within communities, the range of personnel employed to enforce them, and the substantial costs these systems entailed.[156] Yet, these sources are very rare and potentially represent only well administered and wealthy localities; they cannot reveal the general level of enforcement. They also cannot provide information on the degree to which all infected households were quarantined because infected households that were not quarantined do not feature in these lists. It is therefore difficult using these documents to independently evaluate the state's attempts to change behaviour by preventing contact or to measure the degree of social bias in the implementation process.

Historians including Slack, Wrightson, and Henderson powerfully reveal independent perspectives of quarantine enforcement by analysing court depositions and private correspondences.[157] Using incidental information from court depositions, Wrightson reveals how quarantined people in Newcastle in 1636 made their wills by dictating to scriveners standing outside windows and on the other side of locked doors.[158] He also reveals how strict quarantine was softened by people using their back doors or climbing through windows.[159] Slack and Eckert cite direct contemporary descriptions of quarantine enforcement finding evidence for evasion, laxity, and partial or full-scale breakdowns in authority.[160] However, contemporary descriptions and court depositions tend to be unsystematic, prone to exaggeration, and difficult to measure and compare across time and space. Henderson has performed the most systematic analysis of enforcement using mortality data for multiple outbreaks in 17th century Italy. He argues the exceedingly high proportion of all deaths occurring at plague hospitals in Florence, Pistoia, and Rome suggests enforcement was very strong.[161] Yet in other major Italian cities, such as Venice, Prato, and Padua, enforcement looks much weaker and the same is likely to be true elsewhere on the Italian peninsula, where

---

[154] E.g. Newman, *Shutt Up*, 816–17; Bowers, *Plague and Public Health*, 57; Tomić and Blažina, *Expelling the Plague*, chapters 5–6. Eckert discusses several similar studies of central European plague responses. See: Eckert, *Structure*, chapter 4

[155] Tomić and Blažina, *Expelling the Plague*; Eckert, *Structure*, 24–34; MacKay, R., *Life in a Time of Pestilence: The Great Castilian Plague of 1596–1601* (Cambridge, 2019); Christensen, *In These Perilous Times*, 439-442

[156] Slack, *Impact*, 276-283; Newman, *Shutt Up*, 819-821

[157] Slack, *Impact*, 278–9; Wrightson, *Ralph Tailor's*, 48–9; Eckert, *Structure*, 24; Calvi, G., *Histories of a plague year. The social and the imaginary in Baroque Florence*, translated by Dario Biocca and Bryant T. Ragan Jr (Oxford, 1989); Parets, M., and Amelang, J. S. A., Journal of the Plague Year: The Diary of the Barcelona Tanner Miquel Parets, 1651 (New York, 1991); Brockliss, L. W. B and Jones, C., *The Medical World of Early Modern France* (Oxford, 1997).

[158] Wrightson, *Ralph Tailor's*, 48-9

[159] Wrightson, *Ralph Tailor's*, 48-9

[160] Slack, *Impact*, 278–9; Eckert, *Structure*, 24–34

[161] Henderson, *Florence under siege*, 130

measures were more ad hoc.[162] This thesis will build on Henderson's approach, by using mortality data to develop independent and systematic evaluations of enforcement in early modern England which can be compared directly with his results for Italy.

Thesis Outline

The structure of this thesis broadly reflects the structure of the introduction. First, I will analyse the epidemiological context of plague and other major sources of mortality crises in early modern England. I will also seek to explain the patterns of plague incidence and severity that emerge. After the dynamics, I turn to different aspects of plague responses over three chapters, two of which are concerned with measuring the enforcement of household quarantine and the final chapter with the establishment and use of pesthouses as alternative sites of isolation and care. Finally, I will conclude by considering the broad implications of these four substantive chapters for a several of the themes drawn out in the preceding historiographical discussion. These include patterns of mortality and probable transmission mechanisms, the impact of human interventions on mortality, the relative influence of central and local authorities in shaping policies and their implementation, the contribution of the broader public, and the motivations of these actors in mounting resistance against plague using the institutions of the state. Before turning to the dynamics of plague, I will briefly outline in greater detail the contents of each substantive chapter.

Chapter 2 asks two questions. The first is mainly descriptive: 'what were the dynamics of plague in early modern England?' This will establish the essential context for the chapters on responses and illuminate why plague, along with harvest failure, was selected by contemporaries as a source of instability to be controlled through state intervention. At the centre of this analysis is a new dataset of monthly burial counts covering around 4,000 English parishes between 1538 and 1667. It is the product of kind donations of digitised burial data from genealogical organisations and historians. This data is combined with a range of pre-existing datasets on town population sizes, parish maps, port towns, and the locations of principal roads and navigable rivers. I develop a systematic approach to the identification of plague surges at the national level and localised epidemics at the settlement level. This allows for the analysis of plague dynamics over a wider area and with greater precision than many previous studies.

The resulting analysis is guided by the second question: 'to what extent were the patterns of plague shaped by direct human action, and the human and natural environment?' I argue there was an essential stability in the structure of mortality across 7 of the major plague surges that occurred in early modern England. Whilst the human and natural environments fundamentally shaped the dynamics of plague, there is little evidence at the aggregate level that domestic plague responses had significant impact. One of the main reasons for this is the central role played by London in disseminating plague through the trade network, and particularly through the navigable rivers and coastal shipping networks. As chapter 4

[162] Henderson, *Invisible Enemy*, 266

suggests, quarantine was never implemented strictly enough in London to prevent it acting as a potent source of plague. That said, the very heightened vulnerability of ports and the early patterns of dissemination outside the capital strongly suggest it was not always the sole originator of plague surges. This indicates ship quarantines could have successfully kept plague from England after 1664-5. Moreover, the peculiarly low levels of dispersion in England relative to Italy and the Low Countries (and relative to English medieval plagues), may indicate local preventative efforts consistently reduced the spread of plague, particularly along roads, though this requires further research.

Having set out the epidemiological context and presented the evidence against the successful domestic control of plague, I conduct a case study of household quarantine enforcement in the vitally important city of Bristol. Chapter 3 thus investigates the scale and distribution of enforcement, both at the parish and household levels and evaluates claims that household quarantine was motivated primarily by a desire to control the poor rather than the plague. The burial register evidence from 9 of the 18 Bristol parishes is combined with detailed records of the location, household structure, and wealth of the population of one central parish, Christchurch. The quantitative sources are also combined with qualitative records from the town council and guilds to provide a rounded portrayal of the implementation and enforcement of household quarantine in 1603-4. Using the degree to which burials were clustered into household groups in each epidemic, I find strong evidence for enforcement in 1603-4. Wealthy central parishes were generally more capable of controlling population movement, probably due to their size, available resources, and concentration of city elites.

Building on the success of the clustering methodology for identifying quarantine enforcement, in chapter 4, I measure the change in clustering across 56 parishes within 21 English settlements during the 7 plague surges defined in chapter 2. This chapter is structured like a traditional scientific paper. To maximise statistical rigour, I use a fixed effects regression model and run ‘placebo’ tests to account for additional potential drivers of changes in clustering over time. The results show household quarantine was widely enforced outside London. Once other drivers of clustering are accounted for, there is very little evidence the London authorities managed to control population behaviour effectively enough to change the distribution of burials. Comparing the regression results to a well-documented case of quarantine enforcement in Salisbury in 1604 reveals it was not as exceptional as the survival of the records that describe it. Yet, the analysis of clustering also suggests thorough records do not fully indicate the degree of enforcement, with other epidemics for which no documentary evidence survives showing greater levels of control over population behaviour. Overall, this chapter reveals evidence of vigorous, yet imperfect enforcement and therefore highlights the very considerable challenge early modern states faced in limiting the spread of plague.

After studying quarantine enforcement using a highly statistical approach, I use the final substantive chapter to portray a more nuanced, colourful, and personal image of plague responses through the first systematic analysis of English pesthouses. The analysis rests on a wide survey of primary printed and secondary literature alongside evidence gleaned from the richest known manuscript sources. The results challenge several fundamental assumptions about pesthouse use in England. Contrary to existing historical opinion, pesthouses were used extensively, with the peak of establishments around 1600. Also, they almost always remained part of local plague responses after they were first used. Moreover, pesthouses were primarily established by local authorities acting upon their own initiative, national regulations mandating the use of pesthouses appearing 60 years after the peak of establishments. The heavy bias towards establishment in eastern towns located on navigable rivers or on the coast suggests local magistrates were influenced by European practices. Though, the coincidence of pesthouse establishment and the publication of the first household quarantine regulations suggests the regulations created new responsibilities and imperatives for establishment. The analysis of the patients, staff, and activities of the pesthouses suggests the authorities used them as sites for the treatment and care, as well as isolation, marginal people who were, or had been, rendered incapable of receiving care whilst isolated at home. This is a much kinder interpretation of facilities that are sometimes portrayed as little more than prisons for the infected.

The broad conclusion of this thesis is that local English communities invested heavily in resisting the plague and mitigating its effects. The policies recorded on paper were enforced in many areas with sufficient vigour and upon a sufficiently broad section of society as to leave an indelible mark upon the patterns of burials recorded in many parish registers. Whilst the patterns of plague at the national level do not suggest a great deal of success in controlling the disease, the local records of response show an intense and generally committed struggle against infection. People from across society were involved: the town and parish elites devised and adopted policies, the broad mass of middling householders paid for their implementation, and some of the poorest parishioners worked as the nurses and watchmen for the provision of care and the enforcement of quarantine. The clear pattern of increased burial clustering is a stark reminder of the brutal character of household quarantine, but we should not forget the scale of the threat posed by bubonic plague. And still, the authorities incorporated into their plague strategies a basic level of care for those who could not rely on their fellow householders through the institution of the pesthouse.

Uncovering the motivations of those who contributed to this struggle against plague is a treacherous business, particularly since they are bound to be almost as numerous as the people involved. Yet it does appear that there was a kinder, more charitable impulse contributing to the implementation of plague responses than some of the existing literature allows. It has also proven very hard to find evidence that this system was primarily concerned with controlling the potentially disruptive poor as opposed to the infected. This dynamic portrayal of plague and plague responses, therefore, reflects the range of contributions, motivations, and consequences that would define subsequent societal efforts to control infectious disease. Shaped, as they were, by the experience of plague.

Chapter 2. The Dynamics of Plague

Introduction

Bubonic plague was the most consistent cause of major mortality crises in early modern England. There were at least 12 plague surges in the c.130 years between 1538 and 1667. Using a new dataset covering around 4,000 English settlements and containing around 10 million individual burials, I describe the dynamics of these outbreaks with new levels of precision and geographical breadth. The analysis builds on Slack's ground-breaking case studies of Essex and Devon over roughly the same period by studying a wider geographical area and employing additional data on settlement population sizes and the locations of ports, navigable rivers, and principal roads.[163] This helps contextualise the plague responses analysed in subsequent chapters. But as well as describing the impact of plague on English society, I also demonstrate how the natural and human environment of early modern England shaped the dynamics of plague. In doing so, I provide new evidence that contributes to four big debates in the history of plague: the scale of its demographic impact, the role of rats as a transmission vector, the international origins of successive surges of plague activity, and the degree to which interventions assisted in the 'retreat' of plague in the 17th century.[164]

Plague's dynamics changed little between 1538 and 1667. I show it was consistently a disease of large, densely populated, wealthy, and well-connected settlements. It had a predilection for the warmer southern regions, ports, and settlements located on navigable waterways. For all these reasons, plague was most active in London and its hinterlands, especially those connected by the Thames. By international and historical standards, early modern England was highly fortunate. Even in the worst years, plague at most doubled crude death rates, killing an additional 3% of the population. This is mostly because plague struggled to leave its preferred niches and consequently affected no more than 8% of settlements over a 2–5-year surge in activity, despite travelling to distantly located settlements. Small rural settlements were particularly protected from experiencing an outbreak, but severity could be very high when they did. All this contrasts sharply with the much more severe medieval and contemporary European outbreaks where plague spread very widely, affecting large and small settlements alike, and therefore raises questions about the causes of these differences.

Whilst I do not pretend to offer a comprehensive explanation, climate and economic integration emerge as two key variables. Along with the evidence linking plague to water transportation and the contrast between the incidence of plague and influenza, these findings suggest the presence of the black rat (also known as the ship rat) was necessary to begin an epidemic. Yet by revealing the still heightened vulnerability of settlements located on principal roads, I suggest some form of human-to-human transmission is likely, probably the carriage of rat fleas in goods and clothing. Moreover, the importance of ports as sources of

[163] See: Slack, *Impact*, chapter 4
[164] See literature review for full discussion of these issues.

inland epidemics and the early spread of plague among settlements connected to water but distant from London confirms the perceptions of contemporaries that the origins of plague surges were foreign. As well as contradicting those who argue plague surges were generated from London, this finding supports the key assumption of Slack's theory that ship quarantine explains the disappearance of plague after 1667 by breaking England's connection. with the pan-European system of plague.[165]

The Raw Dataset

This chapter analyses a novel dataset containing aggregated monthly burial totals covering more than 4,000 of the c.10,000 English parishes between 1538 and 1667. The data was originally recorded in parish registers which were made compulsory in 1538 by Thomas Cromwell.[166] The dataset was assembled from databases held by several entities that digitise manuscript registers for genealogical purposes. These include ancestry.com and many family history societies which collect and manage genealogical data for individual counties.[167] The data also includes all parishes analysed by Wrigley and Schofield and Cummins et al.[168] The data was donated in a range of formats. Dates and parish names were then standardised and where individual-level data was provided, this was aggregated to the monthly level (later chapters exploit the individual level data). The dataset contains 112 (3%) multi-parish settlements (generally large towns). Since the settlement is the primary unit of interest, multi-parish settlements are treated as a single unit. Where plague is identified in one parish, the settlement is deemed to have experienced an epidemic. Similarly, parish-level severity figures are averaged across all parishes to arrive at settlement-level severity.

Whilst parish registers are an incomparably rich source of burial data with unrivalled spatial reach, the data they contain is sometimes poor quality. The quality of the data used here may have been further weakened by errors during the transcription process. So, before the burial data can be analysed, it must be evaluated, and periods of poor-quality data flagged and removed. This is achieved using a modernised version of the defective registration strategy employed by Wrigley and Schofield.[169] Appendix 1 contains a detailed discussion of this approach. Briefly, periods of poor-quality data are identified probabilistically by evaluating groups of months for which a total number of burials is predicted to have occurred using earlier data. If the actual number of burials falls below what is expected 99% of the time, this period is defined as defective. This approach occurs iteratively with each new iteration ignoring flagged periods of high and low burials from the calculation of expected burials used in the next round. Finally, the beginning and end of defective periods are identified by

---

[165]Keeling and Gilligan, *Metapopulation dynamics*, 903–906; Cummins et al, *Living Standards*, 19; Slack, *Disappearance*, 469

[166] Gordon, A. The Paper Parish: The parish register and the reformation of parish memory in early modern London. *Mem Stud* 11, 51–68 (2018), 53

[167] I am particularly grateful to Romola Davenport at CAMPOP and Cliff Webb for donating large segments of the data used in this chapter along with the family history societies of Berkshire, Buckinghamshire, Essex, Kent, Manchester and Lancashire, Northumberland and Durham, Oxfordshire, and Shropshire for their kind donations.

[168] Wrigley and Schofield, *Population History*; Cummins et al, *Living Standards*.

[169] Wrigley and Schofield, *Population History*, Appendix 12

evaluating each month within the flagged period by comparing it on an individual basis to expected levels of burials. This approach reveals about 18% of months in the full dataset to be defective (see table 1.1). These periods are discarded from the analysis.

Settlement Characteristics

Table 1.1 provides a full description of the dataset analysed in this chapter (excluding northern regions for reasons discussed below). This shows the dataset contains a total of 3.8 million months of burial data observed across 3,731 settlements. Of these, 3.1 million months contain data of a sufficient quality to be analysed (not defective). Table 1.1 enumerates months containing mortality crises of differing lengths and plague months specifically. These are discussed in depth below. Table 1.1 also describes the characteristics of settlements that will be analysed in relation to plague epidemics – their size, function, and geographical position. The categories of settlement size for towns are static estimates that describe the relative position of settlements using an average of population estimates around the middle of the study period. Major towns are defined as those with a population of more than 10,000 people; regional towns as those with a population between 2,500 and 10,000; market towns those with less than 2,500 people. No data is available for the population of rural settlements, so they were divided according to whether they experienced an average of 6 burials per year during the 17th century to make them comparable with existing studies.[170] Much of the additional settlement information was kindly donated to this project by the Cambridge Group for the History of Population, including data on the principal roads of England in 1671, the navigable river network in 1600, and the location of English ports. These data allow for estimates of distance from roads, rivers, and ports which are also described in table 1.1.

Completeness

Whilst the dataset covers all settlement sizes and functions, its completeness varies over time, space, and settlement size characteristics. The data is much more complete for the east of England, southeast, and southwest than it is for the midlands and especially the north (see figure 1.1). This is particularly true early in the period but still in 1667 less than 10% of settlements are in observation in the north whereas around half are in observation in the east and southeast. Northern regions are excluded from this analysis on the grounds that especially low coverage may lead to unrepresentative results. The use of the term ‘national’ when dealing with aggregate estimates in this chapter is therefore actually shorthand for central and southern England.

[170] See appendix to: Curtis, *Was Plague*.

Table 1.1. Description of the Full Dataset - All Settlements, 1538-1667

VARIABLES	Count	% of Total Months / Settlements	Mean	SD	Min	Max
Across Months:						
Burial Totals	3,801,618	100%	0.939	14.12	0.000	10,203
Defective Data	689,865	18%	N/A	N/A	N/A	N/A
Crisis Months (1+ Duration)	63,196	1.7%	N/A	N/A	N/A	N/A
Crisis Months (2+ Duration)	21,094	0.6%	N/A	N/A	N/A	N/A
Plague Months	6,728	0.2%	N/A	N/A	N/A	N/A
Across Settlements:						
Multi-Parish Settlements	112	3.0%	N/A	N/A	N/A	N/A
Major Towns (>10,000)	5	0.01%	N/A	N/A	N/A	N/A
Regional Towns (2,500-10,000)	44	1.2%	N/A	N/A	N/A	N/A
Market Towns (<2,500)	382	10%	N/A	N/A	N/A	N/A
Large Rural (>=6 burials / year)	1,059	28%	N/A	N/A	N/A	N/A
Small Rural (<6 burials / year)	2,241	60%	N/A	N/A	N/A	N/A
On Principal Road	1,276	34%	N/A	N/A	N/A	N/A
On Navigable River	307	8.2%	N/A	N/A	N/A	N/A
Ports	41	1.1%	N/A	N/A	N/A	N/A
Dist. Principal Road (Miles)	3,731	N/A	2.514	2.140	0.000	13.96
Dist. Navigable River (Miles)	3,731	N/A	11.03	8.311	0.000	37.63
Dist. Head Port (Miles)	3,731	N/A	31.77	17.04	0.000	72.88
Dist. Port (Miles)	3,731	N/A	23.92	14.73	0.000	61.39
Dist. London (Miles)	3,731	N/A	74.59	33.20	0.000	193.9
Dist. Major Town (Miles)	3,731	N/A	37.75	19.72	0.000	86.11
Dist. Regional Towns (Miles)	3,731	N/A	11.46	6.005	0.000	45.85
Total Months Observed	3,731	N/A	1,019	435.2	1.000	1,548
% Poor Data Months	3,731	N/A	19.48	22.08	0.000	99.49
% Crisis Months (1+ Duration)	3,731	N/A	1.572	2.706	0.000	81.98
% Crisis Months (2+ Duration)	3,731	N/A	0.507	1.402	0.000	51.87
Total Plague Months	3,731	N/A	1.803	8.727	0.000	360.0
% Plague Months	3,731	N/A	0.190	0.735	0.000	23.26

Figure 1.1 also displays how improvements in the recording process and the prioritisation of later periods by family history societies mean more burial data is available over time. Coverage prior to the 1560s is very low. Even in the east of England only 10% of settlements are observable and in the northeast this figure is only 0.2%. In 1598 local clergy were instructed to copy paper registers (which had already begun to deteriorate) on to parchment. They were required to cover the whole period of registration back to 1538 but the authorities were particularly keen that copies were made of registers from the beginning of Elizabeth's reign in 1558.[171] The effect of this is very clear in the data – for most regions the proportion of settlements in observation doubles over the last four years of the 1550s. Thus, any conclusions drawn about plagues prior to 1563 should be treated with caution.

The data is further biased towards larger settlements with a higher proportion of major and regional towns included in the data than market towns and especially rural settlements (see

[171] Dyer, *The English Sweating Sickness of 1551*, 363

figure 1.2). By 1667, whereas two-thirds of major and regional towns are observable in the data, around half of market towns and only a quarter of rural settlements are included. To address these biases, aggregated estimates will be derived using weights to rebalance the dataset along the time, regional, size, and geographical dimensions.

<u>Figure 1.1. Proportion of Settlements from Each Region Observed Over Time, 1538 - 1667</u>

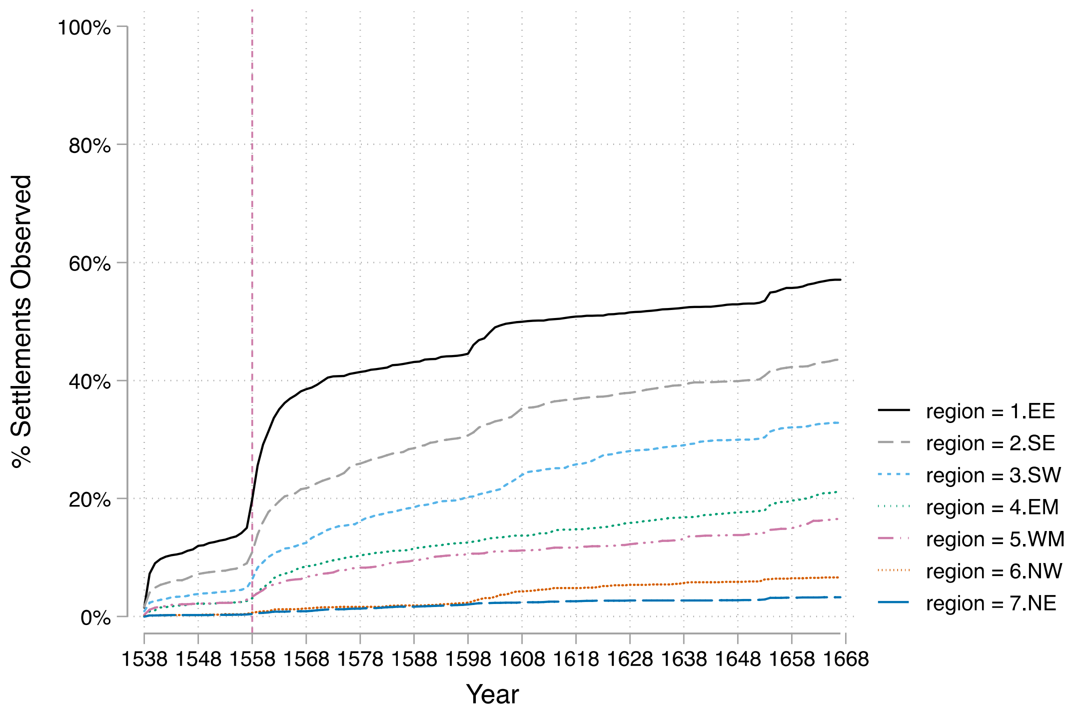
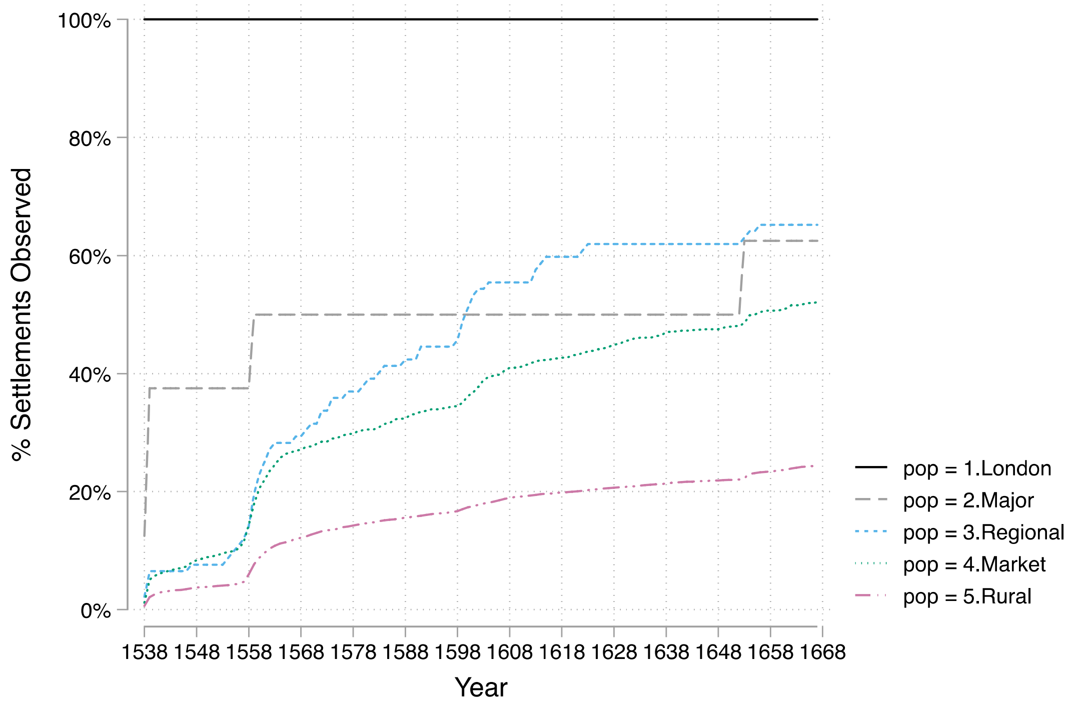


Figure 1.2. Proportion of Settlements Across Settlement Types Observed Over Time, 1538 - 1667



To estimate the incidence and severity of plague in early modern England, it is necessary to adjust the dataset to improve its representativeness. This is achieved using inverse probability weighting which reweights observations in aggregated analyses according to how likely they are to appear in the dataset.[172] So, observations from a rural parish in the midlands will receive a larger weight (because it is less likely to appear) than a regional town in the east of England. The weights are derived from a logistic regression where the outcome variable takes a value of 1 if the settlement is observed and 0 otherwise. To capture the changing sample composition over time, weights are calculated for 16 sub-periods which represent the 8 national plague outbreaks identified below and the 8 intervening time periods between 1538 and 1667. A settlement is only attributed a 1 if less than 25% of months contain poor quality data in the subperiod.

The dependent variables in the logistic regression are regional and settlement size dummies, and a set of variables characterising a settlement as on a principal road, navigable river, or as being a port. Distances to the nearest road, river, port, and major town are also included. The resulting weights are defined as the inverse of the predicted probability of a settlement's inclusion in the dataset using the estimated models for each sub-period. So, if there is a 20% probability of a settlement being included (given its size, function, and geographical characteristics), it receives a weight of 5 to account for the 4 other similar settlements which, on average, are not observed.

[172] Valliant, R., Dever, J. A. & Kreuter, F. Practical Tools for Designing and Weighting Survey Samples. *Stat. Soc. Behav. Sci.* 565–603 (2018), 574. See section 18.4.1 on 'quasi-randomisation.'

Table 1.2. Description of Inverse Probability Weights for Full and Constrained Samples

Sample	N	Mean	SD	CV	Min	Max
Full	25,522	5.76	16.36	2.84	1.14	1,934.58
Full (1563+)	24,595	4.67	3.97	0.85	1.14	47.81
Full (Ex. Rural & 1563+)	2,719	2.95	1.91	0.65	1.14	16.11
Towns Sample (1563+)	2,719	2.80	1.60	0.57	1.11	17.59

Note: Northern settlements are excluded from all samples.

Within reasonable bounds, this reweighting process will lead to more representative results than unweighted estimates. However, for settlements with rare characteristics or in the early years when coverage is low, this approach leads to very heavy reliance on a small number of settlements, each of which is attributed a very large weight. The degree to which a few settlements are being relied on heavily is reflected in the variation of weights in the dataset. Prior to 1563 the variation of weights attributed to included settlements is large. This can be seen in table 1.2 which describes the distribution of weights in the full dataset including and excluding the period between 1538 and 1563 in the first two columns. Excluding the early period reduces the standard deviation of the weights from 16.36 to 3.97 whilst the mean falls to a lesser extent meaning there is still a decline in coefficient of variation (sd / mean) from 2.84 to 0.85. So, any weighted estimates taken from the period prior to 1563 should be treated with particular care since a small number of settlements are exerting a strong influence on the results.

The final two rows of table 1.2 suggest aggregate estimates are most reliable when the sample is restricted to towns. This is clear by comparing the coefficients of variation of the weights in the full, post-1563 sample with and without rural settlements included which falls from 0.85 to 0.65. Yet, to ensure the towns sample most closely reflects the experience of all English towns, the weights must be modelled without the inclusion of rural settlements in the sample. The final row of table 1.2 describes the results of weighting using a sperate urban sample and shows an even lower coefficient of variation (0.57) in the weights indicating even broader influence of towns on weighted aggregate estimates. In this analysis, I will rely on two sets of weights: one set used in analyses including all settlements, and another used when only analysing urban plague dynamics.

Identifying Plague Epidemics

Following Eckert, I identify plague epidemics from monthly burial counts using the severity, duration, and seasonality characteristics of known outbreaks.[173] Table 1.3 contains descriptions of each rule included in the plague detection algorithm. First, the burial total for each parish and each month is evaluated for severity. Previous studies have relied on deviations in burial totals from the average, with thresholds being set above which a mortality

[173] Eckert, *Structure*, chapter 6

crisis is deemed to have occurred.[174] This approach is problematic because it fails to account for normal levels of variation in burial totals around the mean and the fact that this variation will differ in parishes depending on their population size. This analysis follows Cummins et al who compare mortality in a given unit of time to the distribution of burials outside of epidemics.[175] A month is identified as a 'crisis month' if the burial total is higher than would be expected 99% of the time, under the assumption that burials follow a Poisson distribution.[176] The distribution of burials against which each month is evaluated is determined using average burials in the same and adjacent 2 months over the 4 previous years. Whilst essential to identifying epidemics without cause of death information, the setting of a severity threshold will mean minor occurrences of plague are excluded from this analysis.

Second, to be identified as a potential plague epidemic, at least two crisis months must occur consecutively. Figure 1.3 describes the proportion of settlements experiencing a mortality crisis lasting a month or longer in each year along with the effects of applying additional duration and seasonality conditions to more effectively isolate plague. All series are weighted using the inverse probability method described above. The proportion of settlements experiencing a mortality crisis fluctuates in a roughly normal distribution (standard deviation of 5%) around an average of 14% with no discernible long-term trend. This shows short and isolated mortality crises were a very common occurrence in early modern England. The proportion of settlements experiencing a crisis lasting at least 2 months also shows no trend but differs in levels and distribution. The average for the 2+ month series is 3% and the distribution is right skewed, with pronounced surges (the maximum is 10%) when settlements simultaneously experienced mortality crises. The minimum 2-month duration condition therefore removes many random and localised mortality events, exposing those more likely to have a common cause.

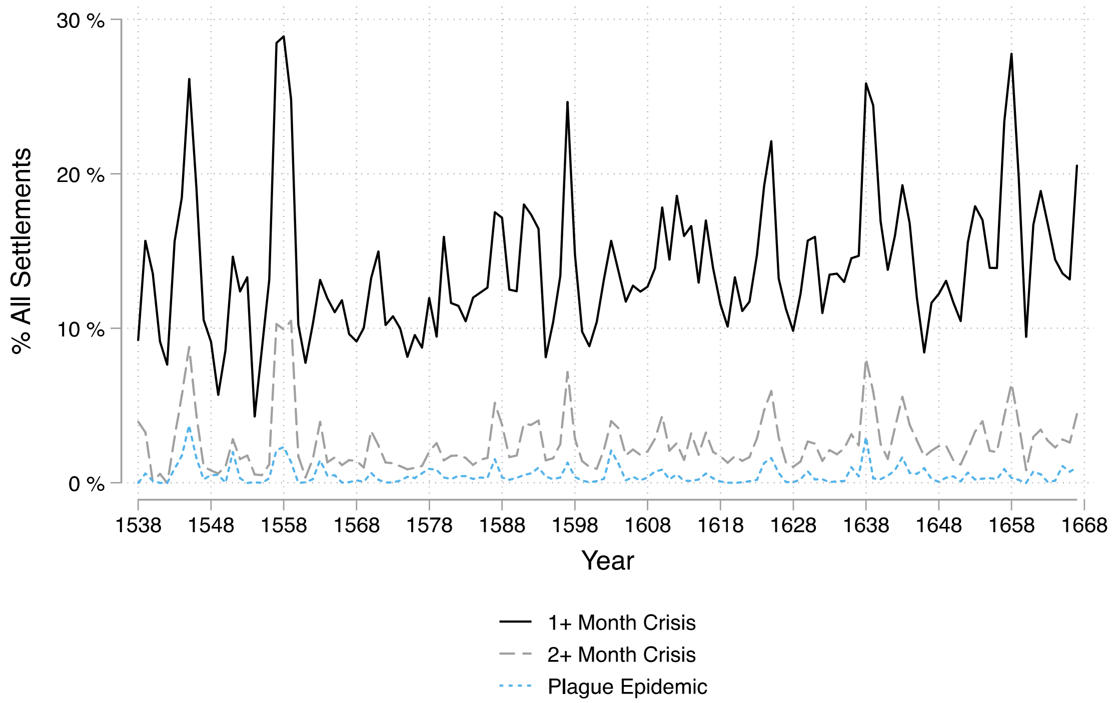
---

[174] See literature review for a more detailed discussion. Hinde, A. A review of methods for identifying mortality "crises" using parish record data. *Local Popul Stud*, 86 (2010); Slack, *Impact*, 81; Alfani, *Plague in the Seventeenth Century*, 417; Curtis, *Was Plague*, 142

[175] Cummins et al, *Living Standards*, 16; Also see: Wrigley and Schofield, *Population History*, appendix 12

[176] Here I am following Cummins et al's procedure for identifying crisis mortality in plague epidemics in early modern London. Cummins et al, *Living Standards*, 16

Figure 1.3. % of All Settlements Experiencing 1+ and 2+ Month Crises and Plague Epidemics (Weighted), 1538 – 1667



Yet since there are many potential causes of nationally significant mortality crises, I also include a third condition in the algorithm which allows for the more precise isolation of plague epidemics based on seasonality patterns. Known plague epidemics have a very well attested seasonal pattern. Burials rose in the spring or summer, peaked in late summer or autumn (most often October in England), and then declined quite rapidly in winter.[177] The algorithm contains two slightly different tests to determine if collections of crisis months fit the seasonality patterns of plague. These are set out in table 1.3. If one test is met, the event is defined as a plague outbreak. Figure 1.3 also describes the proportion of all settlements experiencing a plague outbreak in each year. This series has a mean of 0.5% and a maximum of 4%. The plague series is therefore even more heavily right skewed than the 2+ month series with a maximum 8 times larger than the mean (compared to 3.3 times for the 2+ month series). The fourth stage is to evaluate burials in the months following the epidemic to check for less severe, but still unusually high mortality that probably represents the gradual decline in the epidemic's intensity. Additional months are included if burials were higher than would be expected in 85% of non-epidemic months.

[177] Krauer, F., Viljugrein, H. & Dean, K. R. The influence of temperature on the seasonality of historical plague outbreaks. *Proc Royal Soc B Biological Sci* 288, 20202725 (2021)

Table 1.3. Plague Identification Conditions

System Component	*Conditions*
Lambda Parameter	Trailing average: 3 months centred on given month over 4 previous years. Adjusted for changing levels over period used for average.
Crisis Mortality Threshold	Define as crisis mortality month if mortality exceeds the 99th upper percentile value of the Poisson distribution with rate parameter lambda.
Absolute Minimum	Only define as crisis month if >3 burials are recorded in given month.
Duration Threshold	Include mortality event if length (months) >1.
Seasonality Test I	Include mortality event if up to 4 consecutive crisis months within the period June to November (inclusive) contain >=50% of total annual burials. If true for one year of multi-year crisis, all crisis months are included.
Seasonality Test II	Include mortality event if at least one set of consecutive months between June to November (inclusive) contain some proportion of total annual burials between 40% and 50% and the peak of the crisis occurs in August or September.
Long Tail Identifier	Include non-crisis months in a mortality event if: 1. The event in question meets all other conditions. 2. The month directly follows the last crisis month. 3. Mortality exceeds the upper 85th percentile value for a Poisson distribution with rate parameter lambda.

The algorithm detects most serious outbreaks of plague without picking up an intolerable number of false positives. Attributions of mortality to plague in the London Bills of Mortality between 1644 and 1667 provide a good dataset to test the algorithm's ability to identify plague months. A full description of the validation exercise can be found in appendix 2. The main result is that the system identified 535 of the 686 months in which more than 1 plague burial was identified in the London Bills (78%). It did this while also identifying 100 additional months for which the Bills did not identify plague as a cause of death (16%). A true positive rate of 60% was found using qualitative data on years in which settlements outside London experienced an epidemic associated by contemporaries with plague. Since this data does not reveal true cases where no plague occurred, it is impossible to calculate a false positive rate for this data. Overall, these tests suggest the detection algorithm can identify most months in which plague was active. To further remove false positives from the sample of identified plague epidemics, this chapter studies years in which plague epidemics were widely experienced in England.

Defining Surges in Plague Activity

Once plague epidemics are identified at the settlement level, we can analyse the aggregated totals of plague incidence to identify surges in plague activity - national outbreaks. These periods have been identified by previous generations of plague historians who have relied on partial quantitative data supplemented with qualitative accounts of plague activity by contemporaries.[178] This chapter will combine the findings of other historians, particularly Shrewsbury, with a systematic quantitative approach to defining national plague surges between 1538 and 1667. Figure 1.4 presents the total number of plague epidemics identified in each year along with plague per page per year in Shrewsbury's *History of Bubonic Plague in the British Isles*.[179] Shrewsbury relied on many qualitative sources to create his chronology of plague outbreaks, above all the Calendars of State Papers which contain correspondence between statesmen who often mention the time and location of plague outbreaks. Aside from offering an important window into contemporary awareness of the spread of plague, this information provides a way of independently checking the chronology revealed through the parish registers.

Figure 1.4. Total Plagues Identified by Shrewsbury and Using Plague Detection Algorithm, 1538-1667.

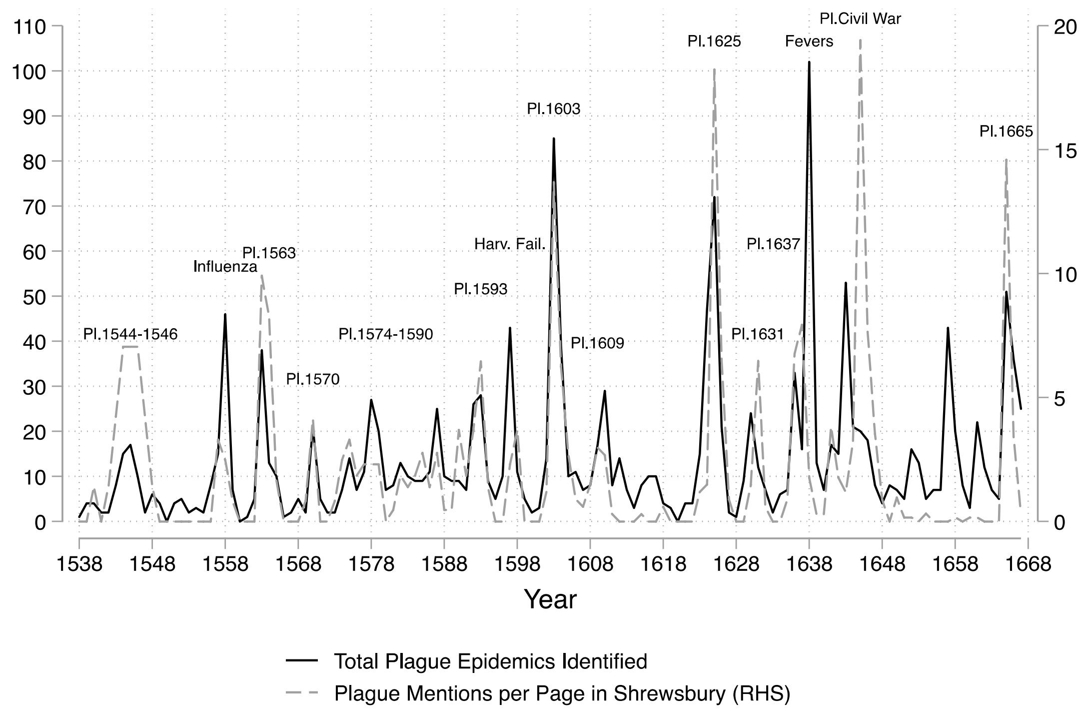
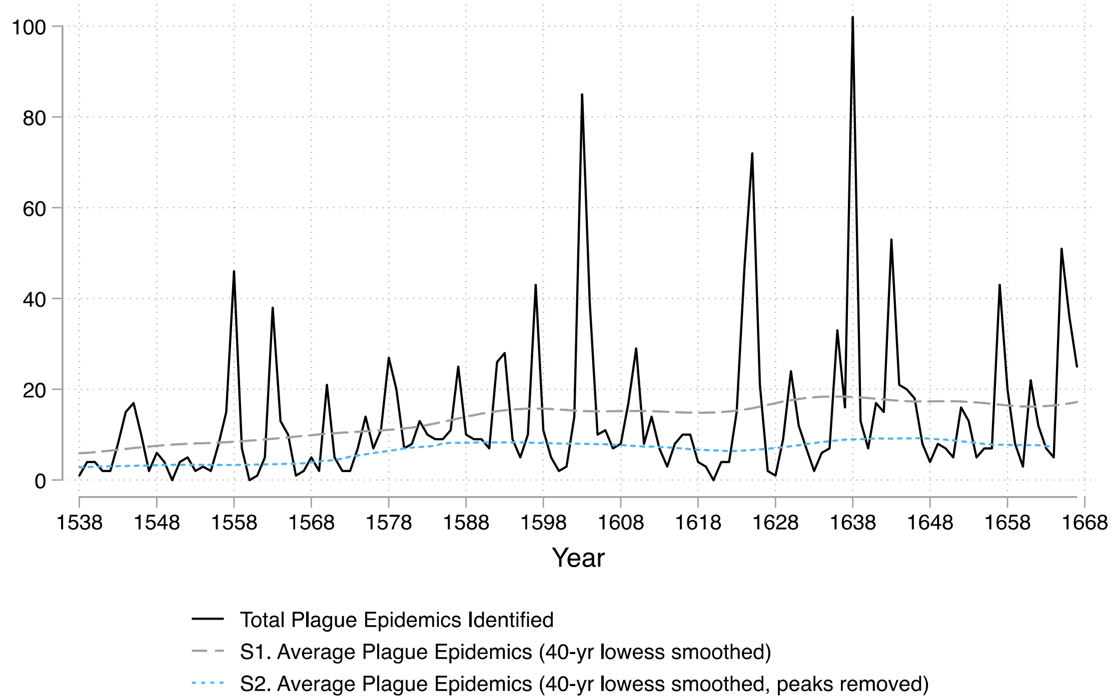


Figure 1.4 reveals a very close association between peak years of plague activity identified by Shrewsbury and using the plague detection algorithm on the parish register dataset. In at least 7 cases, the local peak of plague incidence matches exactly, and in a further 3 cases it is only

[178] Shrewsbury, *History*; Slack, *Impact*, 61-62
[179] Shrewsbury, *History*.

1 year different. Figure 1.4 highlights these by including the year in which the Shrewsbury data records a local peak in incidence. There are at least another 2 other periods where both datasets find plague incidence was high. One is the period between 1574 and 1590 where plague did not cause a major surge so much as a prolonged period of elevated activity. This peculiar pattern suggests some interesting difference in the behaviour of plague that should be investigated in a separate paper. In this chapter, the period of plague persistence in the 1570s and 1580s will be set aside. As will the other period of heightened plague activity which coincided with the English Civil War in the 1640s. Comparing the two series, it is clear the plague detection algorithm identifies further plague surges in at least three periods where other diseases are thought to have been most prevalent. These are during the serious epidemic of the late 1550s, thought to have been caused by influenza, the severe harvest failure of 1597, and during the epidemic of 1638 which was accompanied by widespread 'fevers.'[180] Mortality during these periods will be analysed throughout this thesis as useful comparison cases that reveal the idiosyncrasies of plague.

Figure 1.5. Total Plague Epidemics Identified with First and Second Stage Smoothing, 1538 - 1667



It is also clear from figure 1.4 that plague activity was elevated in the years surrounding the remaining 10 peaks in incidence. It is therefore important to define the start and finish of each plague surge. This is a challenging task. The plague identification approach reveals a very low number of epidemics occurring in most years, so it is not usually possible to pinpoint a start date. Moreover, the validation exercises described above suggest some of these

[180] Wrigley and Schofield, *Population History*, 333; Appleby, *Disease or Famine*, 408-414; Slack, *Impact*, 69-77

epidemics may not have been caused by plague. Also, whilst contemporaries in variably identified the beginning of each surge as coinciding with the arrival of a ship from abroad, historians debate whether new plague surges were caused by importation.[181] Contemporary accounts must also be treated with caution. The issue of importation is considered more closely later in the chapter.

To avoid relying on the accounts of contemporaries, I define the bounds of each plague surge probabilistically using deviations from trend levels. This is achieved through a 2-stage process of smoothing the incidence data, where the second smoothing round excludes all data points falling above the trend line produced by the first round (see figure 1.5 for trend lines). The start and end years of each epidemic are identified by moving outwards from the peaks discussed above, defining the start and end as the year before the total number of plague epidemics falls below the second stage smoothed trend (blue dotted line in figure 1.5). This produces the start and end dates listed in table 1.4. Since the epidemics which peaked in 1570, 1609-10, and 1630-1 were relatively mild, they will be set aside in the rest of this chapter as the probability of false positives is higher in years where we know plague activity was lower.

Table 1.4. Dates of Plague Surges in Early Modern England, 1538-1667

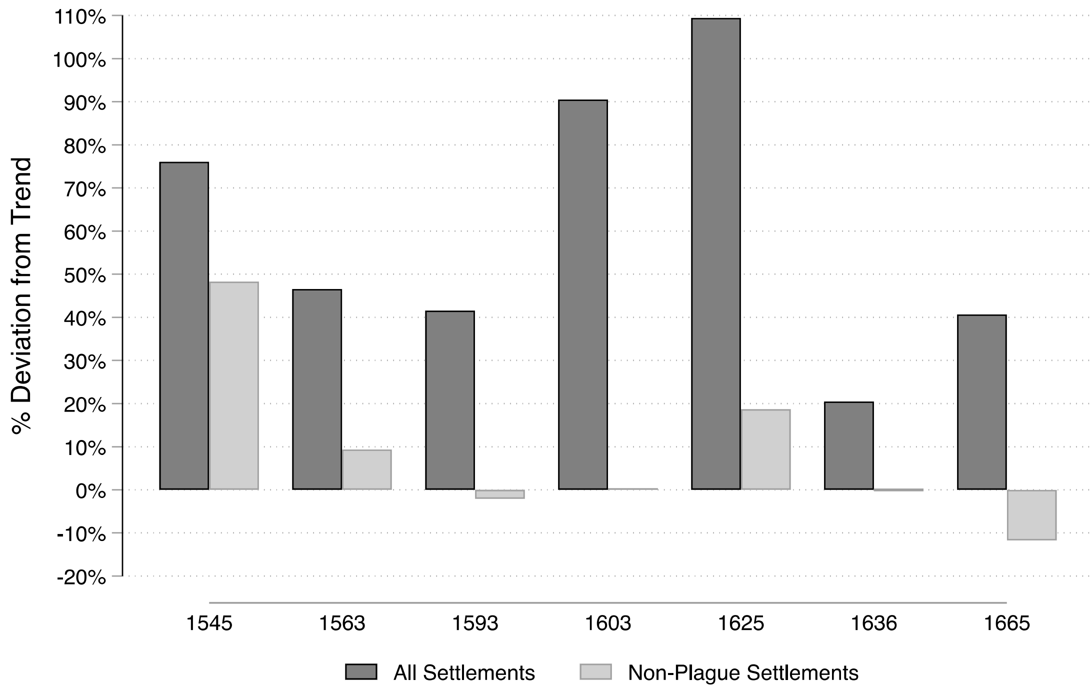
Plague Surge Peak Year	Shrewsbury Peak Year(s)	Start Year	End Year	Surge Length (Years)	Included?
1545	**1544-1546**	**1543**	**1546**	**4**	**y**
1563	**1563**	**1562**	**1565**	**4**	**y**
1570	1570	1570	1571	2	n
N/A	N/A	1574	1590	17	n
1593	**1593**	**1592**	**1594**	**3**	**y**
1603	**1603**	**1602**	**1606**	**5**	**y**
1610	1609	1608	1612	5	n
1625	**1625**	**1623**	**1626**	**4**	**y**
1630	1631	1629	1631	3	n
1636	**1637**	**1636**	**1637**	**2**	**y**
1643	1645	1641	1646	6	n
1665	**1665**	**1665**	**1667**	**3**	**y**

[181] E.g contrast: Slack, *Impact,* 68; Cummins et al, *Living Standards*, 19. See literature review for a full discussion of this debate.

Plague Incidence and Severity During 7 National Plague Surges

The Black Death is thought to have killed between 25% and 55% of the English population between 1347 and 1350.[182] In the 17th century, similarly severe plague surges have been identified in northern Italy (30%-35%) and the Low Countries (17%).[183] During the Second Pandemic, plague could kill 50% to 60% of a settlement's population during severe outbreaks, but 30% to 40% was more typical.[184] Still, to achieve such high aggregate death rates, these plague surges must have spread widely between settlements. Recent estimates suggest the worst plague surges caused extreme epidemics in around 44% of settlements in 17th century northern Italy and 37% in the Low Countries.[185] The best estimates of incidence and severity in early modern English plague surges is not directly comparable since it does not study surges as distinct units. Nevertheless, it suggests plague was far less pervasive and had a much lower impact on national mortality rates. For example, Wrigley and Schofield identify 1625/6 as the worst plague year in their sample of 404 English parishes (370 in observation at this date) but still only 14% of parishes experienced a crisis lasting at least one month and the national crude death rate only increased from its average of 2.6% to 3.5%.[186] Were English plague surges really more limited than medieval and contemporary European examples and if so, why?

Figure 1.6. Deviations from Trend Burial Levels in 7 Peak Plague Years for All Settlements and Settlements Not Experiencing a Plague Epidemic



[182] Hatcher, *Plague*, 25
[183] Curtis, *Was Plague*, 158-160; Alfani, *Plague in Seventeenth Century Europe*, 411
[184] Alfani, *Plague in Seventeenth Century Europe,* 417; Britnell, R. The Black Death in English towns. *Urban Hist* 21, 195–210 (1994), 198-201
[185] Curtis, *Was Plague*, 158-160; Alfani, *Plague in Seventeenth Century Europe,* 411
[186] Wrigley and Schofield, *Population History*, 333, 653

My data broadly confirm Wrigley and Schofield's estimates of the magnitude of plague mortality in early modern England. Figure 1.6 plots weighted deviations from trend burial levels, defined as a 13-year centred national average, for each peak plague year (crisis years are excluded). The deviations are estimated for all settlements and for the subset of settlements for which no plague was identified during the plague surge. For all settlements, the deviations from trend burials in peak plague years range from +20% in 1636 and +110% in 1625. Average non-epidemic crude death rates for England in this period were around 2.8%.[187] So, these deviations imply national crude death rates in peak plague years of between 3.4% (1636) and 5.9% (1626).

However, these are probably underestimates of the true national mortality impact since some of the most heavily affected London parishes are missing from the dataset. Whilst this does not seem to matter for 1603, in 1625 and 1665 our data suggests London burials were around 5 times higher than their 5-year average rather than 6 times higher which is closer to the truth.[188] Accounting for this in the national mortality calculation only slightly increases the national crude deaths rate in 1625 from 5.9% to 6.1% and in 1665 from 3.9% and 4%. Still, the general conclusion is unchanged. Whilst these estimates are a little higher than Wrigley and Schofield's, they are much lower than Curtis' for the Dutch Republic which range from 10% in 1602 to 17% for 1635.[189] They are also far below Alfani's estimate of a 30%-35% crude death rate for northern Italy in 1629-30 –estimates that are comparable to the Black Death.

Analysing deviations from burial trends for settlements for which no epidemic is identified shows the plague identification algorithm includes most epidemics in these plague years. To the extent that evidence drawn from the small sample of data in the 1540s can be trusted, the large positive deviation in mortality for non-plague settlements is probably the result of a mortality caused by a harvest failure in 1545.[190] The 1540s aside, the small size and inconsistent direction of deviations from trend for non-plague settlements suggest they represent random fluctuations and not a consistent error arising from the seasonality and duration conditions applied to identify mortality crises. The plague identification approach successfully identifies most plague mortality. This is important because it means we can use the sample of identified plague epidemics to help decompose national mortality into incidence (proportion of settlements affected) and settlement-level severity to understand why plague's mortality impact was particularly low in early modern England.

Part of the explanation for lower national mortality in early modern England is that epidemics were less severe within settlements than on the continent in the 17th century. To see this, I calculate the percentage deviation of annual burials from trend using the same approach as

[187] Calculated from: Wrigley and Schofield, *Population History*, 333
[188] Cummins et al, *Living Standards*, 14
[189] Curtis, *Was Plague*, 146
[190] Slack, *Impact*, 84. The same may be true of the smaller deviation in the 1620s. There was a severe harvest failure in 1623, though many of the settlements affected were in the north which is excluded from this analysis. See: Appleby, *Disease or Famine*, 408

Curtis for three plague surges which are common to both analyses (the 1620s, 1630s, and 1660s). In the Low Countries, 26% of settlement-level epidemics experienced deviations of 300% or more and 7% experienced deviations of 900% or more, in England (using the same method as Curtis), these figures are 12% and 1%, respectively.[191] Epidemics were more severe in the Low Countries than England. Though, the difference is much more extreme in the case of Italy in 1629-30 where the proportion of settlement-level epidemics for which burials deviated from trend by 300% or more is 41%.[192] Higher settlement-level severity certainly contributed to differing aggregate mortality, particularly in the case of Italy.

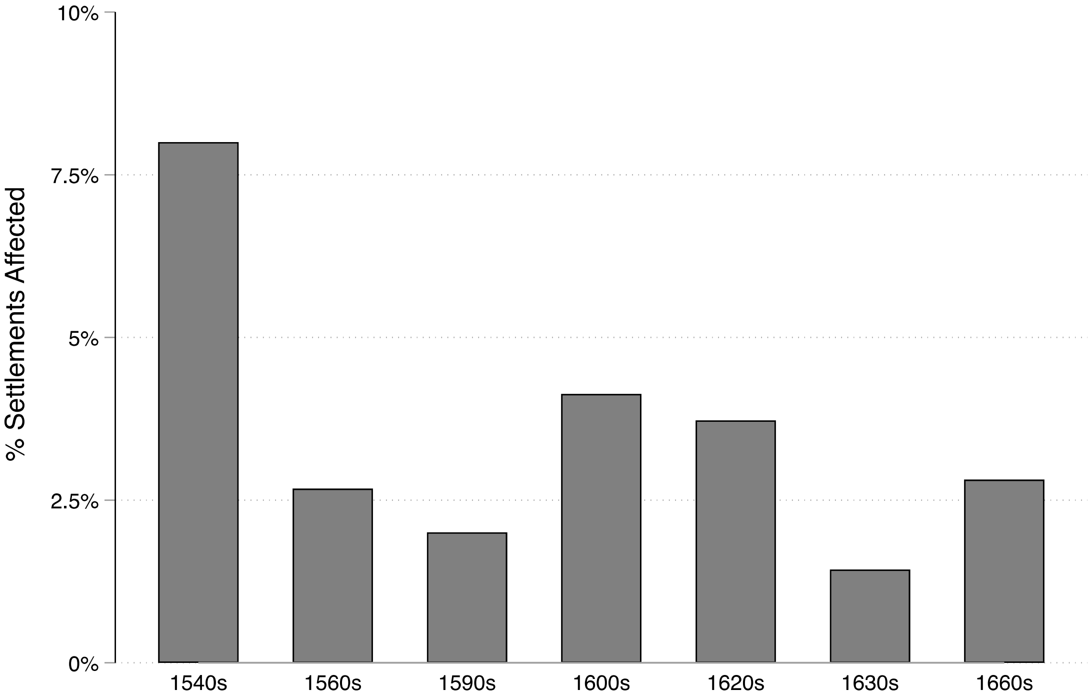
Yet the proportion of settlements affected was also much lower in England. Figure 1.7 displays the weighted proportion of settlements identified as experiencing a plague outbreak in each of the 7 plague surges. In the 16th and 17th centuries, major plague surges affected no more than 8% of all English settlements and on average 3.5%. The differences with the continental studies are very striking. Eckert finds 81% of settlements experienced a plague epidemic in the Rhine region between 1600 and 1613 (and 25% in the 1660s).[193] Alfani finds 82% of settlements experienced an epidemic in northern Italy in 1629-30.[194] Similarly, Curtis finds 84% of settlements were affected in the Low Countries on average in the surges occurring in the 1620s and 1630s combined.[195]

In England, studying incidence in the surge of the 1630s in complicated by a concurrent outbreak causing fevers in 1638. But examining the surge of 1623 to 1626 reveals only 3.7% of settlements were affected. This contrast is particularly remarkable given that Alfani argues plague travelled from northern Europe down to Italy in the 1620s, causing the extremely pervasive and lethal surge around 1630.[196] Moreover, recent DNA analysis has argued the strain of *Yersinia pestis* responsible for the northern Italian outbreak is not genetically distinctive in ways that suggest higher virulence.[197] The higher pervasiveness and severity of the continental plague surges was therefore the result of wider environmental factors, either natural or human.

---

[191] Calculated from table 6 in: Curtis, *Was Plague*, 146
[192] See appendix to: Alfani, *Plague in Seventeenth Century Europe*
[193] Eckert, *Retreat*, 12
[194]Alfani, *Plague in Seventeenth Century Europe*, 420
[195] Curtis, *Was Plague*, 159
[196] Alfani, *Plague in Seventeenth Century Europe*, 413
[197] Seguin-Orlando, A. *et al.* No particular genomic features underpin the dramatic economic consequences of 17th century plague epidemics in Italy. *Iscience* 24, 102383 (2021)

Figure 1.7. Total Incidence of Plague in 7 National Plague Surges



Plague could cause widely differing epidemiological consequences despite remaining relatively genetically stable.[198] This highlights the possibility that the decline in pervasiveness of plague in England at some point after the Black Death was due to environmental factors. However, it is difficult to investigate this possibility directly because there is little evidence of a continued reduction in pervasiveness over the early modern period. Figure 1.7 reveals no general trend in incidence with surges experiencing the largest total cumulative dispersion occurring throughout the study period in the 1540s (8%), the early 1600s (4.1%), and the 1620s (3.7%). In between, there occurred more limited surges in the 1660s (2.8%), 1560s (2.7%), 1590s (2%), and 1630s (1.4%). The data confirms Slack's impression that the final plague surge which peaked in 1665 was limited in its dispersion Intriguingly, this trend is mirrored elsewhere in Europe, including the Low Countries and the Rhine region.[199] That said, there does not seem to be a more general correlation between pervasiveness in different areas of Europe. However, as Slack argued, the earlier surges with limited dispersion in the 1560s and 1590s caution against the conclusion that plague was 'retreating' from England over this period.[200]

---

[198] It should be noted that Spyrou et al find evidence of a change in virulence-related genomes in DNA extracted from victims who died in the later in stages of both the first and second pandemics. However, they argue they are probably not responsible for changes in virulence in outbreaks, rather they may be related to the disappearance of plague from some rodent reservoirs. See: Spyrou et al, *Phylogeography*, 9
[199] Eckert, *Retreat*, 12; Curtis, *Was Plague*, 159
[200] Slack, *Impact*, 69

<u>Figure 1.8. Seven Maps of Total Settlements Affected in Each Plague Surge (All Settlements in Background)</u>

Was the changing pervasiveness of plague surges due to differences in the extensiveness of the area covered or the intensity with which that area was affected? The maps in figure 1.8 reveal settlements across England were affected in each major plague surge. The maps portray all settlements experiencing an outbreak in black. The rest of the sample are included in the background to show the geographical extent of coverage during each surge. All data are included here, even for the north of England. In each of the 7 surges, settlements across the entire extent of the sample are affected, from north to south and east to west. Each surge can therefore be justifiably called 'national.' The trendless variation in pervasiveness, then, was the result of variations in the intensity with which plague spread within early modern England.

Yet, if there is no general declining trend in pervasiveness, the first surge in the 1540s does stand out as particularly widespread. Does the evidence confirm Wrigley and Schofield's suspicion that this epidemic represents the end of 'a late medieval regime of widespread epidemic mortality'?[201] Slack investigated this possibility through case studies of incidence in Devon and Essex. These produced contradictory trends. In Essex, the 17th century epidemics were more pervasive than the 1540s but in Devon the opposite was true.[202] In fact, the surge of activity in Devon in the 1540s – where 80% (28/35) of parishes were affected - is the only parish register evidence we have showing levels of pervasiveness comparable to the Netherlands and Italy in the 17th century.[203] However, Wrigley and Schofield's finding that 15.5% of the 58 parishes they observe in 1545/6 experienced a crisis lasting at least one month suggests the experience of Essex was more typical than Devon.[204]

Figure 1.7 confirms this, showing 8% of settlements experienced plague epidemics between 1543 and 1546. Adopting the same approach as Slack and focusing only on the two counties where coverage is strongest, Bedfordshire and Cambridgeshire, produces evidence of plague in 17% (5/29) of settlements and of mortality crises lasting at least 2 months in 34% (10/29) of settlements. The large number crises that do not conform to the seasonal pattern of plague reaffirms the general claim above that elevated mortality was partially due to the harvest failure in 1545.[205] This suggests the experience of Devon was not representative of the national impact of plague in the 1540s and consequently that this epidemic should not be characterised as the last of the more pervasive medieval plague surges.

Historians generally accept the Black Death (1348) spread very widely across England.[206] Indeed, with such a high proportion of the population living in dispersed rural settlements, the plague must have swept across England in the 14th century in a similar way to Italy in 1629-30 if estimates of total national mortality between 25% and 55% are correct.[207] The national dynamics of plague in the 16th and 17th centuries reveal a very different and largely stable pattern. A major plague surge could at most double the national crude mortality rate. Plague could still cause highly lethal settlement-level epidemics, like the famous examples of Newcastle in 1636 and Colchester in 1666 which killed around 50% of these cities'

---

[201] Wrigley and Schofield, *Population History*, 178; Slack finds additional evidence for this in his case study of Plague in Devon. Slack, *Impact*, 84, 99.
[202] Slack, *Impact*, 104-105
[203] Slack, *Impact*, 84
[204] Wrigley and Schofield, *Population History*, 653
[205] Slack, *Impact*, 84
[206] Hatcher, *Plague*, 24
[207] Hatcher, *Plague*, 25; Shrewsbury disputes this, claiming plague would not be capable of spreading so far into rural areas. As a result, he argues the Black Death killed 5% of the English population: Shrewsbury, *History*, 123

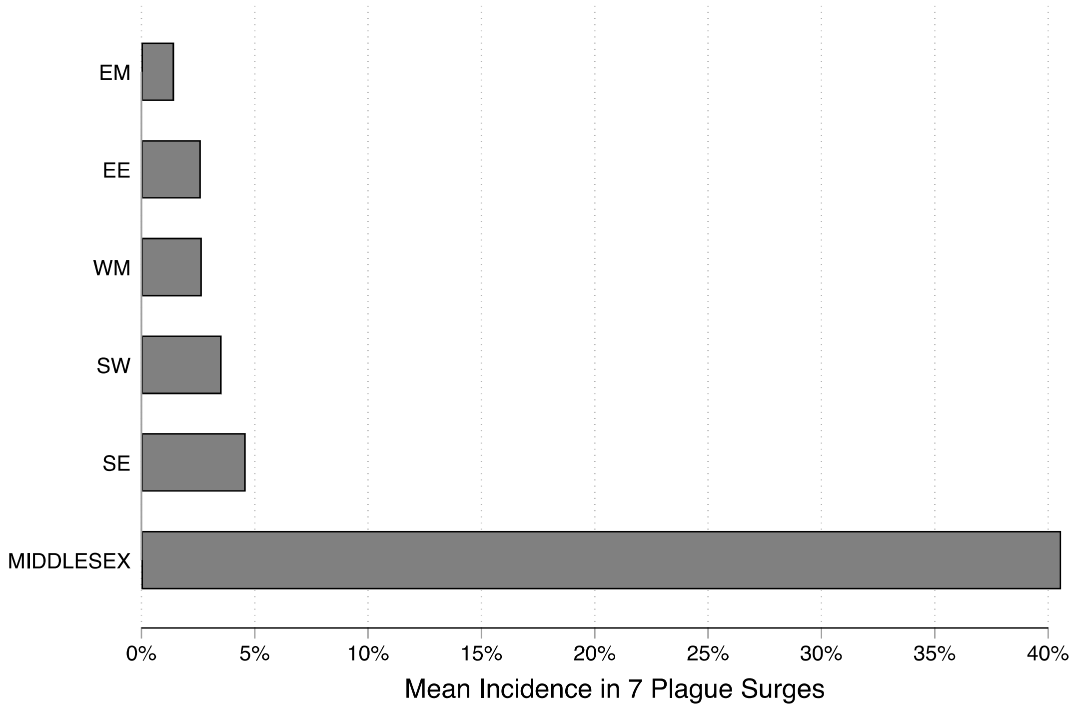
populations.[208] But these events were rarer than in the Low Countries and especially Italy in the 17th century and in England itself in the 14th century. An even more obvious difference was the degree to which plague could spread between settlements. In early modern England, plague's ability to travel was heavily constrained. The emerging evidence for the relative genetic stability of the pathogen suggests this was the result of differences in the wider natural or human environment rather than a unique strain of plague.

Regional Variations

To better understand the environmental factors shaping the dynamics of plague in early modern England, we must consider variations in severity and incidence at the regional and then settlement levels. Figure 1.9 presents the average proportion of settlements affected in each region across the 7 plague surges. Middlesex is separated out from the regions because it displays such an extreme level of incidence. On average, 41% of settlements there were affected during a national plague surge (average of 30 in observation). In comparison, incidence in the regions are similar, with a bias towards higher incidence in southern regions, and particularly the southeast where just under twice as many settlements were affected as in the east midlands – the least affected region on average. The relative levels of incidence are fairly constant if each epidemic is studied separately. In every case, incidence is highest in Middlesex and in every epidemic but two – 1543-6 and 1602-6 – the southeast is the second most affected region. Notably, in the 1540s, the southwest was the second most affected region, followed by the west midlands, and thus followed the regional incidence pattern of harvest failures (discussed below) more closely than the regional incidence of plague – further evidence suggesting other diseases contributed to this crisis. In the first plague surge of the 17th century, it was the eastern regions that bore the brunt of the disease, particularly eastern England.

[208] Slack, *Impact*, 107; Wrightson, *Ralph Tailor's*, 166; E. A Wrigley, People, Cities and Wealth: The Transformation of Traditional Society (Oxford: Basil Blackwell, 1986), 160

Figure 1.9. Mean Incidence Across 7 Plague Surges by Region

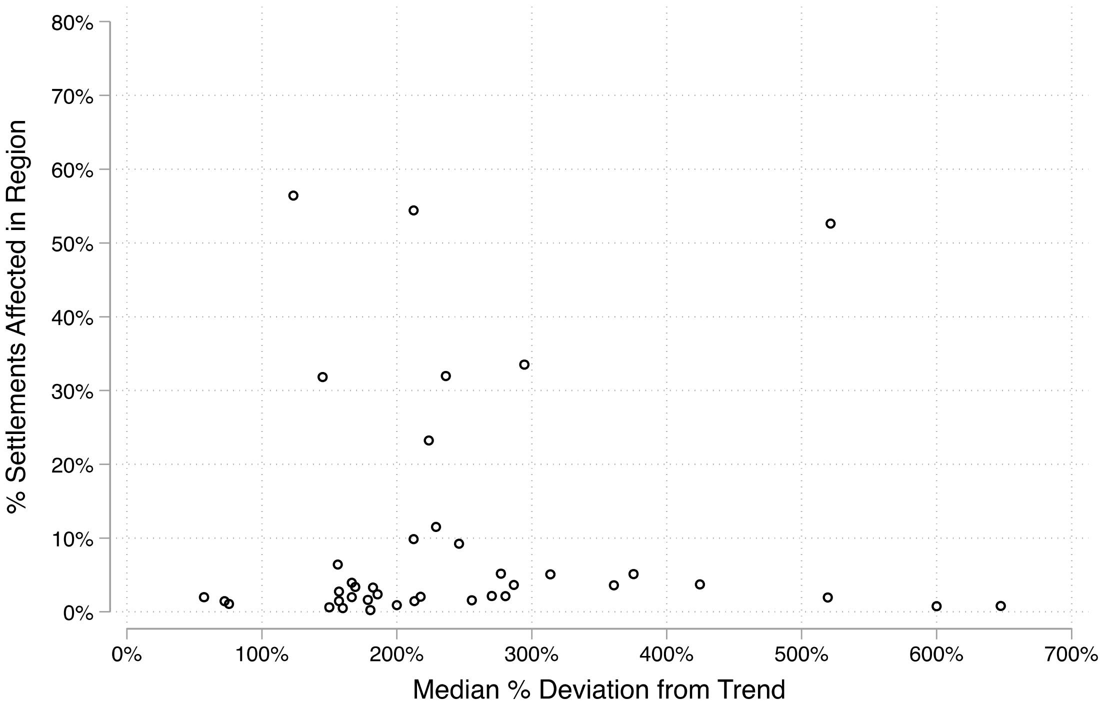


Note: The incidence data was aggregated using inverse probability weighting for each surge and then the mean incidence was averaged across surges. There is an average of 30 settlements in observation in each surge in Middlesex, 529 in the southeast, 355 in the southwest, 137 in the west midlands, 812 in the east of England, and 223 in the east midlands.

Multiple studies have found that when plague spread to a greater number of settlements, it also killed more people within each settlement.[209] For England, Slack found that burials in plague years deviated further from trend in affected parishes in Devon than Essex, whilst Devon also experienced higher incidence. Figure 1.10 tests this relationship using a pooled sample of regional incidence and median percentage deviation from annual burial trends. The international comparisons above suggest a relationship between severity and pervasiveness but within England no such relationship is apparent. For instance, settlements in Middlesex experienced median deviations from annual trend burials of between 120% and 520% and settlements in the east midlands experienced deviations between 0.72% and 600%, despite the vastly different degrees of pervasiveness in these regions. The causes of variations in incidence within England are therefore independent of the factors affecting severity.

[209] Slack finds this in a comparison of two English counties, Devon and Essex: Slack, *Impact*, 104; Alfani finds the same through international comparisons, particularly between England and Italy: Alfani, *Plague in Seventeenth Century Europe*, 417-420.

Figure 1.10. Regional Incidence of Plague vs Median Deviation from Burial Trend (Pooled Sample)



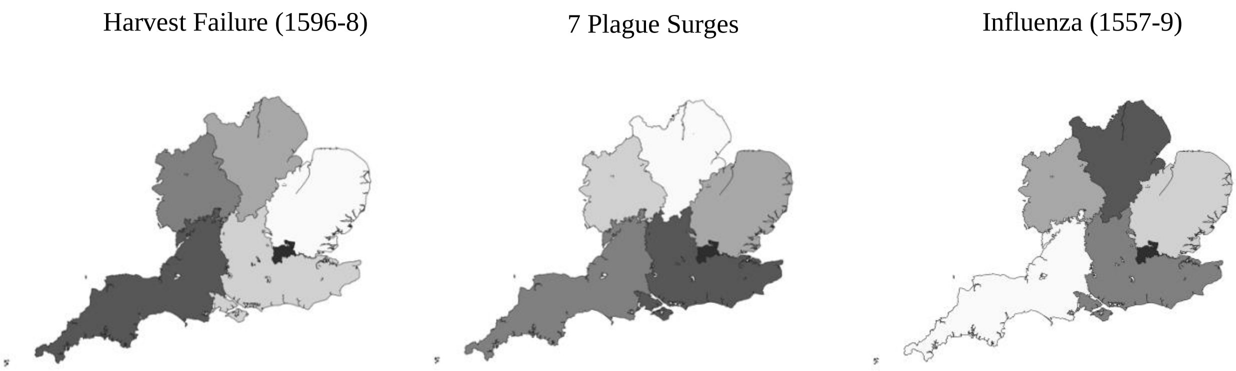
Comparing the regional incidence of mortality associated with influenza in 1557-9 and a harvest failure in 1586-8 suggests one set of factors affecting plague incidence was trade and population density. Figure 1.11 maps the regional incidence of these three types of mortality crisis. Crises associated with harvest failure were most extreme in the west midlands and southwest. These were the poorer, predominantly highland, and pastoral regions of England where grain yields were lower. They were therefore most vulnerable to climate driven reductions in grain output. In contrast, the least affected region, the east of England, was a wealthy, predominantly grain producing region. Consequently, the drop in grain output does not appear to have led to significant increases in mortality between 1586 and 1588. This finding confirms Slack's analysis within Devon during the same harvest failure where the bulk of mortality occurred in the northern pastoral highlands of the county.[210]

The spread of influenza in 1557-9 should be the most closely associated with trade and connectivity since it travels easily and directly between humans. This is supported by the general eastern bias in its dissemination. These were the areas most well integrated in the national and international trading network. The pattern of plague falls between the two. Plague incidence does not neatly fit the arable – pastoral divide. Instead, it is the south and east that are most affected with the midlands less so. This suggests whilst trade and the density of communication was important, so to was climate, with southern England being warmer than areas further north. This fits with the known role of ectoparasites in the transmission of plague – who proliferate most at higher temperatures. This may help explain

[210] Slack, *Impact*, 92

why the southern Low Countries (Spanish Netherlands) and northern Italy experienced higher incidence than England which is further north and therefore colder.

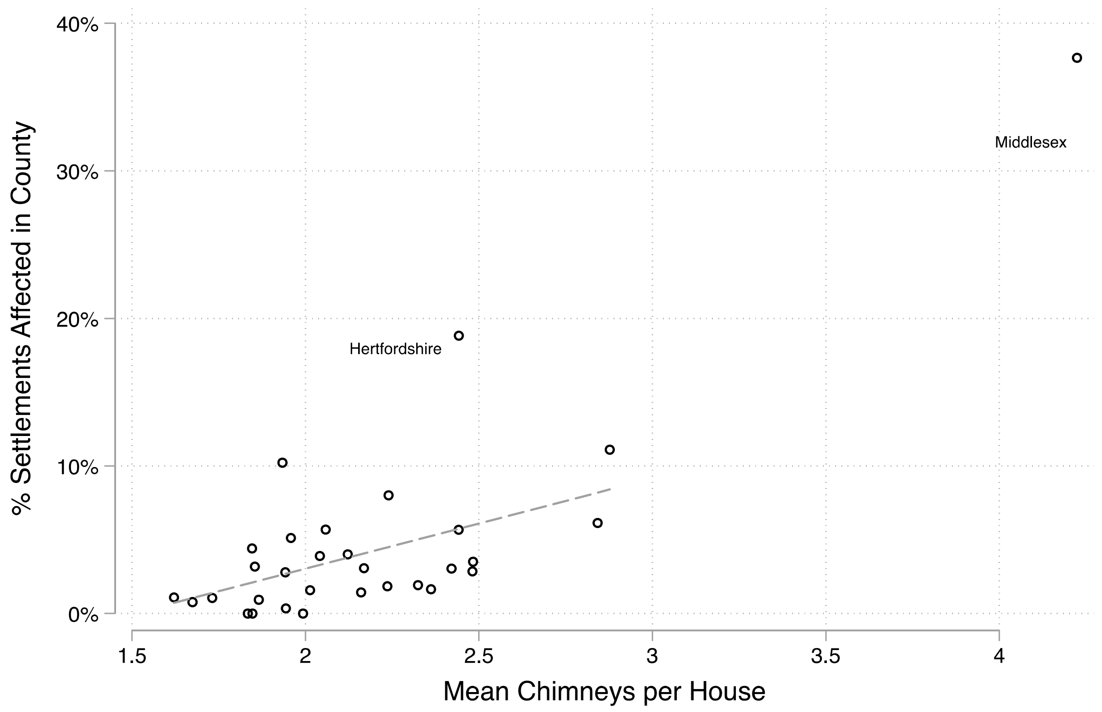
Figure 1.11. Regional Incidence of Plague, Harvest Failures, and Influenza



The association with trade is also supported by the positive relationship between incidence and county wealth displayed in figure 1.12. County wealth is proxied here using the average number of chimneys per house in the county. This information derives from a 17th century table held by the early economist and demographer Sir William Petty, and ultimately from contemporary hearth tax returns.[211] Figure 1.12 shows county-level wealth correlates positively with the incidence of plague. The areas of England affected most were those with the highest levels of wealth. In pre-industrial England, this wealth was a function of greater grain yields and urban trading activity. Greater wealth also generally meant greater inequality and greater levels of population density. These factors may also help explain the differences in mortality across Europe – England was poorer, less urbanised, and less densely connected than northern Italy and the Low Countries. Middlesex, the area that most closely resembled these European regions in terms of wealth, trade, and population density, is the county for which the dynamics of plague are most similar.

[211] Slack, P. Measuring the national wealth in seventeenth-century England. *Econ Hist Rev* 57, 607–635 (2004) see p.617-619 for discussion. Table is printed in appendix.

Figure 1.12. Average Plague Incidence (County Level) vs Mean Chimneys Per House in Heath Tax



Note: The incidence data was aggregated using inverse probability weighting for each surge and then the mean incidence was averaged across surges.

Settlement Level Mortality Patterns

If the vulnerability of settlements varied by county and region, it varied even more heavily by population size. This general feature of early modern plague surges has been found repeatedly in early modern England, though the relationship is investigated here with new levels of precision.[212] The data presented in figure 1.13 confirms a consistent and very strong association for England that holds across the whole distribution of settlement sizes. Major towns like Bristol or Norwich were almost 5 times more likely to experience an outbreak than a market town with less than 2,500 people and market towns were 2.3 times more likely than large villages. On the one hand this is exactly what would be predicted given the greater communications of large settlements with all others in the transportation network. There is the highest probability of disease reaching the most connected settlements and the most connected settlements also tend to be the largest. That explains why similar associations are visible for the influenza epidemic of 1557 and the harvest failure of 1596-8. Figure 1.14 describes the association between incidence and settlement size for plague alongside the influenza epidemic of 1557 and the harvest failure of 1596-8. To make the data comparable, all crises of 2+ month duration are included. In all three cases, larger settlements are much more likely to be affected.

[212] Slack, *Impact*, chapter 4; Wrigley and Schofield, *Population History*, 687

Figure 1.13. The Mean Incidence of Plague in 7 English Plague Surges by Settlement Size

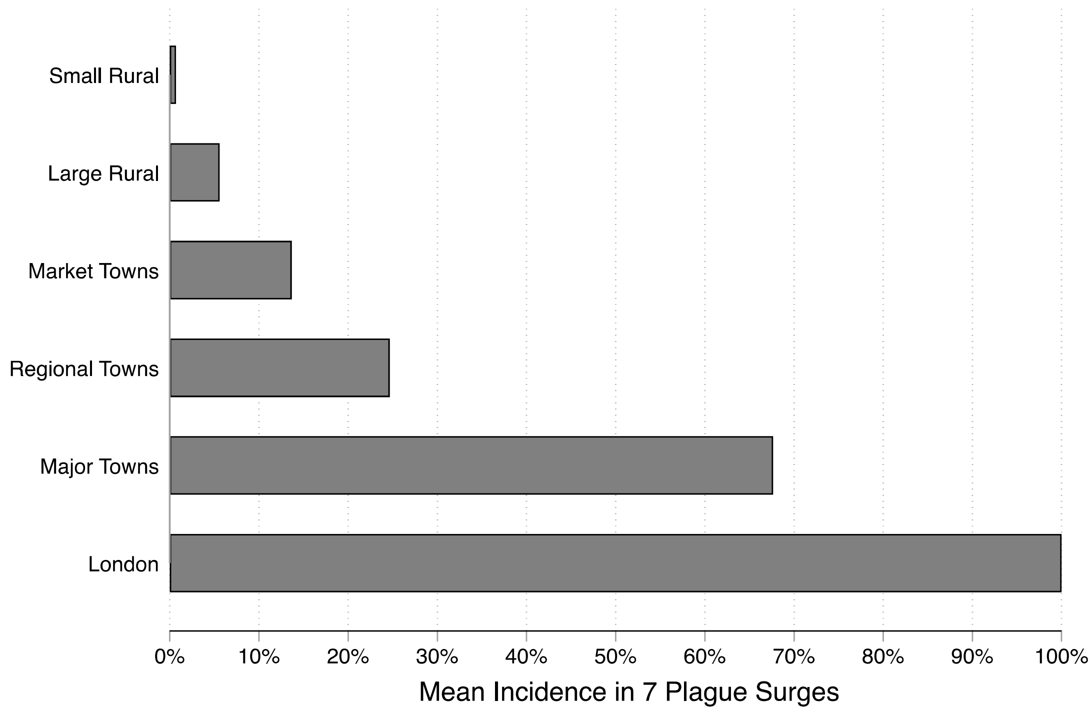
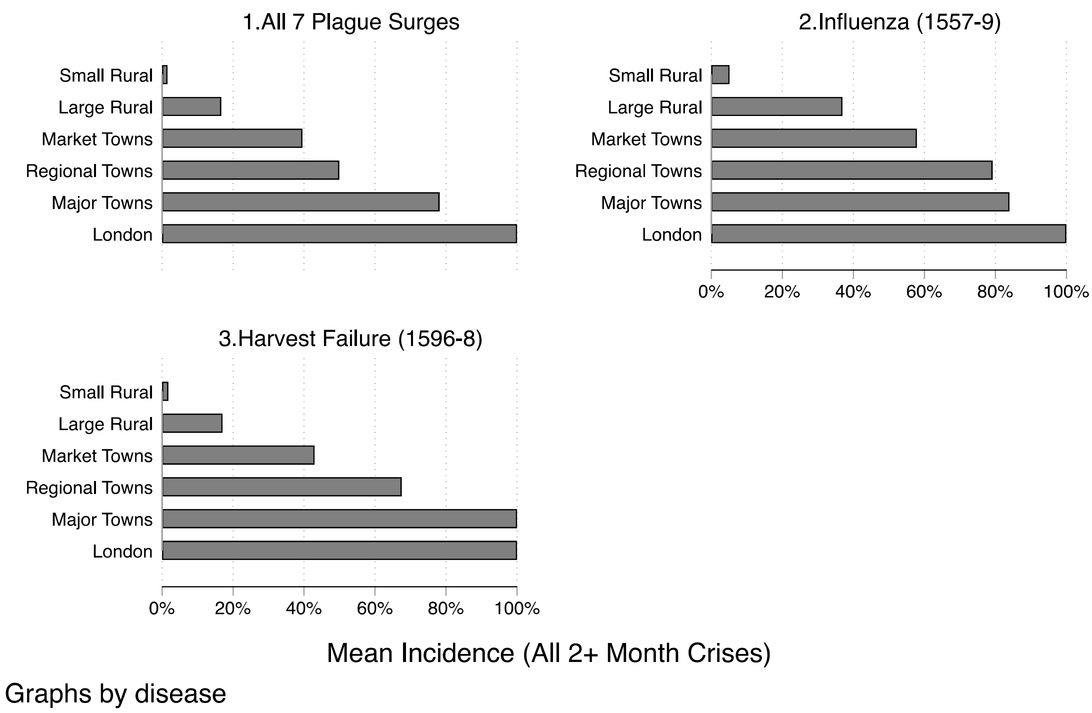


Figure 1.14. The Incidence of Crisis Mortality due to Plague, Influenza, and Harvest Failure by Settlement Size



Yet whilst the general pattern is the same, the causes of mortality crises do produce important idiosyncrasies in the character of the settlement size – incidence relationship. The association is weakest for influenza where major towns were only 6% more likely to experience a crisis than regional towns, 45% more likely than market towns and 120% more likely than large rural settlements. The softer gradient (compared to plague) is easily explained by the transmissibility and case fatality of the disease. Influenza is highly infectious and less fatal than plague and therefore travels further. In contrast, mortality from harvest failures was more tightly concentrated in large settlements and particularly in towns than influenza and plague. Major towns were 6 times more likely to experience a crisis than large rural settlements. This may initially seem counterintuitive, but it should be remembered that the urban poor – without access to land for their own subsistence - were particularly vulnerable to high food prices. Moreover, during periods of subsistence crisis, impoverished rural people migrated to towns in search of alternative employment – bringing with them disease and intensifying problems of overcrowding in poor neighbourhoods. Once again plague falls between these other two causes of mortality crisis. On the one hand, its transmission to smaller settlements was reduced by its lethality or reliance on ectoparasites. On the other, its weaker association with poverty than subsistence crisis meant it reached smaller communities to a greater extent.

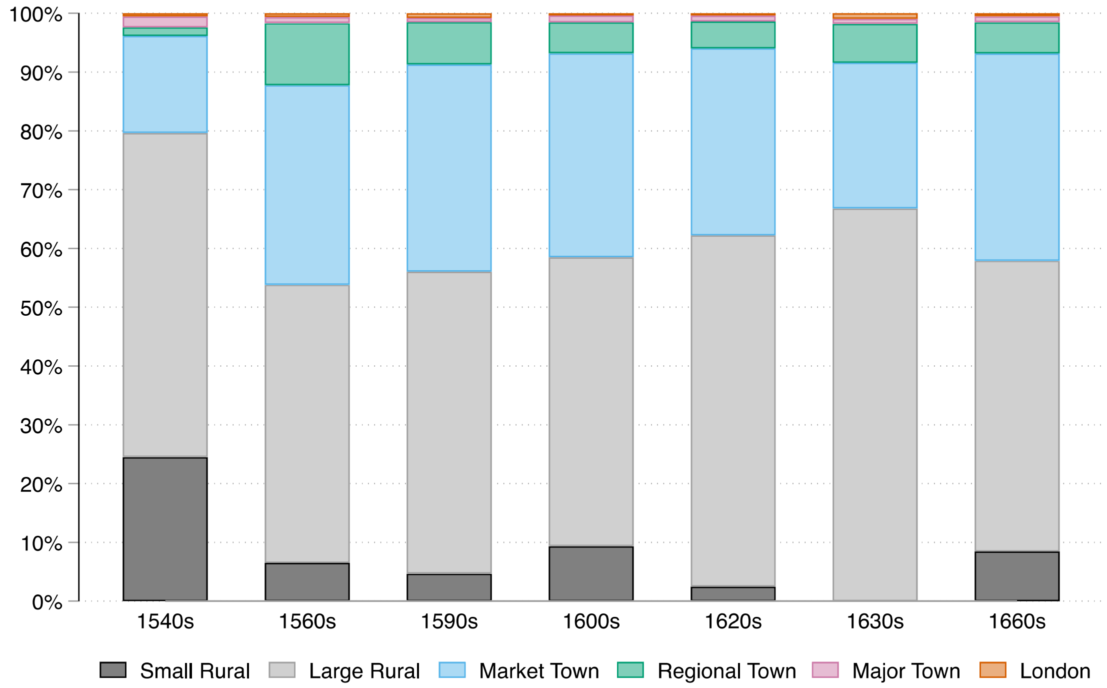
The strong urban bias in incidence contrasts very sharply with patterns found in contemporaneous plague surges in the Low Countries, Italy, and central Europe. Though he does not produce precise statistics, Eckert's impression from studying 850 parish registers from across central Europe was that in contrast to England, 'plague was just as active in rural parishes… as in the cities.'[213] Curtis finds 83% of rural settlements with burials of 6 per year or more were affected on average across three 17th century plague surges.[214] In England (and using the same 6 burial threshold), only 5.5% of large rural settlements were affected. Even if we restrict the analysis to only those settlements within 25 miles of London – the region most heavily affected in every major outbreak – we still only find 24% of large rural settlements were affected, on average. If we further abandon the seasonality conditions used to identify plague epidemics, the incidence of large rural settlements rises to 33% - still less than half the levels found in the Low Countries. Curtis argues high rural incidence is explained by the high quality of road and water transportation, as well as the high levels of market integration in the Low Countries.[215] However, that even in the vicinity of London plague failed to reach a minimum of two thirds of settlements suggests further explanations are required.

As discussed above, the average level of severity was also lower in England than elsewhere in Europe. However, the relationship between severity and population size is more comparable. Whilst the average deviation from trend burials is higher in London than other settlements (400% vs mean for all settlements of 240%), there is no general relationship. For instance, major towns experienced average deviations of 230%, the same as the average for

[213] Eckert, *Retreat*, 5
[214] *Curtis, Was Plague*
[215] *Curtis, Was Plague*

large villages. The same pattern is found by Slack in his case studies of English counties, by Alfani in 17th century Italy, and Curtis in 17th century Low Countries.[216] Benedictow also finds no evidence of a correlation between morbidity and population size in early modern France or Italy.[217] He argues this pattern does not fit with a human-to-human transmission model. A disease that spreads between people should produce higher morbidity (and therefore mortality) when population density is higher, as it would be in a town than in a village.[218] He therefore suggests the lack of relationship between population size and severity is due to the rat-based nature of plague. However, I am also unable to detect an association between severity and population size during the influenza epidemic in 1557-9 or the harvest failure of 1596-8. There are too many potential drivers of severity to draw any clear conclusions about its relationship with severity using simple descriptive statistics. This relationship deserves greater attention in future work.

Figure 1.15. The Composition of the 7 Plague Surges by Settlement Type



But if plague epidemics show a marked bias towards large and particularly urban settlements, did this relationship change over time? This is an important question for understanding how the demographic impact of plague could have declined so dramatically after the 14th and 15th centuries. The existing evidence concerning whether plague became an increasingly urban disease is inconclusive. Slack found plague epidemics spread less widely, especially among the villages in Devon after 1540 but in Essex no such trend was visible.[219] Figure 1.15 shows the proportion of all epidemics attributable to each settlement category in each plague surge. It reveals no sign of a general trend towards greater concentration of plague in urban

[216] Slack, *Impact*, 109; *Curtis, Was Plague*, 162-165; Alfani, *Plague in the Seventeenth Century*, 417
[217] Benedictow, *Morbidity*, 419
[218] Benedictow, *Morbidity*, 419
[219] Slack, *Impact*, 84; 104

settlements. In fact, between 1560s and the 1630s there is an increase in the proportion of epidemics occurring in rural settlements from 54% to 67%. This could reflect the greater integration of rural settlements into trading networks over this period.

The only evidence suggesting plague became more urban comes from the 1540s when 80% of epidemics occurred in rural settlements. The main difference between the composition of outbreaks in the 1540s and later surges is that a quarter of epidemics are attributable to small rural settlements whereas for the other surges this figure ranges from 0 to 9%. The most likely explanation for this difference is that it derives from using weighted averages at this early date when coverage is low. As discussed above, this leads to unrealistic reliance on a few settlements and undermines representativeness. If the proportion of small rural settlements is estimated without weighting, the 1540s no longer stand out. Small rural settlements comprise 12% of the total in the 1540s whilst for the other plague surges this figure is between 2% and 11%. More generally, the unweighted estimates confirm the general conclusion that there was no trend towards greater concentration of plague in towns. Plague was more likely to affect towns, but that vulnerability did not change over time.

So far, we have studied the incidence and severity of plague at the national, regional, county, and settlement levels. This has revealed, in detail, plague's distinctive impact. It preferred wealthy, densely populated areas and was by far the most regular cause of nationally significant crisis mortality. The impact of plague also stayed broadly constant over time, even if some outbreaks were deadlier and spread further than others. These findings have important implications for the broader literature on plague during the Second Pandemic. How could this disease, which affected no more than 2% - 4% of English settlements in the 16th and 17th centuries, have been responsible for regulating national population levels in the 14th and 15th centuries when population was less dense? Is it realistic to believe plague could spread between people (without rat intermediaries) when it was so markedly constrained in its ability to travel to smaller settlements? Why did a disease with no sign of declining incidence or severity suddenly disappear from England after 1667?

The Transport Network

Understanding the ways plague did or did not travel between settlements is a crucial area for investigating these questions further. Many historians have sensibly assumed plague's ability to travel by ship, river boat, cart, or pack horse.[220] Only one attempt has been made to measure this systematically.[221] Whilst the paper does find a strong association between navigable rivers and the incidence of plague, its uncritical reliance on Biraben's very unrepresentative European plague incidence dataset means its findings should be treated with some caution.[222] It is also unfortunate that the authors only study the relationship between

[220] E.g Slack, *Impact*, 86; *Curtis, Was Plague,* 165-6,
[221] Yue, R. P. H., Lee, H. F. & Wu, C. Y. H. Navigable rivers facilitated the spread and recurrence of plague in pre-industrial Europe. *Sci Rep-uk* 6, 34867 (2016).
[222] Roosen, J. and Curtis, D. R. Dangers of Noncritical Use of Historical Plague Data. *Emerg Infect Dis* 24, 104-107 (2018)

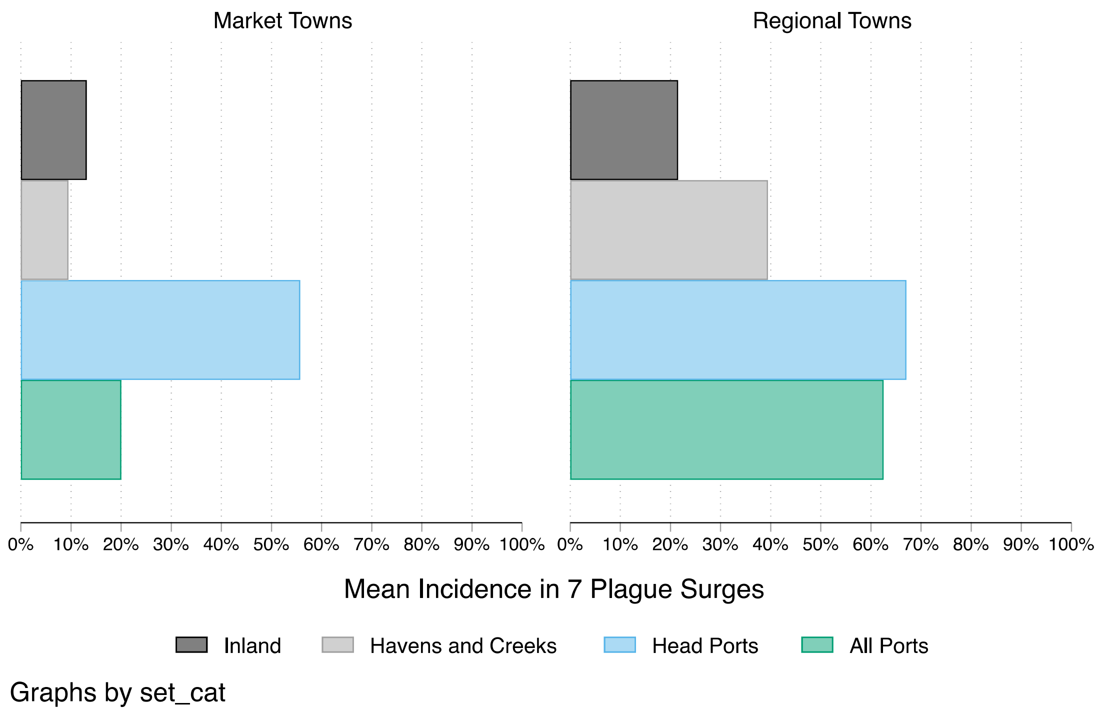
plague outbreaks and navigable rivers without comparing plague's ability to travel using different forms of transportation. Here I analyse the weighted aggregated incidence data for English settlements to investigate how a settlement's susceptibility to plague changed depending on exposure to different forms of transportation. This will allow us to address the broader questions about plague's reduced demographic impact, modes of transmission, and sudden disappearance.

In early modern England, one of the most efficient forms of long-distance transportation, particularly for bulk goods like grain, timber, and coal, was costal shipping. If plague was travelling using these shipping networks, we should find port towns were more susceptible to an outbreak than towns of a similar size situated inland. Figure 1.16 displays average incidence across the 7 plague surges for regional and market towns with separate figures for ports and inland settlements. Connectivity to shipping doubled a settlement's vulnerability to epidemics overall. For market towns, ports were around 1.5 times more likely to experience a plague outbreak on average (20% vs 13%). For regional towns, ports were 2.7 times more vulnerable (63% vs 22%). Plague travelled very effectively by ship.

The greater difference in incidence between larger inland and port towns is probably explained by the disparity in traffic through the ports of larger settlements. Figure 1.16 supports this by separating out the most important ports, using designations of main 'head' ports and smaller 'havens' or 'creeks' that are used in contemporary customs accounts.[223] For market towns, it was only the larger head ports that experienced elevated risk of experiencing an epidemic and even for the larger – and therefore better connected – regional towns, head ports were 1.7 times more likely to experience an outbreak than havens and creeks (67% vs 39%) and 3 times more likely than inland towns of a similar size (69% vs 22%). The greater the flow of ships through these ports, the higher the chance plague would drop anchor.

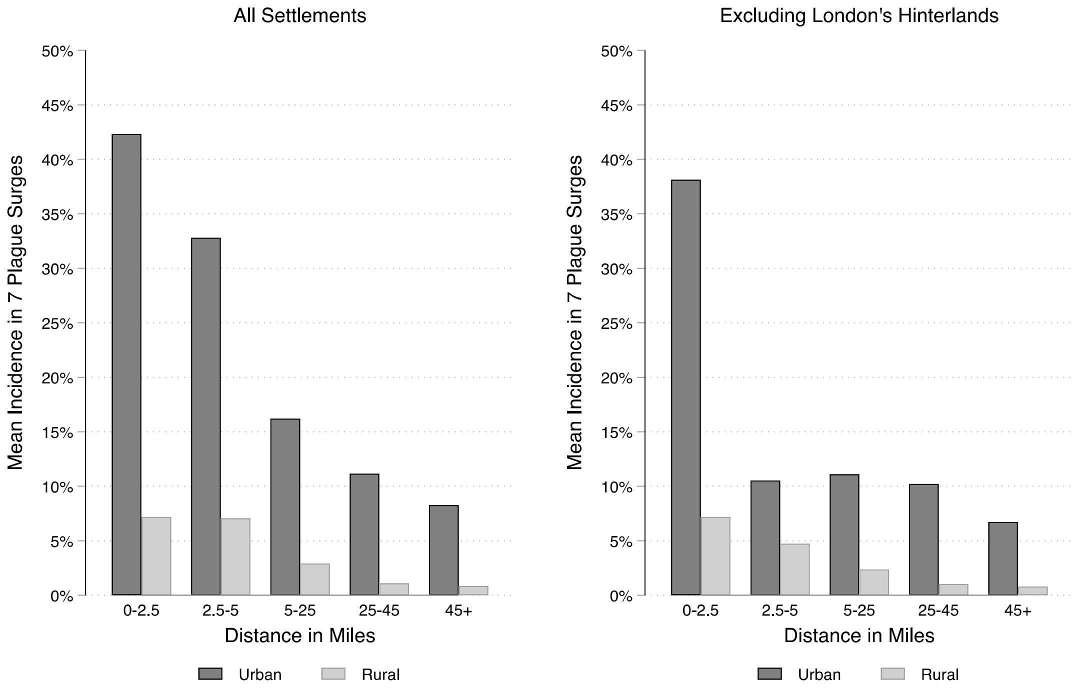
[223] Sacks, D and Lynch, M. 'Chapter 12. Ports 1540-1700' in Clark, P (eds). The Cambridge Urban History of Britain: Volume 2, 1540-1840. Vol. 2. (Cambridge, 2008), 388-9

Figure 1.16. Incidence for Ports and Inland Settlements in 7 Plague Surges by Town Size



Ports also acted as important centres for the dissemination of plague inland. Figure 1.17 analyses the changing vulnerability of towns and villages to plague depending on their distance to the nearest port for all settlements and for those for which London is not their nearest port. Ports themselves are excluded from the analysis. Figure 1.17 shows the probability of a town situated within 2.5 miles of a port experiencing an outbreak was almost as high as for the ports themselves (38% to 42% vs 60% for all head ports). The full sample shows a consistent negative relationship between incidence and distance for urban and rural settlements alike though for towns this pattern breaks down when settlements near London are excluded. Whilst rural settlements still show a consistent pattern, towns more than 2.5 miles from a port experience no additional vulnerability. This chart reveals the far-reaching effects of London's epidemiological environment on nearby towns, perhaps in part due to the active river trade with towns along the Thames. That the association between incidence and distance to ports remains consistent for rural settlements across England probably reflects the smaller number of potential locations with which smaller settlements had regular communication. Ports, and particularly London, acted as transmitters of plague to more locally orientated settlements.

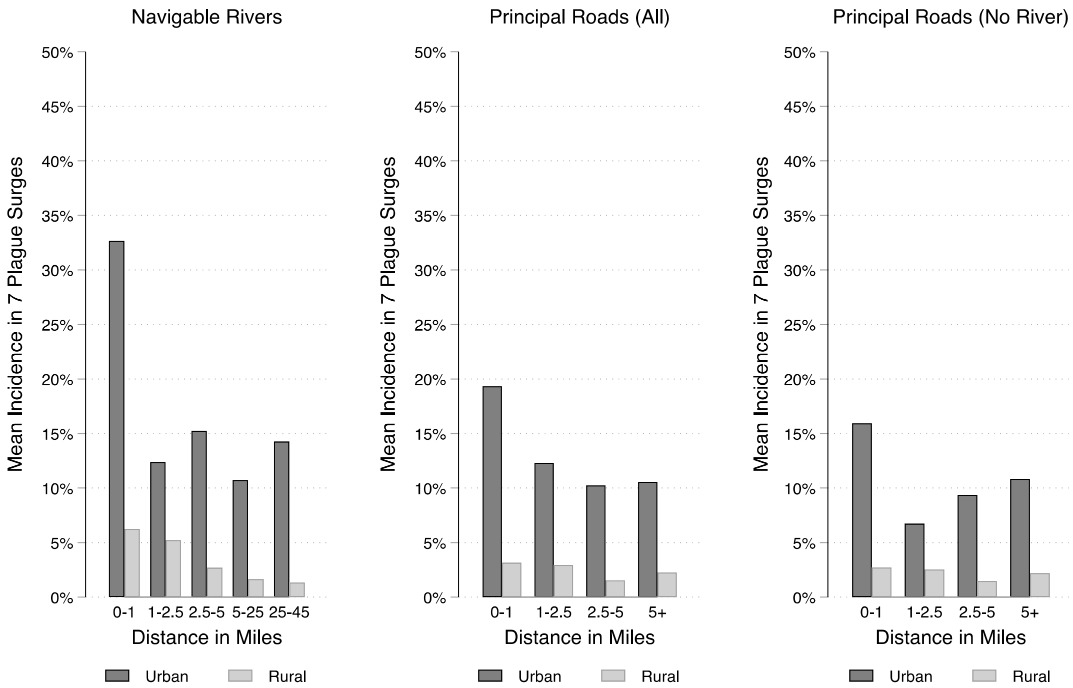
Figure 1.17. Average Plague Incidence for Urban and Rural Settlements vs Distance to Nearest Port in Miles, All Settlements and Excluding London's Hinterlands



Those settlements were exposed to infection from people and goods arriving by both river and road. This can be seen in the first panel of figure 1.18 which shows the relationship between mean incidence across the 7 plague surges and distance from a navigable river for rural and urban settlements. Whilst we do not have data on the exact locations of river ports, it is likely that settlements within a mile of a navigable river were located on its banks with direct access. For towns, being located on a navigable river increased vulnerability to plague by a factor of 2.6 (33% vs average of c.12.5% for settlements further away). Though, for towns located any further away than a mile, there is no further evidence of a relationship with distance. This again suggests there were too many other sources of infection for towns. This theory is supported by the second panel of figure 1.18 which describes the relationship between incidence and distance from the nearest of the 'principal roads' mapped by Ogilby in 1671. This reveals a more consistent negative relationship for towns, showing many were vulnerable to plague arriving over land as well. For rural settlements, there is a consistent negative relationship between incidence and distance from both navigable rivers and principal roads. Plague could utilise a range of transportation to reach new settlements.

That said, figure 1.18 also shows navigable rivers were the most effective channel through which plague was transmitted. Settlements located on or very near a navigable river were 1.7 times more likely to witness an outbreak than settlements located within the same proximity of a principal road. However, this probably understates the additional vulnerability caused by navigable rivers because some settlements were located on the intersection of rivers and roads. The third panel of figure 1.18 tests this by recalculating the association between incidence and distance from principal roads with settlements located within a mile of a navigable river excluded from the sample. It shows, settlements within a mile of navigable rivers were about twice as vulnerable as settlements that were only directly accessible by road. Plague travelled over land, but it had a predilection for water transport.

Figure 1.18. Average Plague Incidence for Urban and Rural Settlements vs Distance to Nearest Navigable River and Principal Road, With and Without Settlements on Navigable Rivers



Note: Like the analysis of ports above, all major towns and London are excluded from these samples.

The importance of water transport for the spread of plague helps to explain why it failed to reach more than 5%-8% of English settlements in the early modern period when it must have reached a much higher proportion of settlements in the 14th century. The extent of the navigable river network declined substantially after the Black Death, partly due to the growing number of bridges and mills.[224] It is also likely the volume of trade in bulk goods like grain – the most common goods to be transported by boat - declined with the reduction in population from the 14th to early 16th centuries.[225] This would have reduced demand for river transportation and thus the need to prevent rivers becoming silted up. The Great Ouse lost around 20 miles of navigable river between the 13th and 17th centuries, stretching from St Ivies to Bedford. Similarly, in the 13th century the Thames was navigable for 100 miles upstream of London (to the village of Radcot in west Oxfordshire) but by 1600 had lost about

[224] Satchell, M. Navigable waterways and the economy of England and Wales: 1600-1835. [Unpublished] (2017) Available: https://www.campop.geog.cam.ac.uk/research/projects/transport/onlineatlas/waterways.pdf [Accessed 29.09.2023], 13-17 (https://www.campop.geog.cam.ac.uk/research/projects/transport/onlineatlas/waterways.pdf)
[225] Clark, G. The long march of history: Farm wages, population, and economic growth, England 1209–18691. *Econ Hist Rev* 60, 97–135 (2007), 123

35 miles and was no longer navigable all the way to Oxford.[226] There is evidence the size and quantity of vessels used on navigable rivers also declined dramatically.[227] The decline in both the extent and intensity of water transportation may help explain why early modern plagues were relatively limited in their pervasiveness.

Yet this raises the question of why plague did not become more pervasive as trade expanded again around 1600. Beginning with improvements to the River Lea in Middlesex in the later 16th century, navigable rivers were once again extended to support growing levels of trade.[228] The Severn, Avon, and Thames were all extended in the 1630s and 1640s and in the east, fen drainage projects led to the creation of new waterways that were also used for trade.[229] Grain markets also become more integrated in this period, suggesting greater volumes of trade and more frequent shipments.[230] However, as we have seen, there is no long-term trend in the proportion of settlements affected in the 7 plague surges between 1540 and 1670 and the final two of these surges were relatively limited in scope. Why did the extension of trade not increase the number of settlements affected by plague? Whilst the data cannot address this question, one possibility is that over the 300 years since the Black Death, local communities had learned how to limit the spread of plague through the restriction of water transport to and from affected settlements. We know, for instance, that ships were prevented from travelling from Yarmouth to the Tyne to collect salt in 1636.[231] These systems may not have been sufficient to prevent epidemics entirely (especially since plague could also travel by road), but it may have been sufficient to counter act the tendency towards greater levels of pervasiveness created by the extension and greater intensity of trade.

The relative importance of road and river transport for the dissemination of plague is also very important for understanding its transmission mechanisms. Historians still debate the extent to which plague was transmitted by human ectoparasites (the human flea - *Pulex irritans* - or the body louse - *Pediculus humanus humanus*) rather than by the traditional culprit – the fleas of the black rat (*Xenopsylla cheopis)*.[232] Settlements closely associated with water transport were much more likely to experience a plague outbreak. This suggests the black rat (also known as the ship rat) and its fleas were important for the triggering of an epidemic. However, since plague could clearly travel by road and rats are unlikely to remain in a moving cart and certainly not in hand-held luggage, plague must have been carried either by infected people (who were subsequently bitten by rat fleas in new settlements, setting off a fresh epizootic) or, perhaps more likely, by ectoparasites inhabiting clothing or the goods people carried. This suggests the common tropes about plague arriving with parcels of cloth

[226] Satchell, *Navigable Waterways*, 13
[227] Satchell, *Navigable Waterways*, 13-14
[228] Satchell, *Navigable Waterways*, 17
[229] Satchell, *Navigable Waterways*, 18-21
[230] Federico, G., Schulze, M.-S. & Volckart, O. European Goods Market Integration in the Very Long Run: From the Black Death to the First World War. *J Econ Hist* 81, 276–308 (2021), 293-294
[231] Richard Welford, History of Newcastle and Gateshead Volume 3 (London: Walter Scott, 1887), 342
[232] Cohen, *The Historian*, 196-7; Little, *Plague Historians*, 274-282 (2011), Benedictow, *Epidemiology*, Dean et al, *Human ectoparasites*

(most famously associated with Eyam in 1666) may have some truth.[233] Of course, if plague could travel long-distance via ectoparasites without the involvement of rats, it seems reasonable to think it could also travel short distances– for instance between multiple members of the same family. Nevertheless, plague's preference for water transmission suggests rats were involved, even if it was not necessary for every human infection to be caused by a fresh flea jump from a dying rat host.

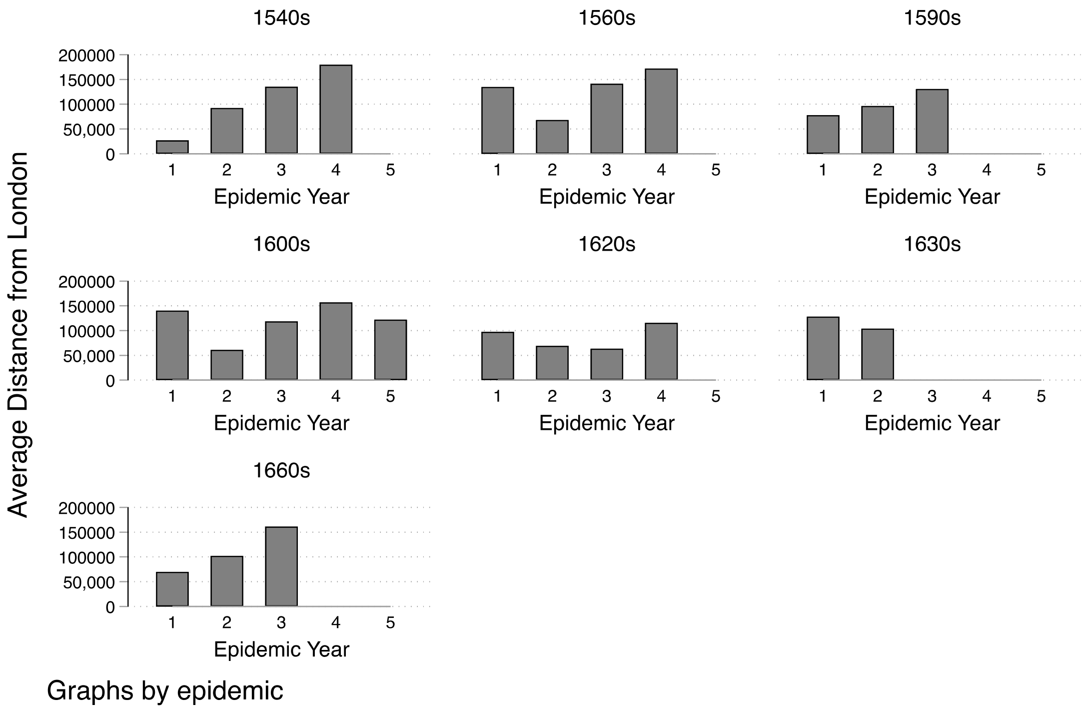
The Importation of Plague

The ease with which plague travelled by boat and ship and the additional vulnerability of settlements near ports and waterways also suggests English plague surges were triggered by the arrival of plague from abroad. Until relatively recently, this was taken for granted by historians including Shrewsbury and Slack.[234] Indeed, the assumption that plague surges were imported is key to Slack's argument that the disappearance of plague in after 1667 was due to the successful implementation of ship quarantine.[235] However, several studies argue plague surges could have been caused by spillovers from a domestic plague reservoir among the London rat population.[236] Cummins et al argue this because plague did not begin in London parishes closest to the river Thames. The results presented here appear to contradict those of Cummins et al. However, the contradiction could be resolved if rats, not humans, were responsible for transporting plague from the London docks to the suburbs where the first signs of a human epidemic are visible. That said, whilst the plague spread through the water transportation network, it could still have originated in the London rat population, rather than abroad.

The evidence from the parish register data does not support the theory that plague outbreaks originated from the London rat population. Figure 1.19 describes the average distance from London of affected settlements in each year of each major plague surge. This shows that plague did not always immediately radiate out from the capital. In 4 of the 7 surges (1560s, 1600s, 1620s, and 1630s) plague affects settlements that were on average further from the capital than settlements affected in subsequent years. Though there are clear signs that once plague hit London and its vicinity, the area acted as an important transmitter of plague to settlements across the country with average distance to London increasing again in all but one instance – the 1630s when the period under study is cut short because of the eruption of a flu-like epidemic in 1638. Plague surges did not in all cases originate in London, but they were propelled by it.

233 Wallis, P. A Dreadful Heritage: Interpreting Epidemic Disease at Eyam, 1666–2000. *History workshop journal* 61, no. 1 (2006): 31–56; Risse, *Mending*, 191; Palmer, *Control*, XV
234 Slack, *Impact*, 68; Shrewsbury, *History*, 371
235 Slack, *Disappearance*, 470
236 Keeling and Gilligan, *Metapopulation dynamics*, 903–906; Cummins et al, *Living Standards*, 19

Figure 1.19. Average Distance to London of Affected Settlements Across Epidemic Years



This impression is confirmed if we investigate the dispersion of plague during the surge beginning in 1602 in more detail. This surge was chosen because the very low plague activity in previous years means it is clearly defined. The maps in figures 1.20 to 1.25 (located after conclusion) show 6 snapshots of the settlements affected during this outbreak. Newly affected settlements are displayed in focus with settlements affected in previous periods blurred. The distribution of all settlements in observation are also faintly displayed, as are Ogilby's principal roads (black) and the navigable river network (blue) in 1601. The maps show plague activity was initially concentrated in the east of England, near or on the coast. There is also evidence of plague in London, but the pattern suggests multiple entry points of the disease (one around Yarmouth and a second around London) rather than dissemination from the capital.

In contrast, the dispersion of newly affected settlements in the first half of 1603 suggests London quickly became the most important source of subsequent introductions. By the end of 1603, plague epidemics had broken out in settlements right across eastern and south-eastern England and there is a particular concentration along the Thames valley. Plague also reached Bristol, potentially via Marlborough, from where it appears to have spread across the southwest in the following years. The final maps show plague activity expanding extensively and intensively, with new outbreaks in the already most affected regions combined with extension north and west, including to Manchester in 1605 where it caused a famously devasting outbreak.[237] Overall, the maps suggest plague was introduced in multiple locations with London quickly becoming the greatest source of subsequent epidemics, presumably because it was the centre of the national trade and transportation network.

Further evidence that plague surges originated abroad comes from the tight association between major English outbreaks and those of the wider European maritime region stretching from Brittany to the Baltic but centred on the Low Countries.[238] For instance, the outbreak of 1602-5 was preceded by major outbreaks in Norway (1600), Denmark (1600), and the Low Countries (1601).[239] English governments tried to prevent the importation of plague from Amsterdam which suffered epidemics in 1602, 1635, and 1663 – directly before outbreaks in England.[240] There is also a clear synchronisation between plagues in London and those in southern Germany and Switzerland.[241] This suggests England was involved in a much wider European network of plague dissemination and not experiencing separate and internally generated epidemics.

Conclusion

This chapter describes the dynamics of plague in 7 of the most severe plague surges to hit early modern England. To do this, I construct a new dataset of parish register burials covering 4,000 parishes and apply a weighting procedure to improve representativeness. I also implement an approach to identifying plague systematically which relies on the severity, duration, and seasonality of plague epidemics. The analysis confirms existing estimates of English plague mortality in the early modern period were low both by the standards of the Black Death and of contemporary continental plagues. By measuring pervasiveness across plague surges for the first time, I show this is largely because plague failed to spread widely between settlements, with around 3.5% of settlements affected on average. Severity was also much lower than in European and medieval outbreaks. The pervasiveness of plague also changed little over time, prompting questions about when the transition from medieval to early modern plague dynamics occurred in England and why.

Variations in incidence and severity at the regional, county and settlement levels show plague had a strong predilection for wealthy, southern areas with high population density. In contrast to plague epidemics elsewhere and to a contemporary influenza epidemic, plague struggled to

---

[237] Willan, T. S. The Plague in Perspective: The Case of Manchester in 1605. *Transactions of the Historic Society of Lancashire and Cheshire* 132, (1982).
[238] Eckert, *Structure*, 69-70
[239] Eckert, *Structure*, 114
[240] 'Cecil Papers: July 1602, 21-25', in *Calendar of the Cecil Papers in Hatfield House: Volume 12, 1602-1603*, ed. R A Roberts (London, 1910), 239-252. *British History Online* http://www.british-history.ac.uk/cal-cecil-papers/vol12/pp239-252 [accessed 29 September 2023]; 'Charles I - volume 301: November 1-17, 1635', in *Calendar of State Papers Domestic: Charles I, 1635*, ed. John Bruce (London, 1865), pp. 458-485. *British History Online* http://www.british-history.ac.uk/cal-state-papers/domestic/chas1/1635/pp458-485 [accessed 29 September 2023]; Moote, AL and Moote, D C. The great plague: the story of London's most deadly year (London, 2004), 50-1
[241] Eckert, E.-A. Boundary formation and diffusion of plague: Swiss epidemics from 1562 to 1669. *Ann De Démographie Hist*. 1978, 55

spread to small settlements and particularly to rural villages. That said, villages represented a greater proportion of epidemics over time, perhaps indicating improvements in the market integration of these settlements. Variations in severity are not explained by regional incidence or population size. Regression modelling is needed to tease out the determinants of severity during plague outbreaks, this work may also benefit from using data with greater temporal resolution. These results show clearly why the national impact of plague was so relatively limited.

The most vulnerable settlements were ports, specifically the most important ‘head ports’, and the settlements located close by. This, and the additional heightened vulnerability of settlements on and near navigable rivers, shows plague preferred to travel by boat. Though, the association between distance from principal roads and settlements not located on a river show plague could also travel across land, if less efficiently. The predilection for water transport points to an important role for black (or ship) rats in the transmission of plague to humans, as does the poorer efficiency of transmission between settlements compared to influenza – which does travel directly between people. The lack of an association between settlement-level severity and population size may also point in this direction. That said, the ability for plague to travel across land – and at rapid speeds - shows humans could transport the plague outside of rats and begin an epidemic in a new settlement. The most likely explanation for this is that fleas travelled on human clothing.

Finally, I find strong evidence each plague surge required a new importation of plague, countering the hypothesis that surges were the result of spillovers from the London rat population. Aside from the vulnerability of ports, there is also evidence the average distance of affected settlements form London declined at the start of 4 of the 7 major surges, indicating the plague began to spread outside the capital before the locus of infection moved towards it. This pattern is illustrated clearly in the case study of the 1602-6 epidemic which spread around several settlements near Norwich before the centre of activity shifted to London and then exploded outwards across England. The identification of multiple points of entry supports the idea that English plague surges were just one parts of wider European ‘waves’ of infection and thus supports the ship quarantine hypothesis for plagues disappearance after 1667.

Figure 1.20. Dispersion of Settlements Experiencing Plague, 1602 (New Settlements in Bold)

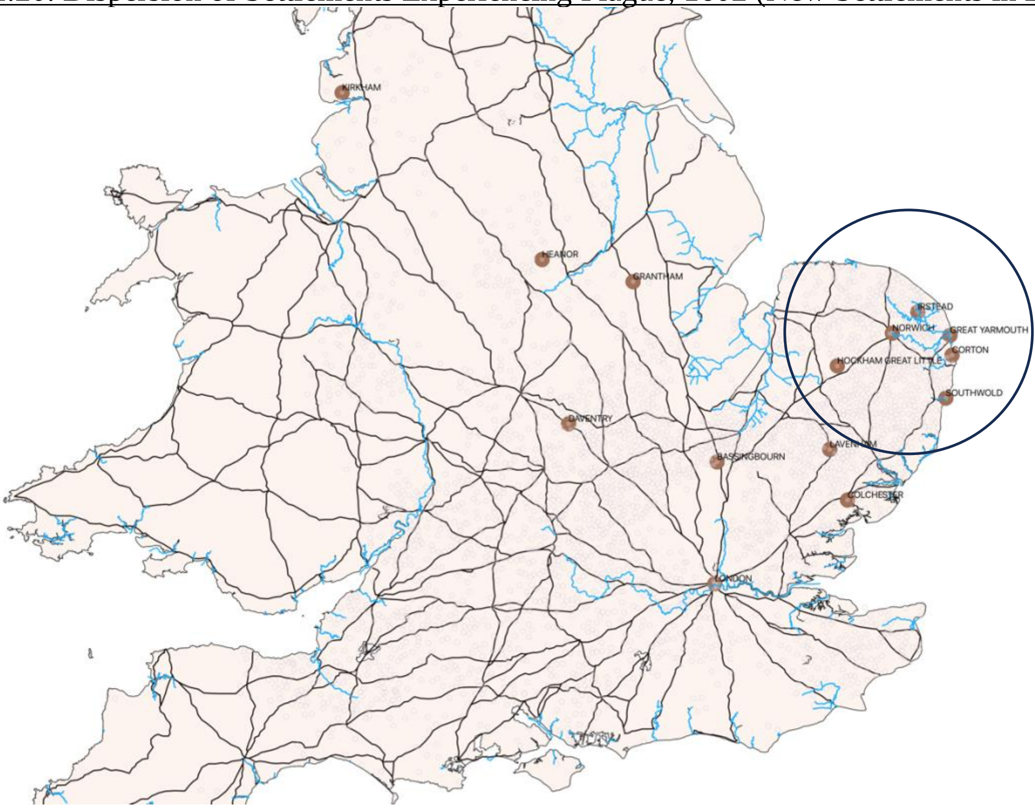


Figure 1.21. Dispersion of Settlements Experiencing Plague, Jan-July 1603 (New Settlements in Bold)

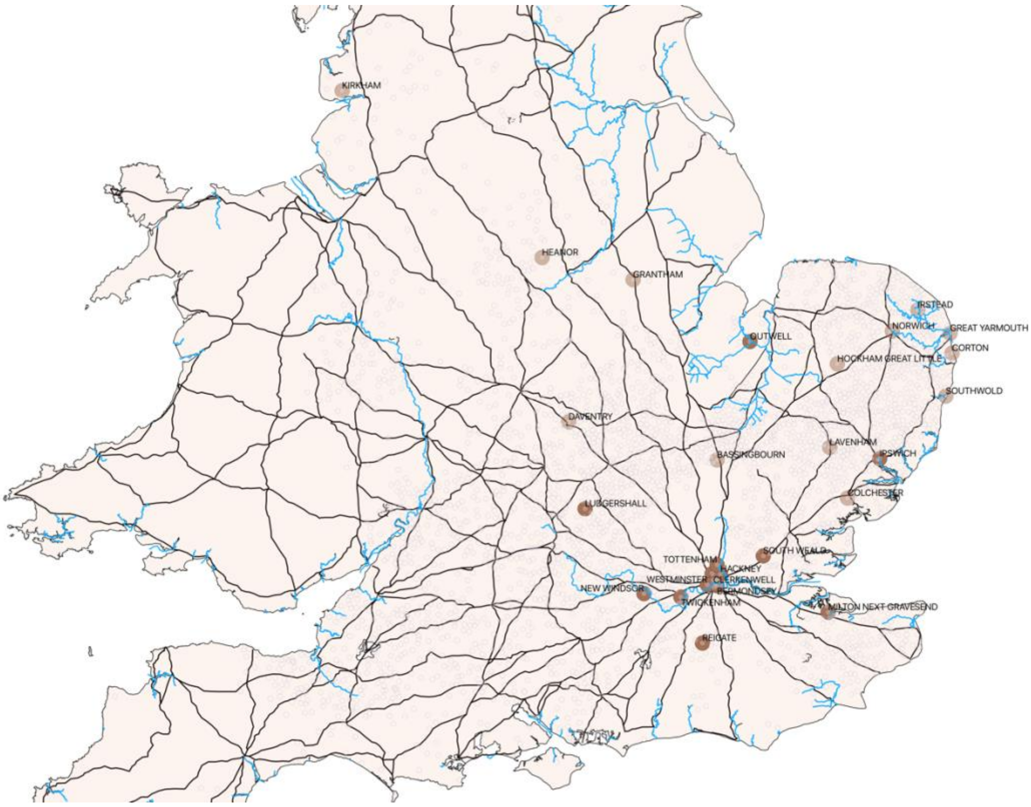


Figure 1.22. Dispersion of Settlements Experiencing Plague, Aug-Dec 1603 (New Settlements in Bold)

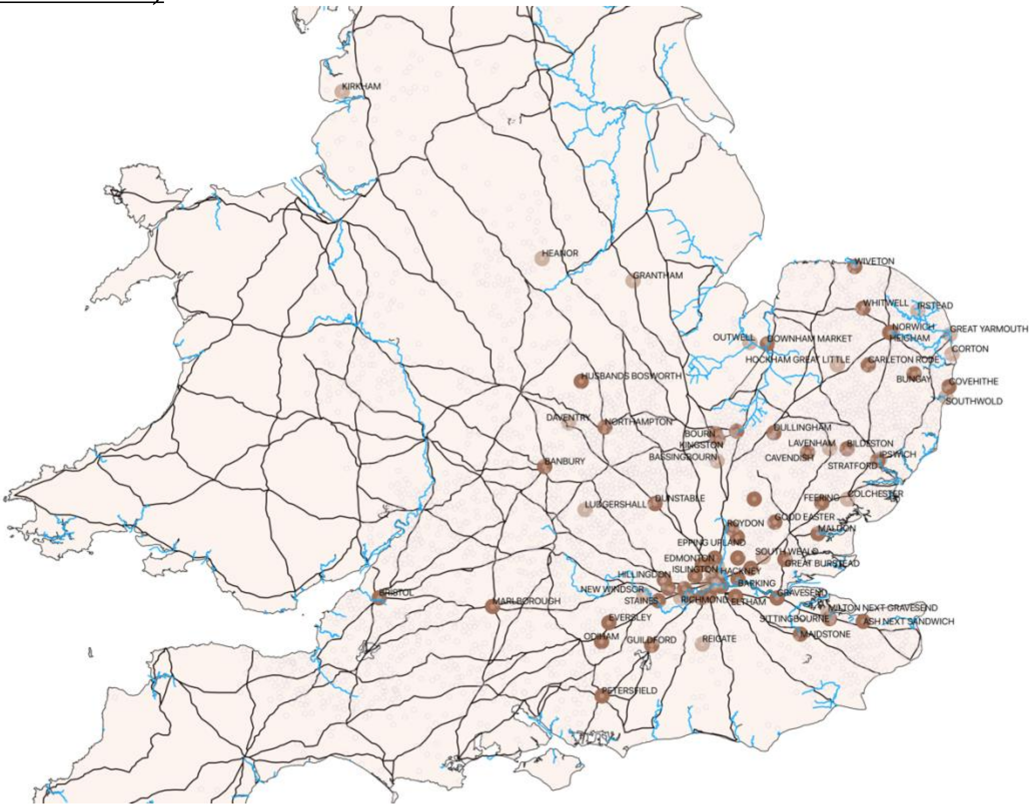


Figure 1.23. Dispersion of Settlements Experiencing Plague, 1604 (New Settlements in Bold)

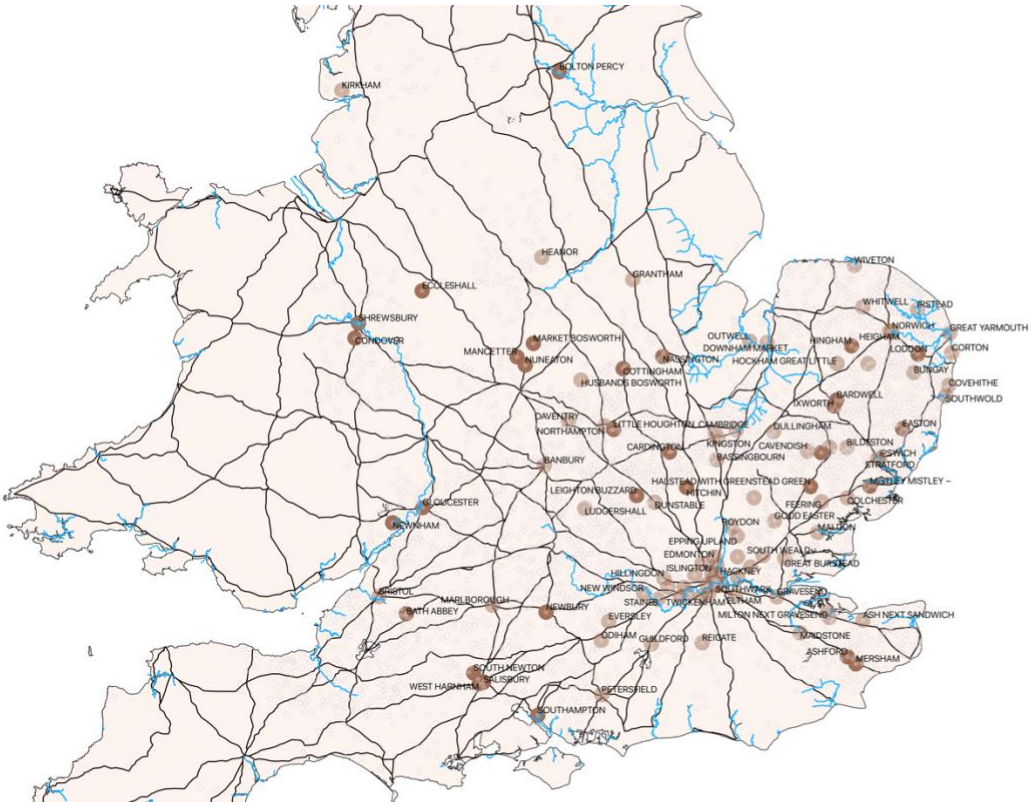


Figure 1.24. Dispersion of Settlements Experiencing Plague, 1605 (New Settlements in Bold)

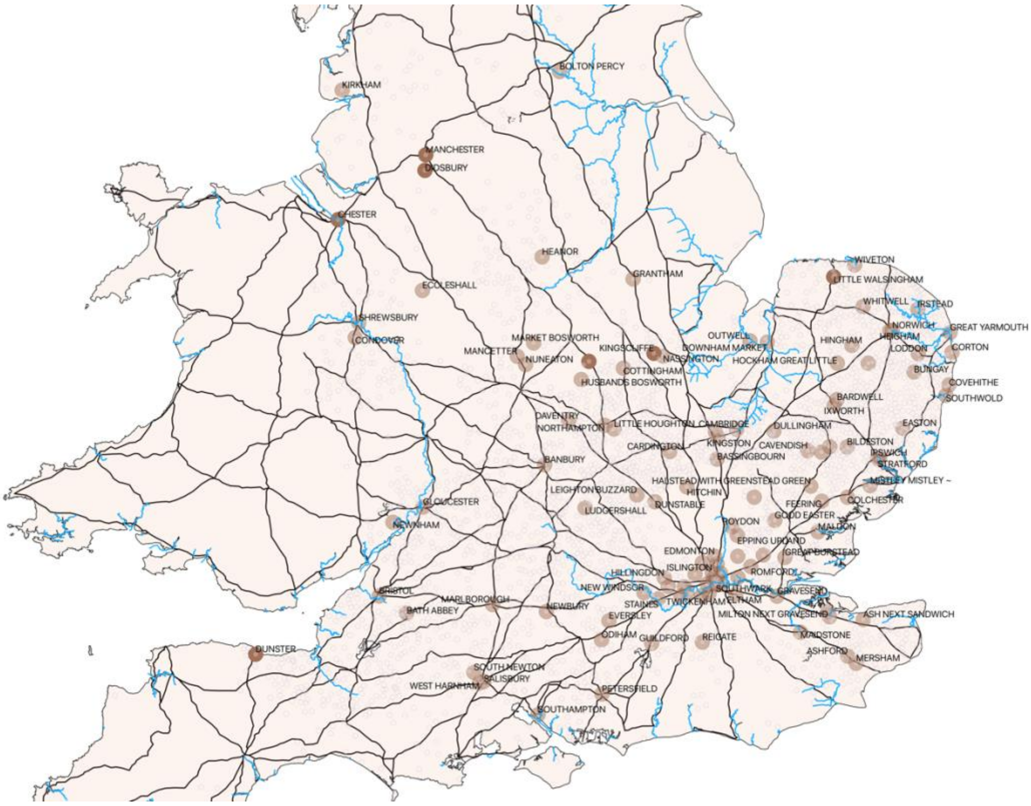
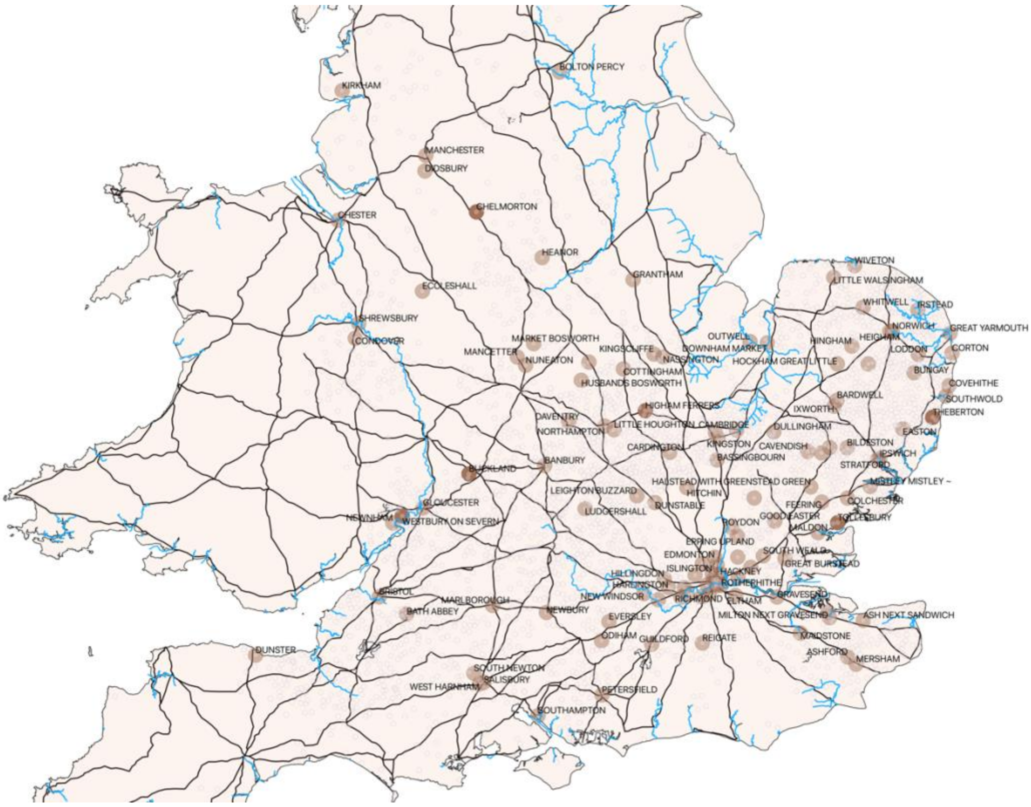


Figure 1.25. Dispersion of Settlements Experiencing Plague, 1606 (New Settlements in Bold)



Chapter 3. The Enforcement of Quarantine in Bristol, 1565-1604

Introduction

Of the many strategies adopted in response to plague, quarantines were the most controversial. Controls at gates and ports were resented but attempts to isolate domestic citizens provoked the most outrage. Across much of Western Europe, local authorities attempted to limit the spread of plague by locking up any suspected carriers in their own homes and supporting them financially where necessary.[242] Many contemporaries saw this as profoundly anti-Christian[243] and economically destructive.[244] Quarantined people are known to have smashed open their padlocked doors and assaulted state officials in attempts to resist incarceration.[245] Yet whilst the costs and controversy of household quarantine policies are clear, we know relatively little about the extent to which they were actually implemented. How successful were early modern states in separating suspected carriers from the healthy population? Were all areas or social groups targeted equally and were quarantines enforced in ways that reveal motivations other than the protection of public health?

As well as costly and controversial, many thought household quarantines were medically dubious. They created incentives for hiding infection, fleeing (and thus spreading disease), and, crucially, they endangered healthy people who were locked up alongside the sick.[246] An anonymous London pamphleteer was speaking for contemporaries across Europe when arguing in 1665 that isolating whole households was actually counterproductive; 'Infection may have killed its thousands, but shutting up hath killed its ten thousands.'[247] Historians concur.[248] Using mortality statistics from quarantined households in Salisbury in 1604, Paul Slack finds a dramatic increase in mortality among household members when they were 'kept in' by the authorities after one person became sick.[249] The proponents of household quarantine recognised this implicitly, but believed the damage was outweighed by the benefits of reducing the number of households infected.[250] Whether or not this was true, household quarantine had lethal consequences for healthy people who were isolated. That this was so presents an opportunity to investigate the extent to which household quarantines were implemented in cities across early modern Europe.

---

[242] In the most advanced cities, plague victims were identified by their symptoms and were then removed to specialised plague hospitals. Henderson, *Invisible Enemy*, 263–274; Slack, *Impact*, chapter 8
[243] *Salomons pest-house*, 62; *Shutting up infected houses*, 6; Slack, *Impact*, 232
[244] *Shutting Up*, 19; Henderson, *Florence under siege*, 132-3 Newman, *Shutt Up*, 817-818; 823
[245] Slack, *Impact*, 298; Tomić and Blažina, *Expelling the Plague*, 14
[246] *Shutting Up*, 9-10
[247] *Shutting Up*, 9-10
[248] Slack, *Impact*, 320; Cipolla, *Flighting Plague*, 18
[249] Slack, *Impact*, 320
[250] Henderson, *Florence under siege*, 132-133; von Ewich, Duetie of a faithfull and wise magistrate, in preseruing and deliuering of the eommon[sic] wealth from infection, in the time of the plague or pestilence: two bookes, trans. J. Stockwood (1583). https://quod.lib.umich.edu/e/eebo/A00472.0001.001/1:1?rgn=div1;view=fulltext (accessed 28 Feb 2022), 53-55

The greatest barrier to understanding the degree to which plague regulations were enforced is the problem of measuring changes in population behaviour. Most studies analyse enforcement using either laws and proclamations or official sources that were generated through the enforcement process.[251] Whilst valuable, laws and proclamations only reflect the intentions of the authorities; they do not reflect what was achieved. Aside from the issue of representativeness (official sources tend to survive for the best administered localities), analysing official sources is problematic because the implementation process is only revealed from the perspective of the state, making it difficult to independently evaluate the state's attempts to change behaviour by preventing contacts. Historians including Paul Slack, Keith Wrightson, and John Henderson, powerfully reveal independent perspectives of quarantine enforcement by analysing court depositions and private correspondences.[252] However, these sources tend to be unsystematic, prone to exaggeration and difficult to measure and compare across time and space.

I propose a new approach which relies on the patterns of mortality caused by household quarantine. This involves linking together surnames listed in burial registers during plague epidemics into household groups and then measuring the impact of quarantine through changes in the level of mortality within those households. As burial registers are the primary source, this approach allows for systematic comparisons of enforcement levels across whole cities and regions instead of being constrained by source availability to a few subunits within these areas. The wide availability of burial data across Europe means this approach can also be used for international comparisons. I demonstrate it here using data from three epidemics that occurred over a 40-year period in early modern Bristol, one of England's most important urban centres. The same approach is also applied to data extracted from Easter tithe books that were first used by Paul Slack to investigate social variations in plague mortality in Bristol.[253] That a national policy of household quarantine was first introduced between the second and third of the Bristol epidemics studied here provides an excellent opportunity to compare mortality patterns and assess the extent of enforcement.

In contrast to the persistent literary tradition stressing social and governmental breakdown in times of plague, historians generally stress continuities in government during post-Black Death epidemics as responses became routinised and measured.[254] Nevertheless, relatively

[251] E.g Newman, *Shutt up*, 816-7; Bowers, *Plague and Public Health*, 57; Tomić and Blažina, *Expelling the Plague*, chapters 5-6

[252] Slack, *Impact*, 278-9; Wrightson, *Ralph Tailor's*, 48-9; Eckert, *Structure*, 24; Calvi, *Histories of a Plague Year*; Parets, *Journal of the Plague Year*; Brockliss and Jones, *The Medical World*.

[253] Slack, P., 'The Local Incidence of Epidemic Disease: The Case of Bristol 1540-1650', in *The Plague Reconsidered: A New Look at Its Origins and Effects in 16th and 17th Century England*, eds Slack, P., and the Cambridge Group for the History of Population Social Structure (Matlock, 1977), pp.49-62; Slack, *Impact*, 124-5

[254] This literary tradition is thought to begin with Thucydides' history of the plague in Athens. Historians who stress continuities in government include: Wrightson, *Ralph Tailor's*, Chapter 4; Slack, *Impact*, Chapter 10; Henderson, *Invisible Enemy*, Chapter 4; Tomić and Blažina, *Expelling the Plague*, Chapters 5 and 6; MacKay, *Life in a Time of Pestilence*, Chapter 6; Bowers, *Plague and Public Health*, Chapter 3. Unlike for medical practitioners, the social responsibility of magistrates to stay in their posts during plague epidemics was widely accepted by the early modern period as much to ensure social order as to alleviate the suffering. Wallis, P.,

few attempts have been made to evaluate the effectiveness of these responses. In the Italian city states, where the most work has been done, historians' evaluations of enforcement suggest considerable variation.[255]As John Henderson demonstrates, the very high proportion of all deaths occurring at plague hospitals in Florence, Pistoia, and Rome during 17th century epidemics suggests the authorities were very successful at identifying and removing the infected.[256] Yet in other major Italian cities like Venice, Prato and Padua enforcement could be far less effective and the same is likely to be true elsewhere on the Italian peninsula where measures were more ad hoc.[257]

Elsewhere, the evidence is less rich but also suggests variable degrees of enforcement. The urban authorities in some Spanish, German and Swiss towns as well as in Dubrovnik invested heavily in ensuring plague regulations were followed and set draconian penalties for evasion.[258] Likewise, in her study of St Martin in the Fields, Westminster, Kira Newman shows local authorities in England could raise and distribute considerable sums and manage numerous personnel in order to maintain a system of household quarantine.[259] Even so, evidence for evasion, laxity, and partial or full scale break-downs exists for towns across early modern Europe.[260] A number of studies also reveal instances where urban governments chose to act flexibly, allowing exemptions and commuting sentences for citizens who were caught breaking the rules.[261]

Understanding the enforcement of household quarantine is also integral to a second broad area of debate: the marginalization, even victimization, of poor and marginal groups in European societies. Beginning in the 1970s with the work of Brian Pullan, historians argued urban elites and medical authorities, concerned with increasing levels of urban poverty, came to perceive the poor and marginal as a threat to social order and as the chief sources of plague epidemics.[262] The outcome of this association was the development of plague regulations, particularly household quarantine, which were 'designed with the poor in mind,' in Paul Slack's memorable phrase.[263] A number of historians have argued plague strategies were not only developed to target the threat of the poor and marginal but were also enforced unevenly, in ways that reflected the desire to control and discipline these groups.[264] More recently,

---

'Plagues, Morality and the Place of Medicine in Early Modern England', *English Historical Review*, 121 (2006), pp. 1–24; Slack, *Impact*, 259.

[255] Henderson, *Florence under siege*, 130, 218-228; Henderson, *Invisible Enemy*, 271; Crawshaw, *Plague Hospitals*, 77

[256] Henderson, *Florence under siege*, 130

[257] Henderson, *Invisible Enemy*, 266

[258] Tomić and Blažina, *Expelling the Plague*; Eckert, *Structure*, 24-34; MacKay, *Life in a Time of Pestilence*

[259] Newman, *Shutt Up*, 809-834. Further evidence of effective enforcement: Slack, *Impact,* chapters 10 and 11; Champion*, London's Dreaded*, 93-7

[260] Slack, *Impact*, 278-9; Wrightson, *Ralph Tailor's*, 48-9; Eckert, *Structure*, 24-34

[261] Henderson, *Florence under siege*, 275; Bowers, *Plague and Public Health*, 13; Eckert, *Structure*, 27

[262] Pullan, *Rich and poor*; Pullan, *Plague and perceptions*, 101-123; Henderson, *Historians and Plagues*, 481-499; Carmichael, *Plague and the Poor*, 125; Slack, *Impact,* 306; Similarly, Newman argues the government had 'incorporated moral judgements about the poor and unsettled' into its quarantine policy.' Newman, *Shutt Up*, 828

[263] Slack, *Impact*, 306

[264] Slack, *Impact*, 306-7; Carmichael, *Plague Legislation*, 522-523; Also, Henderson, *Historians and Plagues*

historians such as Jane Crawshaw have challenged this characterisation, instead framing plague quarantines as fundamentally charitable and medical institutions designed to protect public health.[265] Newman complicates the older narrative by considering the experience of the households of middling artisans – not just the 'poor' and 'rich' - revealing the willingness of the authorities to quarantine 'respectable' families and even gentlemen.[266] By investigating variations in patterns of enforcement across society, we can learn more about whether quarantines were used principally as tools for discipline and control.

After contextualising plague regulations in England and describing the three plague epidemics studied in this chapter, I turn to the response of the Bristol Corporation to the plague epidemic in 1603-4 - the first to occur after household quarantine became mandatory in England in 1578. Then follows a description of the burial register data and the approach to measuring the implementation of quarantine in the parishes of Bristol using the clustering of deaths within households. Special attention is given to the parish of Christchurch for which population lists and other sources make it possible to investigate the implementation of quarantine across wealth, street, and political groups. The final section considers potential explanations for the variation in levels of enforcement that are revealed in the foregoing analysis, before concluding.

Plague Regulation in England

After 230 years of experimentation in English towns, household quarantine was adopted as a national strategy by the Privy Council in 1578 as the centre piece of the Elizabethan Plague Orders.[267] Justices of the Peace were required to oversee the parish officers on the ground and report back to the Privy Councillors at the centre. Special plague taxes were to be raised in instalments; affected households were to be quarantined; water, food, and fuel were to be provided where necessary. The *Orders* required the 'shutting up' of all inhabitants, sick or well. Watchmen were to be stationed outside to prevent movement. Inhabitants could be released only six weeks after the last victim had recovered or died. Lest anyone should claim the policy was 'not charitable,' the Privy Council was clear: the provision of 'succour and relief' during the 'tyme of their restraynt' was itself an act of Christian charity.[268] Be that as it may, it was also the fundamental condition for ensuring most 'infected' households could be kept alive whilst unable to work for at least a month and a half of isolation from the rest of their community.

---

[265] Crawshaw, *Renaissance Invention*, 172-173; Newman, *Shutt Up*, 826
[266] Newman, *Shutt Up*, 816-7; 824; 827
[267] Slack, *Impact*, 203: 206-7; Rawcliffe, *Urban bodies*, 32-3; Kallioinen, *Plagues and Governments*, 35–51. The Privy Council copied the policy of household quarantine from the more advanced Italian cities. Milanese plague regulations issued in 1576 and 1577 are preserved among the papers of the Clerk to the Privy Council of Elizabeth I. They bear a striking resemblance to the English Plague Orders published the following year. See: Basing, P. & Rhodes, D., English plague regulations and Italian models: printed and manuscript items in the Yelverton collection. *The British Library Journal* Vol. 23 (1997), 60.
[268] *Orders, thought meete*, items 2, 4, 5, 7, 8, and 9

The degree to which this centrally mandated policy was enforced by the governments of England's towns and cities remains unclear. Bristol was considered by contemporaries one of the 'chiefe places' in England after London and York.[269] In terms of population, it was by far the largest town in the west and the third largest in England after London and Norwich with around 13,500 people in 1600.[270] Bristol was a regional centre for trade and manufactures. It was also an international port. Like most ports and large urban centres, it was characterized by profound contrasts in wealth, crowding and housing between the wealthy centre and more peripheral impoverished parishes dominated by manufacturing and inhabited by labourers.[271]

Early modern Bristol provides one of the best opportunities to study the implementation of quarantine after 1578 because of the frequency and timing of its plague epidemics. Two of these epidemics occurred directly before 1578, one in 1565 and the other in 1575. A third plague epidemic occurred in 1603-4, 25 years after the publication of the Plague Orders. The patterns of mortality before and after their publication can be compared for the same parishes. Before comparing the patterns of mortality within affected households, however, it is important to establish that some of the basic characteristics of these outbreaks remained constant over this 40-year period.

Contemporary references and wider historical knowledge of plague epidemics confirm all three outbreaks were caused by plague. For each, contemporary chronicles and marginal notes in burial registers show plague was identified as the cause of the epidemic. All three epidemics also display the classic characteristics of an urban plague epidemic. Figure 2.1 displays the overall daily mortality trends for two-year periods containing each of the three plagues.[272] The curves are smoothed using a 21-day centred moving average. The plagues of 1565 and 1575 are strikingly similar. Though mortality peaked around 2 weeks later in 1575, the shape of the curves and the extremity of the epidemics are almost identical: the plague erupted in early summer and peaked at around 9 burials per day before declining in the autumn and ceasing with the colder winter months. In 1603-4 the plague began even later than in 1575 and then peaked in September at just over 5 burials per day. Whilst mortality then trailed off with the winter, it did not disappear as it had done previously but instead festered on before erupting again in the summer of 1604, albeit with less impact than in the previous year. All three epidemics are comparable to others described as plague epidemics across early modern Europe.[273]

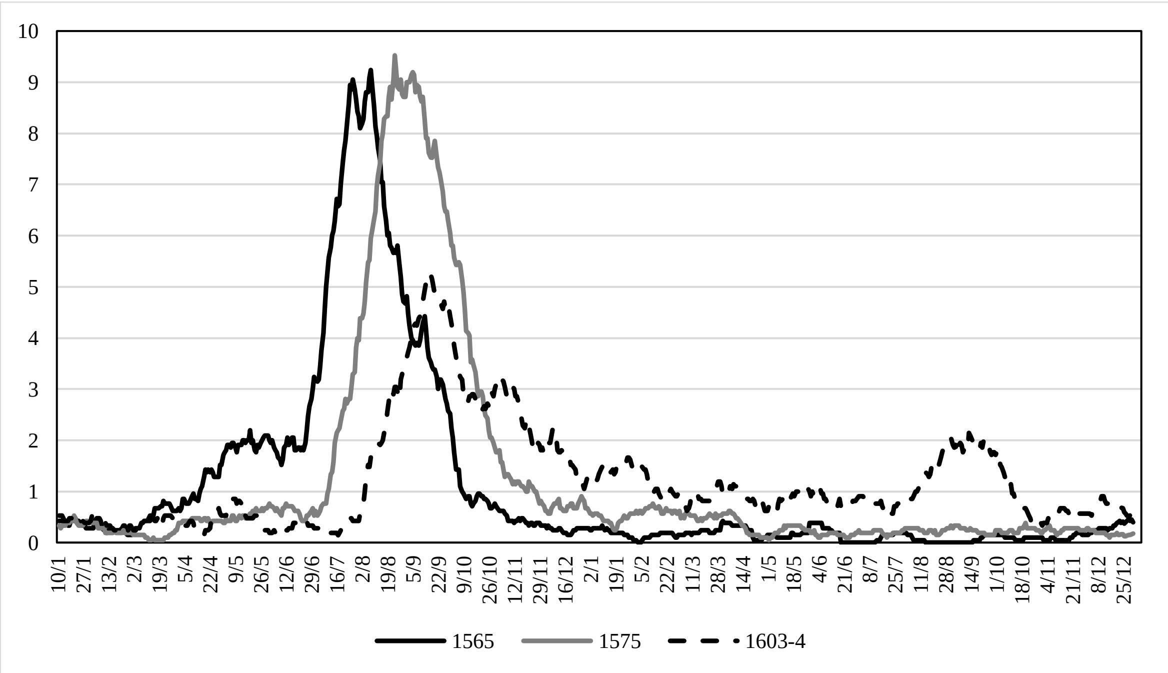
All three plagues were also similar in their severity. Each plague killed a similar proportion of the total population and affected children and adults in similar proportions. Contemporary chroniclers estimated the death toll from plague in 1565 and 1575 to be 2,000 in both years

---

[269] Lobel, M. D., and Carus-Wilson, E. M., The Atlas of Historic Towns. Volume Two: Bristol, Cambridge, Coventry, Norwich (London, 1975), 15
[270] See appendix 3, table A.3.3.
[271] Appendix 3, table A.3.1 and Sacks, D H., *The Widening Gate: Bristol and the Atlantic Economy, 1450-1700* (Berkeley, 1991), table 19
[272] The curves represent half the parishes of Bristol and are representative of the city. This sample of parishes are at the heart of the analysis presented in this paper and will be discussed in more detail below.
[273] For instance, Eckert, *Structure*, 37

and they estimated 2,600 died of plague in 1603-4.[274] The population of Bristol grew only slightly between 1565 and 1575 from around 9,000 to 9,500; by 1603 it had risen to around 13,500.[275] So, death rates in the first two plagues were around 20% and in the last of the three they were around 19%. The plague epidemic of 1603-4 lasted longer and was less extreme at its height but it killed a very similar proportion of the population. Relative mortality between children and adults was also remarkably similar on aggregate: 0.8 adults were buried for every child in 1565, compared with 0.63 in 1575 and 0.79 in 1603-4.[276] Yet even for those who were not infected, the consequences of previous epidemics must have been all too easily remembered when plague once again threatened the city.

<u>Figure 2.1. Daily Burials (21 Day Mov. Av.) for 2 Year Periods Containing Plague Epidemics, 1565 -1604</u>



Note: For all three years, these trends represent the mortality curves for the 9 parishes which form the sample used in this study. See figure 2.2 and appendix 3, table A.3.1.

Source: Bristol Archives, Parochial Registers: P.Xch/R/1/a, P.St_J/R/1/a, P.St MR/R/1/2, P.St_N/R/1/b, P.St_N/R/1/c, P.St_JB/R/1/a, P.AS/R/1/a, P.St_W/R/1, P.St_T/R/1/a, P.St_S/R/1/a

[274] Adams, W. Adams's Chronicle of Bristol, F. Fox, ed. (Bristol, 1910), 108; 114; 178; Ricart, R., *The Maire of Bristowe is Kalendar*, ed. Smith, L. T. (Westminster, 1872), 59; Hudd, A E., 'Two Bristol Calendars', *Transactions of the Bristol and Gloucestershire Archaeological Society*, 19 (1894), 134; 136; 138.
[275] See appendix 3, table A.3.3.
[276] Appendix 3, table A.3.2 provides available data on the ratio of adult to child burials.

Plague, Government, and Regulation

On the 23rd of June 1603, Ralph Hurt, Bristol's Mayor, chaired a meeting of the Aldermen and Common Council of the city to respond to the news that plague had returned to London.[277] The Council followed the precedents set during previous outbreaks and established restrictions on the flow of goods and people arriving from 'the Cyttie of London or suburbs thereof.' A certificate of health was required from any Londoner coming to Bristol 'to buye or sell any wears' or to 'lodge or make his or her aboade' and all 'wares & m[er]chandise' were to be aired near the 'Lafforde gate' – on the London road - before entry.[278] Though the minutes of the Council for the 16th century do not survive, the 1603 minutes suggest restriction on long distance trade with infected settlements had been employed during previous epidemics.[279] The city level restrictions in 1603 proved ineffective. On the 18th of July 1603 the plague took its first victim, in Pepper Alley by the docks in St Stephen's parish.[280]

Once plague reached Bristol the actions of the city were, for the first time, defined by the national *Plague Orders* that had been issued in 1578. These required Mayors and Aldermen in any affected town in England, including Bristol, to implement household quarantine in their capacity as Justices of the Peace.[281] Taxation, corporation, and parish register sources reveal many of the Bristol Aldermen and lesser Common Councillors in 1603-4 had been resident in 1575. They would have recognised their personal vulnerability as well as the towns: in that last epidemic, plague had killed three Aldermen and a respected preacher, John Northbrooke.[282]

On the 19th of July – the day after the first case was identified - the Common Council gathered to discuss the official plague response. The register shows almost full attendance: 9 of the 10 Aldermen, both Sheriffs and 25 of 29 Burgesses.[283] The arrival of plague did not cause a flight among the governing elite.[284] Instead, it elicited exactly the response envisaged by the Privy Council in 1578. When plague was noticed in a community, the *Plague Orders* required 'all justices… [to] assemble themselves together… to consult howe these orders… may be put into execution.'[285] The justices were to 'chuse honest persons' to manage the

---

[277] Bristol Archives, Common Council Proceedings, M/BCC/CCP/1/1. Vol 1. Fo. 78

[278] As in other European towns, the authorities were pragmatic in the restrictions they imposed. Only goods and people from London are mentioned by the authorities. So, presumably, trade was allowed to continue between Bristol and other settlements. Bowers, *Plague and Public Health,* Chapter 3

[279] After setting out the procedures for quarantining goods and people from London, the Common Council minutes read: 'as heretofore yt has bin, at the chardges of the Owners…' Bristol Archives, Common Council Proceedings, M/BCC/CCP/1/1. Vol 1. Fo. 78

[280] *Adam's Chronicle*, 177

[281] Since the charter of 1373, Mayor and Aldermen had functioned as Justices of the Peace for Bristol. Latham, R. C., ed., Bristol Charters, 1506–1899 (Bristol, 1947), 4

[282] *Adam's Chronicle,* 114

[283] Bristol Archives, Common Council Proceedings, M/BCC/CCP/1/1. Vol 1. Fo. 79

[284] Further support for this claim can be found in a surviving Easter tithe book drafted during the epidemic in 1604 which shows no sign of household heads being absent from the parish of Christchurch unless they had died during the outbreak.

[285] *Orders, thought meete*, item 1

raising and distributing of money from ‘a generall taxation’ upon ‘speciall persons of wealth.’[286] The Common Council thus established a committee made up of three burgesses and a sheriff to oversee the management of the plague response.

The committee was a managerial, not a medical body. The minutes provide no justification for why each committee member was chosen but their backgrounds reveal no sign of any medical expertise.[287] Instead, these men were chosen for their management abilities. Three of them were merchants operating in the textile trades. They would have been used to running complex operations involving large sums of money. These skills complemented their mandated objective: to raise, hold and distribute funds necessary to ensure households were quarantined and provided for when isolated. On each of the four occasions that money was raised during the outbreak, the minutes show it was intended for the ‘keepinge,’ ‘disposinge [arranging],’ ‘relyvinge,’ or ‘mayntenence’ ‘of the poore Infected people… and for the keepinge of those that are Infected and that whole howsholde from goyinge abroad… vntill order be taken for there release.’[288] The committee was responsible for organising the implementation of household quarantine and financial relief across the city. It maintained its commitment throughout the epidemic.

Identifying Household Quarantine

Did the Bristol authorities succeed in separating suspected carriers of plague from the healthy population in 1603-4? This section analyses patterns of mortality within household groups using data from parish burial registers.[289] If household quarantine was enforced as intended in 1603-4, mortality within affected households should be higher than it was in the plague outbreaks of 1565 and 1575 because healthy people would have been more exposed to the source of infection.[290] Moreover, quarantine would have exacerbated existing problems of domestic cleanliness by, for example, limiting the ability for airing soft furnishings. This may have led to more non-plague deaths within quarantined households as well.[291]

The ideal way to measure changes in within household mortality would be to compare the proportion household members that died during plague outbreaks before and after 1578. However, it is almost never possible to estimate the size of the population at risk in each household where one or more household members were buried during a plague epidemic.

[286] *Orders, thought meete*, items 3 and 6
[287] Robert Aldworth (Sherrif): admitted to freedom in 1584 as a merchant. John Baker: either a weaver in 1575 or unknown in 1591. John Butcher: carpenter 1590 or clothier 1593. Richard Smith: draper 1576.
[288] Bristol Archives, Common Council Proceedings, M/BCC/CCP/1/1. Vol 1. Fos. 79; 81; 83; 92
[289] Whilst parish registers do not record reliable cause of death information for everyone, the number of burials in each parish during a plague were always many multiples of their normal levels, it can be safely assumed that a very high proportion of burials were related to the plague.
[290] Newman, *Shutt up*, 828; Slack, *Impact*, 320
[291] Contemporaries certainly thought this was the case and the London Bills of Mortality record a very large increase in non-plague burials in the 1665 plague epidemic. Though it is likely some of these burials were wrongly diagnosed, intentionally or otherwise, the increases in some disease categories may also have been the result of deteriorating household conditions due to forcible quarantine. *Shutting Up*, 8 and Champion, *London’s Dreaded*, 28 - 29

Instead, the proportion of all burials recorded during each plague outbreak that were 'clustered' into household units can be measured. Previously, historians have measured the clustering of plague burials in this way either to uncover the social distribution of plague mortality or to determine the way plague was transmitted.[292] Paul Slack was the first to recognise the potential for burial clustering to reflect the degree to which household quarantine was implemented, but no one has ever analysed burial clustering systematically to uncover patterns of enforcement.[293]

To measure burial clustering using parish burial registers, it is necessary to connect names of the deceased into household groups.[294] This is done in two ways. The first links individuals based only on their surname. To limit false matches, the 38 common surnames are removed from all parish burial lists. This reduces the number of burials used in the analysis of clustering and assumes the true distribution mortality within common surname households is the same as the distribution of mortality for the rest of the households in the population. The approach also ignores household members who do not share the surname of the household head such as servants and apprentices. By defining non-family household members as individuals, this depresses the parish-level clustering estimates to a different extent depending on the proportion of the population made up of non-family household members and so should be borne in mind when interpreting the results below.

The second approach uses additional information recorded in the burial registers. In some registers and years, the parish clerks recorded the parent or in the case of servants the master/mistress of the deceased person who might be deemed to be the head of household. Table 2.1 contains an example of this practice where the final three columns related the deceased to the head of the household in which they lived. Using individual level tithe lists from the parish of Christchurch to check the full household information approach revealed 100% accuracy in assigning the deceased to their households. Information regarding the household head improves over time and by 1603-4 only the parish register of St John the Baptist does not contain this information. Where both the shared surname and full household approaches could be applied to the same register (tables 2 and 4), the results are very similar.

An example of both approaches using the information in table 2.1 may provide additional clarity. Table 2.1 contains a truncated excerpt from the burial register of the Bristol parish of Christchurch in 1575. This excerpt covers September and October 1575 – the peak months of the plague outbreak of that year. It shows the household of Humphry Andros lost 4 children and 2 servants during this plague outbreak. Both approaches use a household group threshold of 3 or more people. For the surname only approach, 2 people – John White and Richard Gryne – are excluded from the sample because they have common surnames. Of the

[292] Several studies have measure burial clustering in a similar way. Slack, *Impact*, 177; Champion*, London's Dreaded*, 83; Wrightson, *Ralph Tailor's*, 39-40.
[293] Slack compared the level of clustering found in the burial records of the quarantined population in Salisbury in 1604 with those for the town. The proportion of all burials which could be linked together into groups of 3 or more was 42% for the whole population and 61% for the quarantined houses only. Slack, *Impact*, 177-8; 320
[294] Appendix 3 contains a detailed discussion of the way this was done to ensure the results are comparable across parishes and through time.

remaining names, there is only one group of 3 or more shared surnames, the Andros family. The resulting estimate of burial clustering is 50%. Of the 10 in the sample, 5 could be linked into a shared surname group with three or more people. Since the Christchurch register also contains additional information on the relationships between the deceased, it is also possible to calculate a full household information estimate which also turns out to be 50%. Of the 12 people in the full sample (no common surnames are removed using this method), 6 are recorded as relations (family or otherwise) of Humphry Andros.

Table 2.1. Excerpts from Burial Registers of the Parish of Christchurch, 1575

Date	*First Name*	*Surname*	*Relation*	*Relation First Name*	*Relation Surname*
17/9/1575	**George**	**Andros**	**Son of**	**Humphry**	**Andros**
17/9/1575	Henry	Bower	Servant of	William	Gryne
17/9/1575	**Margaret**	**Andros**	**Daughter of**	**Humphry**	**Andros**
…					
1/10/1575	**John**	**Andros**	**Son of**	**Humphry**	**Andros**
1/10/1575	**Elizabeth**	**Andros**	**Daughter of**	**Humphry**	**Andros**
1/10/1575	Joan	Pearce	Servant of	William	Yeomans
1/10/1575	Alice	Caninge	Servant of	Dorothy	Atkins
2/10/1575	William	Hardinge	Son of	John	Hardinge
3/10/1575	John	White			White
5/10/1575	Richard	Gryne	Son of	William	Gryne
5/10/1575	**Thomas**	**Tucker**	**Servant of**	**Humphry**	**Andros**
5/10/1575	**Robert**	**Andros**	**Servant of**	**Humphry**	**Andros**

Source: Bristol Archives, P.Xch/R/1/a

One caveat. As neither the surname only nor the full household information approach can account for the size of each household 'at risk,' larger household sizes in some parishes might cause higher levels of burial clustering. This is because more people would be exposed to infection once plague arrives inside the household.[295] Even so, under the assumption that

[295] Whilst Schofield argues there would be no association between household size and probability of infection in epidemics caused by bubonic plague, the evidence from the famous outbreak at Eyam in 1666 suggest such an association does exist. See: Schofield, R., 'An Anatomy of an Epidemic: Colyton, November 1645 to November 1646' in *The Plague Reconsidered: A New Look at Its Origins and Effects in 16th and 17th Century England*, eds Slack, P., and the Cambridge Group for the History of Population Social Structure (Matlock, 1977), 104; Whittles et al, *Epidemiological analysis*, 5-6.

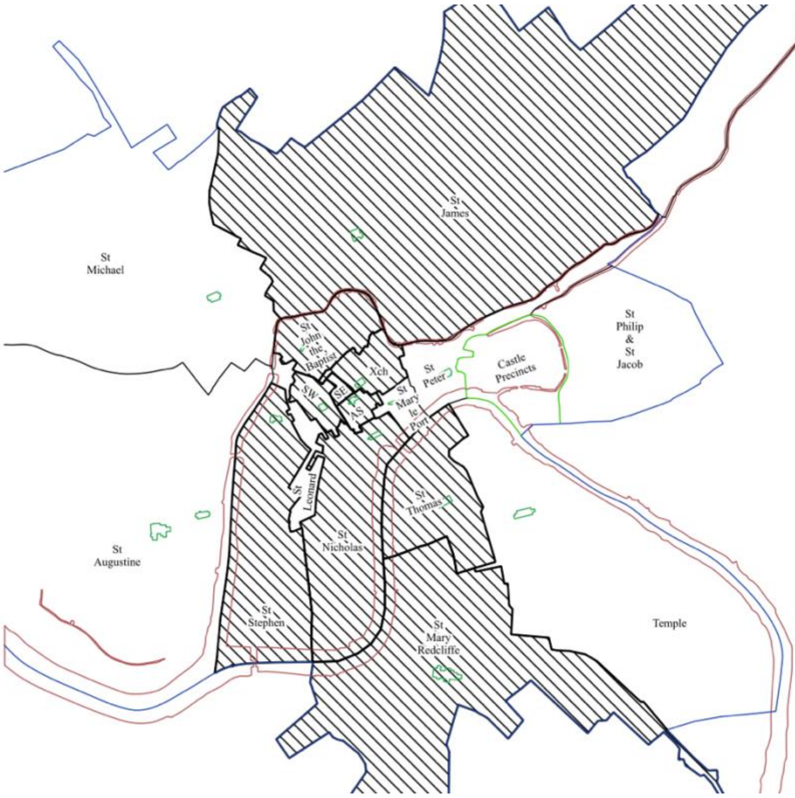
average household sizes did not change dramatically within the same parish over time (and surviving population lists for Christchurch seem to confirm this) we can compare burial clustering patterns within the same parish and across each epidemic. This will still allow us to establish whether household quarantine was implemented to a greater extent in 1603-4.

The evidence from the parish register data does not support this theory. Figure 1.19 describes the average distance from London of affected settlements in each year of each major plague surge. This shows that plague did not always immediately radiate out from the capital. In 4 of the 7 surges (1560s, 1600s, 1620s, and 1630s) plague affects settlements that were on average further from the capital than settlements affected in subsequent years. Though there are clear signs that once plague hit London and its vicinity, the area acted as an important transmitter of plague to settlements across the country with average distance to London increasing again in all but one instance – the 1630s when the period under study is cut short because of the eruption of a flu-like epidemic in 1638. Plague surges did not in all cases originate in London, but they were propelled by it.

Of the 18 parishes of early modern Bristol, 9 have burial registers which survive for all three outbreaks in good condition. Figure 2.2 of Bristol shows the parishes for which registers survive as cross hatched. Contemporary baptism levels and the population estimates using the 1696 marriage duty assessment imply the sample represents around 55% Bristol's population.[296] As well as containing a high proportion of Bristol's population, the parish sample is also geographically comprehensive. The sample parishes cover the centre, periphery, and riverside districts of Bristol and display a very similar level of wealth to the general population. On average the buildings in the sample contained 4.19 hearths whereas the average Bristol building had 3.96 hearths.[297] The sample is therefore suitable for studying the extent to which household quarantine was implemented in 1603-4 across this large and diverse city.

[296] The second column of the table A.3.1 in appendix 3 contains late 17th century population estimates for each parish.
[297] Appendix 3, table A.3.1.

Figure 2.2. Burial Register Survival by Parish



Note: SW = St Werburgh; SE = St Ewen; AS = All Saints; Xch = Christchurch

The Effect of Household Quarantine in Bristol

In 1603-4 the level of burial clustering was substantially higher than it had been in the plagues of the latter 16th century, suggesting a radical disjuncture in the level of enforcement. In tables 2.2 and 2.4 the parish burial samples for 1565 and 1575 have been combined to produce a single 'pre-1578' burial clustering estimate. This is partly for convenience and partly to smooth out the volatile estimates for the smaller parishes of St Werburgh and All Saints.[298] Taking a simple average of the surname clustering estimates reveals a substantial increase after 1578 (final row of table 2.3). In 1603-4 an average of 45% of burials occurred in household groups sized three or more, whereas before 1578 this figure was only 27%. Mortality within affected households was substantially higher after the publication of the Plague Orders.

The final two columns of table 2.2 show an increase in burial clustering in cases where the parish registers provide additional information about the household head. In most cases, the estimates are very similar to the ones produced using only shared surnames. The one exception is Christchurch, but fortunately the full household information is provided in all

[298] Separate estimates for both epidemics are available in appendix 3, tables A.3.5 and A.3.6. They confirm trends discussed here.

plague years for this parish. In the few cases where household head information is provided for earlier epidemics, the results are also very comparable to the shared surname approach. Overall, the 'full household' estimates confirm the evidence of a significant impact of quarantine in the post-1578 epidemic.[299]

Table 2.2. Burial Clustering Levels in 1565 & 1575 (combined) and 1603-4

	Total Burials		Surname Clusters		Full Household Clusters	
Parish Name	1565 & 1575	1603-4	1565 & 1575	1603-4	1565 & 1575	1603-4
St Werburgh	23	42	12%	49%	15%	40%
All Saints	24	15	27%	60%	42%	60%
Christchurch	99	73	35%	72%	29%	58%
St Nicholas	137	169	27%	19%	N/A	27%
St Thomas	203	221	30%	50%	N/A	55%
St John the Baptist	77	114	25%	54%	N/A	N/A
St Stephen	172	236	32%	37%	N/A	41%
St James	170	335	26%	30%	N/A	29%
St Mary Redcliffe	203	288	29%	35%	26%	35%
Sample Av.			27%	45%	28%	43%

Note: N/A is used for cases where the registers do not allow for this type of analysis.

Source: Bristol Archives, Parochial Registers: P.Xch/R/1/a, P.St_J/R/1/a, P.St MR/R/1/2, P.St_N/R/1/b, P.St_N/R/1/c, P.St_JB/R/1/a, P.AS/R/1/a, P.St_W/R/1, P.St_T/R/1/a, P.St_S/R/1/a

The clustering estimates for Bristol in 1603-4 are very comparable to those found in other early modern English populations. Table 2.3 contains results from other studies that define clustering in the same way. In 1603-4, burial clustering in Bristol was comparable to the levels recorded in studies of other English towns, except for London in 1666. The comparison with the evidence from Salisbury and Braintree is especially noteworthy because detailed evidence recording the relief paid to households who were quarantined survives for these outbreaks.[300] The comparable levels of clustering in Bristol 1603-4 and the other epidemics in table 2.3 suggests household quarantine was widely adopted in epidemics across early modern England after 1578.

The levels of clustering in the pre-1578 epidemics was much more comparable to London in 1666, when household quarantine is known to have collapsed, than those found in Bristol in

[299] It is very unlikely the change in clustering in 1603-4 was the result of acquired immunity within the population after 1575. If this had been the case, clustering should be higher in 1575 compared with 1565. Appendix 3, tables A.3.5 and A.3.6 shows this did not happen.
[300] Slack, *Impact*, 177-8

1603-4.[301] For a cross section of London parishes, Champion found 32% of all burials could be attributed to household groups of size 3 or greater.[302] Using shared surnames, the estimates for Bristol in 1565 and 1575 range from 0% to 39% with a median of 28% (n = 18). The full household approach confirms the low estimates are not the result of ignoring non-family household members. The median for the 16th century plagues is 24% (n = 8) and though in one instance (All Saints, 1565) clustering was significantly higher (59%), in all other cases clustering was the same or lower than in London in 1666.[303] In 1603-4, clustering in Bristol had increased in most parishes so that only 2 continued to be comparable to London.

Table 2.3. Comparable Clustering Estimates from Other English Studies, 1579-1666

Place	*Parish*	*Year*	*Burial Clustering*
Norwich	St Peter Mancroft	1579	42%
Bristol	SS. Phillip and Jacob	1603-4	57%
Salisbury	3 Ancient Parishes	1604	42%
Colyton		1645-6	52%
Eyam		1666	72%
Braintree		1666	63%
London Sample	8 parishes from across city	1666	32%

Sources: Slack, *Impact*, 177; Champion*, London's Dreaded*, 83; Schofield, *Anatomy*, 106; Bradley, L., 'The Most Famous of All English Plagues: a detailed analysis of the Plague at Eyam 1665-6'. in *The Plague Reconsidered: A New Look at Its Origins and Effects in 16th and 17th Century England*, eds Slack, P., and the Cambridge Group for the History of Population Social Structure (Matlock, 1977), 92.

The similarity between clustering in 16th century Bristol and London in 1666 suggests household quarantine was not applied rigorously before 1603. No study has ever produced estimates of burial clustering for an epidemic where we know quarantine was not enforced at all.[304] The loss of city records mean that we cannot be sure that no household isolation was in place in 16th century Bristol either: there is some evidence from other communities of experiments with isolation before the national policy was launched.[305] However, the similarity to the rates of clustering in London in 1666 suggest that any local initiatives in the 16th century were limited. The clustering estimates for 1565 and 1575 can therefore be

[301] For evidence of breakdown in London: Slack, *Impact*, 282
[302] Champion*, London's Dreaded*, 83
[303] For separate estimates for the 1565 and 1575 outbreaks in Bristol: appendix 3 tables A.3.5 and A.3.6.
[304] This point was ignored by Schofield so his attempt to reveal the vector responsible for that epidemic using levels of clustering should be treated with some suspicion. Schofield, *Anatomy*, 102
[305] Slack, *Impact*, 201-208

interpreted as upper bound estimates of clustering in plague epidemics where the population was not subjected to household quarantine.

Whilst the consequences of quarantine are visible almost everywhere in Bristol, there are significant variations between parishes. Table 2.4 presents the absolute difference between the pre- and post-1578 clustering estimates in table 2.2. The parishes in table 2.4 are ranked according to the size of the absolute increase in burial clustering with the full household linkage estimates being given precedence where they can be calculated for all three epidemics. The top five parishes display the most significant increases in burial clustering. Both the surname only and the full household estimates are around twice as high in 1603-4 compared to the pre-1578 outbreaks. The estimated effects of quarantine appear more modest in the parishes of St Mary Redcliffe, St Stephen, and St James using the shared surname approach and this is confirmed in the case of St Mary's when using household head information. Only the parish of St Nicholas shows a decline in the level of clustering in 1603-4.

Table 2.4. Absolute Difference in Clustering Levels for Both Approaches

Parish	*Hearths / Entry 1662*	*Absolute Difference (1565 & 1575 vs 1603-4)*	
		Surname-Only	*Full Household*
Christchurch	4.6	37%	29%
St Werburgh	5	28%	25%
All Saints	4.6	33%	18%
St John the Baptist	4.1	29%	N/A
St Thomas	4.3	20%	N/A
St Mary Redcliffe	3.4	6%	9%
St Stephen	3.6	5%	N/A
St James	3.6	4%	N/A
St Nicholas	4.5	-8%	N/A

Note: N/A is used for cases where the registers do not allow for this type of analysis.

Source: Hearths per entry: Bristol Hearth Tax, 1662-1673. (eds) Leech, R, Barry, J, Brown, A, Ferguson, C, Parkinson, E. British Record Society, vol. 135, Hearth Tax Series vol XI, 2018, 344-5; Bristol Archives, Parochial Registers: P.Xch/R/1/a, P.St_J/R/1/a, P.St MR/R/1/2, P.St_N/R/1/b, P.St_N/R/1/c, P.St_JB/R/1/a, P.AS/R/1/a, P.St_W/R/1, P.St_T/R/1/a, P.St_S/R/1/a

The parishes that saw the greatest increase in clustering in 1603-4 were also the most affluent parts of the city. In the areas that were more peripheral - both geographically and socially – the change was much more modest. Table 2.4 contains data on the average number of hearths per entry for buildings recorded in each parish in the 1662 Hearth Tax assessments. The parishes which saw the largest increases in clustering were all located in the prosperous centre or along the riverside: buildings in the top five parishes of table 2.4 had an average of 4.5 hearths. In contrast, the parishes which saw less dramatic increases in clustering contained more moderate sized properties with an average of 3.5 hearths and were located on the periphery of the town.

The contrast between clustering of deaths in rich and poor parts of Bristol raises the important question of how quarantine was enforced at the level of the household. Was quarantine implemented to the same extent across social groups in parishes where evidence of clustering is strong?

An answer can be provided by using rare tithe lists for the parish of Christchurch which contain the names and addresses of householders as well as tithe payment values for household heads.[306] Easter tithe payments in urban parishes were levied on personal profits from crafts and trade.[307] To the extent that assessments of profits were accurate, tithe payments will reflect the distribution of income within the parish. The names in the tithe lists have also been connected to those recorded in the parish registers and freemen have been identified from among the male household heads using the Bristol burgess books.[308]

Table 5 shows household quarantine was implemented in 1603-4 to the same extent irrespective of income when income and enforcement are investigated using the same burial clustering comparisons as above. The Easter tithe books of 1575 and 1601 provide information on the income level of household heads. The first two rows of table 2.5 divide the households of Christchurch at the median tithe payment which in both years was 12

[306] Four Easter books survive, 1575, 1576, 1601, and 1604. This analysis uses those from 1575 and 1601. Bristol Archives, P.Xch/ChW/2/1-4
[307] Wright, S. J., 'Easter Books and Parish Rate Books: a new source for the urban historian', *Urban History*, 12 (1985), 31
[308] Christchurch's Easter tithe books were first used by Paul Slack in his study of plague mortality patterns in Bristol.

pence. The absolute level of burial clustering was higher for more affluent households in 1575 (67% vs 58%.). This is because their average household size was larger (4.8 vs 2.43 communicants per household) and so more people within their households were at risk once one person became sick. The same pattern emerges in 1603-4 but for both groups the level of burial clustering increased substantially. The absolute difference in burial clustering levels is almost identical: clustering increases by 27 percentage points for households occupying both halves of the income distribution. There is no sign the rules were relaxed for households with higher levels of income.

Using the locational information provided in the Easter books reveals no difference in the degree of enforcement by street. When investigating the impact of plague on different social groups in Christchurch, Paul Slack found mortality to be higher on the back streets of the parish, especially in 1603-4. [309] My results confirm this, as is suggested by the much larger absolute number of burials which were attributable to the back streets in the later outbreak. Yet, table 2.5 shows quarantine is just as visible in both street types in the parish. Higher mortality did not prevent parish officials from quarantining households on the back streets to the same extent as on the main thoroughfares.

By linking the names of household heads to the entry lists of burghers for the town, it is also possible to investigate whether a household's political status determined whether they would be quarantined. Grants of freedom reflect the degree to which a household was included in the social and political institutions of Bristol.[310] Freedom, or burgher status, was a prerequisite to joining a guild. Offices in urban government were also only open to burghers, though for most, this meant parish rather than town government. Thus, it was from the burgher community, that the parish officials – churchwardens, constables, overseers etc – who were responsible for managing enforcement were drawn.

[309] Slack distinguished between the large and generally affluent households living on the main thoroughfares (Wine Street and Broad Street) and the poor, labouring households living on the crowed alleys behind (Tower Lane and the Pithay). Even so, 24% of householders on the back streets paid tithes above the median level and 18% on the main streets paid tithes below the median. The information on occupation and household structure recorded in the Easter books and parish registers also depict a varied pattern of residence. Slack, *Impact*, 123-126

[310] Williams, M., 'Bristol burgesses: freedom of the city', Journal of the Bristol & Avon Family History Society, 82 (1995)

Table 2.5. Burial Clustering Comparisons for Christchurch Social Groups, 1575 vs 1603-4

Christchurch Social Groups	*Communicants per Household*	*No. Burials*		*% Burials in Groups of 2+*	
	1575 & 1601	*1575*	*1603-4*	*1575*	*1603-4*
<12 Pence	2.43	33	33	58%	85%
12 Pence +	4.81	46	32	67%	94%
Back Streets	2.51	33	43	58%	86%
Main Streets	4.71	46	22	67%	95%
Non-Burgher	3.42	49	31	57%	84%
Burgher	4.40	30	34	73%	94%
Parish Total	3.80	79	65	63%	89%

Note: Communicants were generally over the age of 16. Children are therefore missing from communicant calculations. Because the Easter books provide additional certainty about the validity of household linkage, the threshold for burial clustering was reduced to 2 or more burials per household.
Source: Easter Books: Bristol Archives, P.Xch/ChW/2/1-4; Burials: Bristol Archives, P.Xch/R/1/a

The results in table 2.5 suggest the enforcement of quarantine was not determined by the level of political privileges held by a household. Burial clustering increased markedly for burghers and non-burgher households alike. The absolute difference in clustering levels was 27 percentage points for non-burghers and 21 percentage points for burghers. Whilst this was slightly lower for the burgher group, this is explained by their particularly high level of clustering in 1575 – there was less room for the levels to increase for this group since the maximum level is 100%.[311]

These measures of socio-economic status complement but do not replicate each other in finding no socially determined differences in the degree to which household quarantine was observed in the parish of Christchurch in 1603-4. Those inhabiting the more affluent streets and households may have witnessed lower mortality, but they were not shown greater discretion by the officers responsible for enforcement, even though these officers would often have been their friends, neighbours, customers, and colleagues.

The division of Christchurch householders into two groups based on affluence, political inclusion, and location obscures potential differences between the mass of the population and

[311] The similar patterns are partially explained by the overlap in these groups of households. For instance, wealthier households were more likely to be burgher households. Yet in 1603-4 one third of poorer households were headed by burghers and one third of wealthy households were not headed by burghers.

the tiny fraction of elite households. In fact, only one such household experienced mortality during the outbreak in 1603-4 but it was one of the wealthiest and most influential in the parish. The household of the Alderman and Mercer, William Yate are recorded in both the 1575 and 1601 Easter books. His Easter tithe payments were among the highest in the parish in both years.[312] His will reveals that he lived in a large property on the southside of Wine Street at the easterly end that was also occupied by his son, Henry. William Yate had dynastic ambitions. He hoped God would call his son Henry to the office of 'Sherriff of Bristow And likewise his sonne John after him.'[313] The Common Council proceedings record him as present in both June and July 1603 when the plague response was agreed.[314] The minutes show that in July, he contributed the mandatory 20 shillings plus an additional £5 to the plague fund.[315] Yate was an archetypal urban elite: a wealthy merchant with considerable political power and experience occupying a large house on a prominent street in the town.

The experiences of his household during the plagues of 1575 and 1603-4 were typical of his neighbours. In the earlier plague the Yate household experienced one death, that of a servant called Thomas Gryne. In 1603-4 the effects were considerably more devastating. Both William and his wife, Margaret, along with a grandchild, Andrew, and a servant of their son Henry, were killed between August and November 1603. Unlike in 1575, the death of one household member was only the start of a tragic autumn for the Yate household. No one was immune from the quarantine regulations in Christchurch, not even the household of a man responsible for implementing them.

Explaining Uneven Enforcement

Why did the central, affluent parishes experience greater levels of enforcement than the poorer, more peripheral ones? The minutes of the Common Council proceedings describe a centrally administered system where funds were redistributed according to the requirements of the parishes.[316] They also reveal a continued commitment to supporting the operation of quarantine throughout the epidemic.[317] How do these observations fit with the clustering evidence which reveals the unevenness of enforcement, and a bias towards affluent areas?

Variation in the degree of enforcement across parishes could be associated with the proportion of households affected. Under the system envisioned by the Plague Orders, every newly infected household had to be identified, locked up and guarded. The spread of plague thus increased the administrative and practical challenges of enforcement. Furthermore, since no members were permitted to leave, entire quarantined households were reliant on savings

[312] 60 pence in 1575 and 72 pence in 1601
[313] Josh Allen's transcription of William Yate's will.
[314] Bristol Archives, Common Council Proceedings, M/BCC/CCP/1/1. Vol 1. Fos. 78-79
[315] Bristol Archives, Common Council Proceedings, M/BCC/CCP/1/1. Vol 1. Fo. 79
[316] Bristol Archives, Common Council Proceedings, M/BCC/CCP/1/1. Vol 1. Fo. 83
[317] They were still raising additional finance for the 'keepinge in' of the 'visited' in January 1605. Bristol Archives, Common Council Proceedings, M/BCC/CCP/1/1. Vol 1. Fos. 78-79; 81; 83; 92

or the parish to provide food and fuel.[318] Whilst some households could support themselves, these were always a minority.[319] The greater the proportion of households infected, the greater the burden on the parish and the greater the chance of the system of quarantine becoming unsustainable.

Figure 2.3 provides some support for this explanation. It suggests parishes with greater proportions of households affected also witnessed the lowest levels of clustering, and thus the lowest levels of enforcement. The x-axis of figure 2.3 represents the total number of households affected by the epidemic, scaled by the average number of pre-plague baptisms. Average baptisms are used as a proxy for relative population size. The y-axis represents the level of clustering in 1603-4. Figure 2.3 reveals a clear negative association between levels of clustering and the extent of infection: the parishes where a greater number of households were affected witnessed lower levels of clustering in 1603-4.[320]

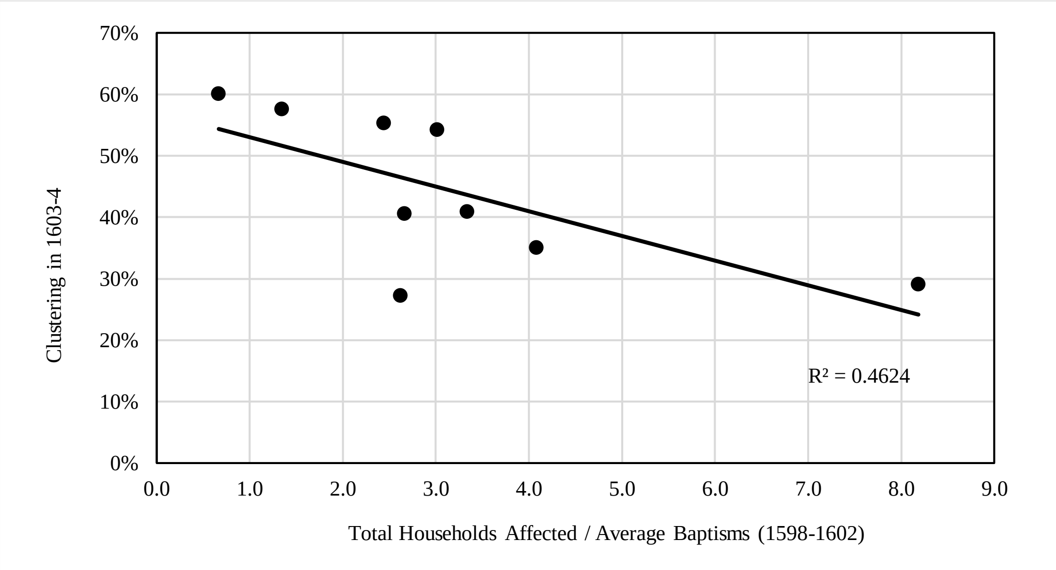
Yet figure 2.3 reveals nothing about the direction of causation between the proportion of households infected and the level of enforcement. More households infected would have meant more strain on the quarantine system, but greater enforcement may also have reduced the proportion of households infected. The association in figure 2.3 could suggest either direction of causation.[321] The relationship could also have operated in both directions simultaneously. Whilst it is plausible that the extent of infection affected enforcement, this cannot be disentangled from the potential consequences of quarantine for the spread of plague.

As well as variations in the parish level administrative burden, differences in the ease of political oversight may also have affected enforcement. It is surely not a coincidence that the areas where the effects of quarantine are most obvious are also the areas where most of the elite resided. In the mid-17th century, double the proportion of common councillors and aldermen lived in the central parishes as lived in the peripheral ones.[322] Of the 12 aldermen present in the Council in 1603, none baptised their children or owned property in the peripheral parishes for which data survives whereas 7 were active in the central districts and a further 5 in the riverside districts. Moreover, the size of the central parishes must have made implementation easier there. All five of the parishes which experienced considerable

[318] The provision of relief by the parish was always the largest single contributor to the expense of enforcing quarantine. Champion, *London's Dreaded*, 76
[319] In St Martin in the Fields, Westminster, in 1636, 84% of quarantined individuals could not meet their living costs during their period of isolation. Newman, *Shutt Up*, 817
[320] This relationship between the proportion of households affected and the level of clustering is not straightforwardly mechanical. The clustering formula (% of total *burials* in groups of 3+) is not determined by the *proportion of households in a parish* that are affected. It is theoretically possible for clustering to be 100% with only 1 household affected or with a high proportion of households affected so long as three or more people in each household die of the disease.
[321] If quarantine reduced the spread between households, there must also have been some inter-parish restriction on movement to prevent reimportation from non-enforcing parishes. Whilst there is no evidence of this from Bristol, elsewhere in England parishioners did restrict entry from outside. Slack, *Impact*, 271; 288
[322] Appendix 3, table A.3.1 reproduces the distribution of current and previous aldermen and common councillors of Bristol during the period of the hearth tax (1662-1672).

increases in burial clustering in 1603-4 could fit comfortably within the boundaries of the largely suburban parish of St Mary Redcliffe.[323] The size and political connections of the central parishes would have improved the ability for the elite to monitor the implementation process, thus ensuring the Plague Orders were followed.

Figure 2.3. Proportion of Household Infected vs Clustering by Parish, 1603-4.



Note: Total households are calculated using full household information apart from in the case of St John the Baptist for which I had to rely on the surname only approach.[324] The R-Squared in this figure is not sensitive to the inclusion of the far-right data-point which represents the parish St James. If St James is removed the r-squared falls only slightly from 0.4624 to 0.438.

Source: Bristol Archives, Parochial Registers: P.Xch/R/1/a, P.St_J/R/1/a, P.St MR/R/1/2, P.St_N/R/1/b, P.St_N/R/1/c, P.St_JB/R/1/a, P.AS/R/1/a, P.St_W/R/1, P.St_T/R/1/a, P.St_S/R/1/a

Whilst the effectiveness of governance must have been crucial, the degree of enforcement was also determined by the financial resources at the town's disposal.[325] As Paul Slack argues, 'The enforcement of household quarantine [nationally]… depended both on the extent of infection and on the amount of money available to pay for it.' [326] The total expected revenue from plague rates ordered by the Bristol Common Council was at least £566.15 in 1603-4. [327] The Councillors themselves were expected to raise £158 and the rest was to come from 4 plague levies on all burgesses who were assessed for the national lay subsidies.[328] Since the rate for the first of these is unknown (it was left to the 'good discreation' of the plague committee), the £566.15 figure is an underestimate. Still, it is high considering a

[323] I am grateful to Matthew Kilner for providing me with this information.
[324] Appendix 3, tables A.3.5 and A.3.6.
[325] The 1373 charter granted separate county status to Bristol and therefore reduced the ability for the Bristol JPs (Aldermen) to raise funds from the surrounding county as was done for more integrated towns. Lobel et al, *Bristol*, 1; Slack, *Impact*, 267
[326] Slack, *Impact*, 279
[327] Bristol Archives, Common Council Proceedings, M/BCC/CCP/1/1. Vol 1. Fos. 79; 81; 83; 92
[328] This was calculated using Slack's figures for the 1597 lay subsidy assessment: Slack, *Local Incidence*, 53

plague assessment for maintaining quarantine in the more populous town of Norwich during the same epidemic was set at less than £300.[329]

The loss of the account books used by the Bristol plague committee in 1603-4 means we cannot know how much of the levies were paid, though threats of imprisonment must have persuaded many to pay up eventually.[330] We also cannot know how much additional revenue was generated through loans or donations made by individual elites, the church or other corporate towns as was often the case elsewhere.[331] Yet it seems unlikely the Council raised enough to ensure the system of quarantine and relief could be maintained across the city. Based on the known costs of enforcement in other English towns, it is hard to imagine the total bill for full enforcement in Bristol coming to less than £3,000.[332] Even if donations and gifts doubled the revenue raised through taxation, the Council would still have faced a considerable shortfall.

Whilst it is unlikely the Common Council raised sufficient funds to ensure the quarantine was enforced everywhere, it still had the power to determine which parishes should receive the money that was collected. The Common Council minutes describe a centralised system of resource distribution.[333] Nevertheless, the greater evidence for enforcement in the central, affluent parishes suggests it was here that the Council directed most of its resources. Several factors might explain this choice, but it surely mattered that these were the areas where the councillors and most of the subsidy men resided. Perhaps, as well as being the areas where they could exert control, the Bristol elite also favoured their own parishes to protect themselves and their families.

Conclusion

The enforcement of household quarantine in Bristol in 1603-4 was unprecedented in the city's history. When plague threatened in 1603, the authorities persisted with their traditional strategy of restricting movement from infected settlements. When it reached Bristol, however, they responded by enforcing household isolation for the first time and with considerable vigour. Despite the potential controversy and the considerable expense, the Bristol authorities met with substantial success in separating suspected carriers of infection from the wider community. We know this because their efforts caused a distinctive shift in the pattern of mortality: burials were much more tightly clustered into household groups in 1603-4 than they had been in the plagues of 1565 and 1575. Whilst the policy of isolation may have had a long history when used against other diseases and in other localities, the

[329] Norwich is a good comparison because Norwich also had county status meaning it was harder for their JPs to assess their hinterlands in time of plague. Slack, *Impact,* 281
[330] Bristol Archives, Common Council Proceedings, M/BCC/CCP/1/1. Vol 1. Fos. 79; 81; 83; 92.
[331] Wrightson, *Ralph Tailor's*, 47; Slack, *Impact,* 279-282; Henderson, *Florence under siege,* 144
[332] There were around 1,500 affected households in the whole town. I have found three estimates of the total cost of implementing quarantine and relief across a whole community. The figures imply a cost somewhere between £3,000 and £5,300. Newman, *Shutt Up*, 817-818; Slack, *Impact*, 280; Wiltshire archives, G23/1/112.
[333] Bristol Archives, Common Council Proceedings, M/BCC/CCP/1/1. Vol 1. Fo. 83

publication of the Plague Orders in 1578 clearly caused a disjuncture in the history of plague responses in Bristol.

Contemporaries and historians agree that household quarantine would increase the mortality risks for healthy people inside quarantined households. Yet, the scale of the impact, revealed here for the first time, is still shocking. Where implemented most forcefully, household quarantine doubled the proportion of burials occurring in groups of three or more. Equally surprising are the very low levels of clustering that were witnessed in the pre-1578 plagues in Bristol. Almost all previous estimates of plague mortality within infected households have resembled those found in the wealthy, central and riverside parishes of Bristol in 1603-4. These results have previously been interpreted in light of the rat-flea theory of plague transmission: high burial clustering was a consequence of the uneven distribution of rat's nests across households, endangering some more than their neighbours.[334] Paul Slack described this pattern as 'one of [plague's] most conspicuous distinguishing features in early modern England.'[335] The results of this study – the first to analyse within household mortality before 1578 – suggest high burial clustering in other epidemics was actually the consequence of household quarantine, and not the presence of rat's nests. In fact, the agreement between clustering in the pre-1578 Bristol epidemics and clustering during the influenza outbreak of the 1550s – the consequence of direct human to human transmission - suggests plague may have been transmitted between humans as well without the involvement rat fleas.[336]

Though the effects of quarantine are visible in almost all parishes in Bristol in 1603-4, they are most clear in the affluent, central, and riverside parishes of the town. The authorities came closest to meeting their objective of separating suspected carriers from the healthy in these areas. This is unexpected given the emphasis of some studies on the links between the development and enforcement of quarantine and the desire to discipline and control the poor and marginal who were more common in the peripheral areas. The degree of enforcement was correlated with patterns of elite residence and thus political oversight, parish size and the greater potential for effective enforcement. It is likely the pressure caused by high proportions of infected households also mattered but it is difficult to separate this from the potential consequences of quarantine itself for reducing the number of households affected. The minutes of the Common Council reveal the funds used to enforce implementation were raised and distributed at the centre, not in the individual parishes as they were in other towns, particularly London. The greater evidence for enforcement in the areas where the elite resided is evidence of their greater ability to exercise power in these areas and, perhaps, their desire to ensure the town's resources were used to protect their own households.

At the level of the parish, the bias is towards the most affluent areas, not towards the poorest. But it could still be that the marginalized were treated more harshly within parishes where

[334] Schofield, *Anatomy,* 102. Schofield, R., *The last visitation of the plague in Sweden: the case of Bräkne-Hoby in 1710–11,* Economic History Review 69 (2016), 616.
[335] Slack, *Impact,* 178; Slack is quoted by Champion*, London's Dreaded,* 82; Wrightson, *Ralph Tailor's,* 38-9. The point originates with Schofield, *Anatomy,* 102.
[336] Slack, *Impact*, 177

enforcement was high. The micro-evidence from the central, affluent parish of Christchurch suggests the authorities were more concerned to prevent the spread of infection than target certain social groups. There is no evidence of a bias in the enforcement of household quarantine in the parish of Christchurch. Neither income, street, nor political status determined the degree to which households were quarantined. This supports recent scholarship which argues the development and enforcement of quarantine and relief was motivated by a desire to reduce infections and not discipline or control.[337]

By revealing the extent and intensity of implementation, especially in parishes like Christchurch, this chapter raises important questions about those who managed and operated this system on behalf of the state. For, whilst the Aldermen and Common Councillors oversaw the plague response, it was the officials in the parishes who coordinated the many activities required by the Plague Orders. Parish offices were staffed by voluntary officials with no formal training who were drawn from the middling and elite classes. After 1578, they were responsible for enforcing the system of quarantine and relief within their own communities. Understanding the tensions created when ordinary people locked up their friends, neighbours, customers, and colleagues is a potentially rich area of historical study that has never been investigated.

Even so, there must have been widespread support for household quarantine in the areas where it was enforced. Hindle argues the Plague Orders were supported only by enforcing magistrates and were inconsistent with the aspirations of the wider populace.[338] Yet, as Braddick shows, the enforcement of social policies presupposes broader coalitions of shared interest among parish officers capable of exercising considerable discretion.[339] Many parish officers and members of the wider public must, therefore, have supported the enforcement of quarantine in Bristol in 1603-4.[340]

---

[337] Crawshaw, *Plague Hospitals*; Crawshaw, *Renaissance Invention*, 172-173; Newman, *Shutt Up*, 826
[338] Hindle, *The State and Social Change*, 170
[339] Braddick, *State formation*, 129-132
[340] Slack makes a similar point here: Slack, *Perceptions*, 147

Chapter 4. The Enforcement of Quarantine in Early Modern England, 1540-1667

Introduction

Chapter 3 revealed the widespread and intense use of household quarantine after the introduction of the national Plague Orders in 1578 in the city of Bristol. We know from documentary accounts of orders and proclamations that local authorities across early modern England adopted these regulations.[341] Do changes in the patterns of burial clustering suggest they enforced them to the same extent as Bristol? Is there evidence that local authorities pre-empted national regulations, enforcing household quarantine before 1578? And where enforcement occurred, is there evidence household quarantine changed broader patterns of incidence and severity in the way the policy intended?

In this chapter, I measure the enforcement of household quarantine across 56 parishes drawn from 21 settlements using the individual-level burial data donated to this project by genealogical organisations. Given the greater scale of the dataset, I employ an automated approach which relies on surname correction and linkage to create a new metric called 'excess clustering' – the difference between epidemic and non-epidemic clustering. Like chapter 3, this allows us to go beyond the documentary sources to measure actual changes in population behaviour due to the enforcement of household quarantine. This chapter builds on chapter 3 methodologically by employing a fixed effects regression framework to control for other possible drivers of changes in burial clustering over time.

The results show household quarantine was enforced by English local authorities with a similar average intensity as Bristol in 1604. The major exception is London where there is little evidence household quarantine was strongly enforced (though high numbers of people fleeing the city may have countered the increase in burial clustering and obscured the effect). The clustering coefficient estimated using the regression model for parishes outside the capital reveals comparable change in clustering on average to that found in Salisbury in 1604. Rare quarantine documents survive for the Salisbury epidemic, revealing the vast scale of the investment made by the authorities when implementing the regulations. The regression results thus show the documents are rarer than the response they record. Yet the results also show increases in clustering could be substantially higher than average (around 4 times). This suggests low level evasion was common.

In contrast to Bristol, the wider sample shows some evidence of early enforcement, prior to the publication of the Plague Orders in 1578. This supports Slack's assertions that some local authorities were precocious in implementing plague responses. The mortality outcomes also contrast with those observed in early modern Bristol. There is no association between levels of excess clustering and the severity of epidemics. There is also no clear relationship between changes in clustering and the degree to which epidemics spread across England. This

[341] Slack, *Impact*, 211-212

suggests household quarantine was ineffective as a measure for the control of plague. However, the lack of an association potentially reflects an important clue about the transmission of plague. Had infected rats been solely responsible, mortality should have increased after household quarantine was introduced. That mortality does not increase suggests people could transport the disease between households as well as between settlements.

In this chapter, I adopt the traditional structure of a scientific paper. This helps to ensure clarity and reflects the quantitative nature of the investigation. Beginning with a description of the dataset and the automated approach to measuring absolute and excess burial clustering, I then validate the approach by re-analysing the Bristol burial data. Since this confirms the effectiveness of the strategy, I progress through a series of descriptive analyses of burial clustering across epidemics and over time. To account for additional potential drivers of burial clustering over time, I test the proposition that clustering increased systematically after 1578 using a fixed effects regression model. Finally, I interpret the results in light of the findings of previous chapters and the wider literature before concluding.

Source, Sample, and Dataset

The individual-level data used in this chapter is drawn from a subset of the parishes included in the monthly burial count series. The make-up of the sample is determined in the first instance by the kind of data that was donated to the project. For several counties, data was only provided in aggregated monthly count form and so could not be used for the purpose of linking together the underlying burials by surname. Still, 1,674,138 individual level data points are available for this analysis. Plague epidemics are identified here using the same rules on severity, duration, and seasonality set out in chapter 2 with one important adjustment – all epidemics are defined as ending in the December of their final year. This removes the possibility that the implementation of quarantine itself affects the length of an epidemic and thus influences the degree of observed clustering. Likewise, only epidemics occurring during the national outbreaks defined in chapter 2 are analysed in this chapter to reduce the possibility that the cause of an epidemic has been wrongly identified as plague. Once those restrictions have been applied to the dataset, 42,746 individual-level burials occurring in 284 parishes and 504 plague epidemics remain available for analysis. These burials can be linked together by surname for each epidemic in each parish.

Since the aim of this chapter is to measure changes in clustering over time, it is important the composition of parishes in the dataset remains as stable as possible. Perfect stability is rendered impossible by the differential incidence of epidemics. The most heavily affected parishes appear most often in the sample. An additional problem is increasing source survival over the study period. This is especially problematic where parishes are only observed after 1578 – when the Plague Orders where first published. In these cases, we lack comparison data to assess the scale of changes in clustering. To address these issues, the following analysis will utilise a sample constructed containing only parishes with at least two epidemics in observation where the first epidemic occurred prior to 1578. This creates a semi-balanced sample and addition of fixed effects in the panel regressions below mean only differences within parishes will be measured to obtain estimates of changes in clustering over time.

The resulting sample of 206 plague epidemics from 56 parishes within 21 settlements is described by national epidemic in table 3.1. The settlements are also mapped in figure 3.1. For the purposes of this analysis, the key comparison is between epidemics occurring before and after 1578 so the distribution of epidemics before and after this date is also included. These rows show the effect of the pseudo-balancing process: whilst the same number of parishes and settlements are represented pre and post, the number of epidemics differs as does the number of plague burials that are being linked together by surname. Also included in table 3.1 is the contribution to the total sample of parish level epidemics made by London parishes. Overall, they represent 63% of burials and 56% of epidemics despite representing 45% of parishes. This is because some London parishes had relatively large populations that were hit more frequently by plague (5 epidemics per parish vs 3 elsewhere). Given their prominence in the sample, the below analysis will also consider patterns of clustering in metropolitan parishes separately.

<u>Figure 3.1. Map of Settlements Included in Dataset</u>

Table 3.1. Composition of Plague Sample by National Outbreak

National Outbreak	*Individual Plague Burials*	*Parish-Level Epidemics*	*Parishes Observed*	*Settlements Observed*
1543-6	369	12	12	9
1562-5	4105	48	48	15
1592-4	2169	29	29	9
1602-6	4302	42	42	15
1623-6	3924	31	31	11
1636-7	837	8	8	5
1665-7	4033	28	28	10
Pre-1578	4611	65	56	21
Post-1578	15492	141	56	21
London Only	12721	119	25	1
Total	20103	213	56	21

Measuring Clustering: Surname Linkage

As demonstrated in chapter 3, it is possible to measure the clustering of mortality within households by linking deceased individuals into household groups using surnames. Given the much greater quantity of data used in this chapter, the linking process must be automated. But whereas hand linkage allows for associations to be made between surnames with slight spelling inconsistencies, automated linkage requires adjustments to be formalised and applied to the data before linkage can occur. I implement a set of adjustments to the original spellings which assume similar sets of characters were used to mean equivalent things. For instance, where parish clerks regularly shift between using a single and double letter for several letters in the alphabet, these are simplified to single letters in every instance. Also, letters that sound similar, for example ‘c’ and ‘s,’ or ‘e,’ ‘y,’ and ‘i,’ are used interchangeably in the records and are therefore replaced with a single letter. So, for example, all ‘i’s and ‘y’s are changed to ‘e’s. The full set of rules are listed in table 3.2. Once surnames have been standardised using this process, they are matched together with all other identical surnames occurring in the same epidemic and parish register.

Table 3.2. Surname Standardisation Rules

Original	*Replaced*
Double: n, l, b, a, r, t, s, p, g	Single equivalents
ee, ye, y, ie, ee	e
ck	k
Last letter: e	Removed
Last letter: s	Removed

The proportion of burial samples linked through this process is only slightly lower than the rates achieved through manual matching. This can be seen by comparing the match rates in a set of registers from Bristol for which the surnames have also been linked together by hand. A difference would be expected since no set of standardisation rules will be sufficient to remove all the idiosyncrasies of early modern spelling. Across 27 samples of burials, drawn from 9 Bristol parishes, hand linkage always returned the highest rates of matching, exact matching before surname modification always returned the lowest rates and match rates for modified surnames falls in between. The results are presented in table 3.3. Overall, 52% of surnames could be linked to at least one additional surname, whereas 55% were when linked by hand. The variation around these averages is small, consistent, with no systematic variation over time.

Table 3.3. Approaches to Linking Compared Using 27 Burial Samples (9 Parishes) from Early Modern Bristol

	Original Spellings	*Modified Exact*	*Manual Linkage*
Mean	50%	52%	55%
Standard Deviation	0.149	0.148	0.156
Count	27	27	27

However, linking people by surname alone, regardless of the method, will lead to both false positive and false negative links. This is clear from chapter 3 where individuals were assigned to household clusters using additional relational information recorded in some Bristol parish registers. The presence of household members who do not share a surname with the household head – most notably servants and apprentices – are ignored and in most cases treated as individuals living alone. Their exposure to a particular household disease environment is thus ignored (false negative). Conversely, surname-only linkage overestimates the size of family groups with common surnames, like Smith, because no additional information allows us to distinguish between multiple households that share a name (false positive).

This chapter develops tests to ensure theses biases are not driving the results. False negatives lower the level of clustering, but this is only critical to the analysis if they also affect the trend in clustering overtime. The effect of false positives can be reduced by relying on 'excess clustering' instead of absolute clustering levels. Excess clustering is calculated as epidemic burials per surname minus pre-epidemic burials per surname. Like the concept of excess mortality, this metric removes 'normal' levels of clustering from the clustering levels found during epidemics. This ensures changes in the structure of surnames over time and across parishes do not bias the results. To do this, it is necessary to define the period over which normal clustering levels are to be calculated. Since, the level of clustering during an epidemic will vary with the absolute number of burials, it makes sense to measure non-epidemic clustering within a sample containing the same number of burials. So, the end of non-epidemic period is defined as the month prior to the start of the epidemic and, counting backwards in time, the start is defined as the final month necessary to ensure the non-epidemic period contains the same number of burials as the corresponding epidemic, regardless of how many months are included. The two periods thus contain the same number of burials but may differ in length.

Description of Burials per Surname

This approach is successful in revealing the distinctive pattern of burial clustering identified by plague historians. Table 3.4 describes the characteristics of burials per surname for plague epidemics, pre-plague periods, epidemics caused by influenza in 1557-9, and the harvest failure of 1596-8. Plague epidemics witnessed greater numbers of burials per surname than the periods directly prior to an epidemic. During plague epidemics there were 1.37 burials per surname on average. In periods for which the same number of people were buried prior to the epidemics, there were an average of 1.19 burials per surname. The difference between the means is statistically significant at the 1% level ($p<0.0001$). Likewise, the lower levels of burials per surname in epidemics caused by influenza and harvest failures is also statistically significant. Plague epidemics are associated with peculiarly high clustering of burials.

Table 3.4. Burials per Surname in Plague Epidemics, Pre-Plague Periods, and Other Epidemics

	Observations	*Mean*	*Median*	*Standard Deviation*	*Min*	*Max*
Plague	206	1.37	1.35	0.20	1	2.40
Pre-Plague	206	1.19	1.17	0.12	1	1.66
Harvest Failure	320	1.14	1.11	0.16	1	2.11
Influenza	365	1.13	1.10	0.16	1	2.20

Table 3.5. Burials per Surname and Excess Burials per Surname in Bristol Parishes, pre/post 1578

	Observations	*Av. Burials per Surname*	*Av. Pre-Plague Burials per Surname*	*Av. Excess Burials per Surname*

Pre-1578	8	1.34	1.18	0.16
Post-1578	8	1.48	1.14	0.34

Note: Excess burials per surname is calculated at the parish level and so does not equal average burials per surname minus average pre-plague burials per surname in the above table.

The automated approach to measuring burial clustering also confirms the results of chapter 3 where I used a manual linking methodology, including additional relational information where possible. Table 3.5 shows average burials per surname increased from 1.34 to 1.48 after 1578. Since burials per surname prior to plague epidemics fell slightly, excess clustering rose even more than absolute clustering: from 0.16 to 0.34. Using the hand linked, surname-only figures for Bristol, I estimate clustering increased by 67%; the excess clustering figures calculated here show a larger increase of 110%. Despite a difference in methodology, the results are very similar. This confirms the success of the automated, excess clustering approach which is applied to the broader dataset to understand implementation in parishes across England.

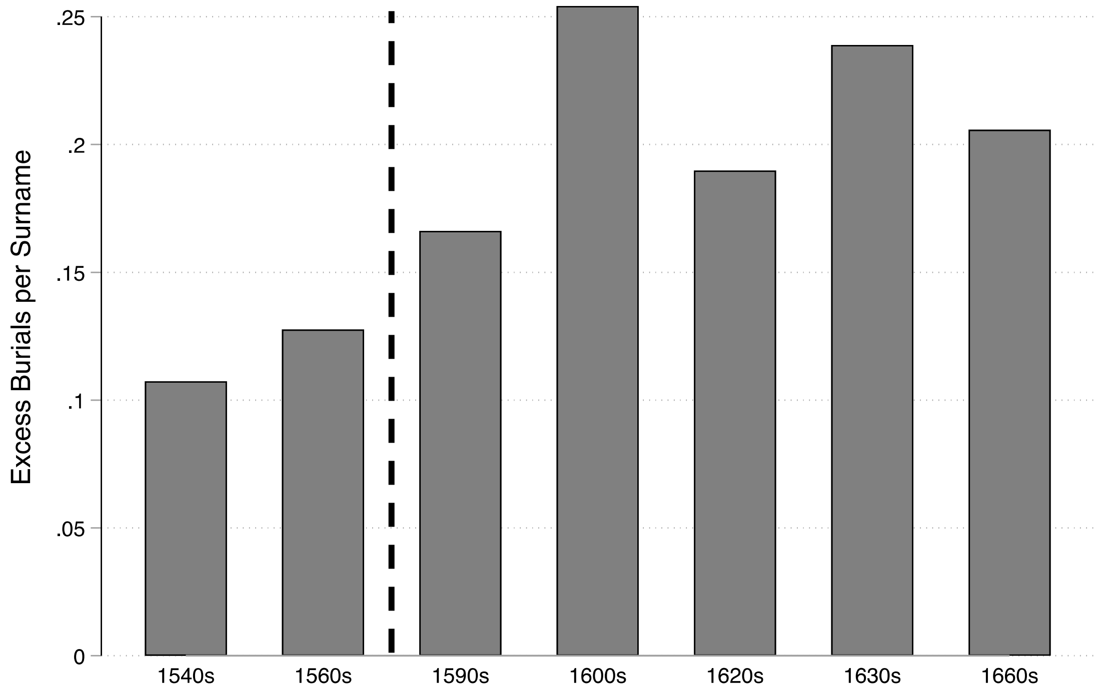
Average burials per surname increase significantly in the wider dataset, matching the pattern found in Bristol. Table 3.6 shows average burials per surname increased from 1.31 to 1.39 after 1578 whilst excess burials per surname increased from 0.12 to 0.21. Both differences in means are comfortably significant at the 1% level. In contrast, burials per surname in the periods directly prior to plague epidemics remained essentially constant (1.19 vs 1.18). This suggests changes in burials per surname during plague epidemics is not related to broader trends in surname distributions within the population. The only significant change in burial clustering after 1578 occurred during plague epidemics.

Focusing on each epidemic separately reveals a sharply increasing trend in burial clustering from the 1540s to 1590s and a gentler and more variable pattern thereafter. Figure 3.2 shows the average excess burials per surname in each of the 7 plague surges. Burial clustering was the lowest in the 1540s (0.11) but still, plague clustering is considerably higher than that found for influenza (0.027), perhaps suggesting plague did not travel directly between humans in a pneumonic form. Excess clustering then rises from 0.11 in the 1540s to 0.17 in the 1590s, or by 55%. This may suggest some local governments were successful in their efforts to enforce quarantine before the national plague orders of 1578. Thereafter, average excess clustering remains consistently higher than in the pre-1578 outbreaks, never falling below its previous low such that by the 1660s the average was 0.21, 24% higher than 1590. The first outbreak of the 17th century witnessed the highest excess clustering (0.25). This peak therefore coincides with the passing of the Plague Act in 1604 which legislated for additional financial support for household quarantine, potentially making the system more effective at keeping people shut up.

<u>Table 3.6. Burials per Surname and Excess Burials per Surname in All Parishes, pre/post 1578</u>

	Plague Epidemics	*Av. Burials per Surname*	*Av. Pre-Plague Burials per Surname*	*Av. Excess Burials per Surname*
Pre-1578	65	1.31	1.19	0.12
Post-1578	141	1.39	1.18	0.21

Figure 3.2. Mean Excess Burials per Surname During Plague Epidemics in Each National Outbreak



Note: Sample sizes in brackets - 1540s (15), 1560s (50), 1590 (30), 1600s (44), 1620s (31), 1630s (7), 1660s (29)

Regression Analysis

Before interpreting these averages as evidence of household quarantine, it is important to remove potential alternative explanations. The rise in burials per surname after 1578 could have been driven by factors other than the enforcement of household quarantine. To investigate this more precisely, the burials per surname data will be included as the dependent variable in a fixed effects panel regression which includes a set of controls that account for alternative drivers of changes in clustering after 1578. The formula for the main specification of the model is described below where the explanatory variable, 'BPS', is burials per surname in each plague epidemic and parish. The independent variable of interest is a dummy variable taking a value of 1 if a parish-level epidemic occurred after 1578 and 0 otherwise. To address the possibility that the increase in clustering was caused by factors other than quarantine enforcement, the model also includes a set of independent variables: average burials in the previous 4 years (a proxy for relative population size), the absolute number of burials occurring during the epidemic, the duration of the epidemic in months, and burials per surname in the period directly prior to the epidemic. The model also includes parish fixed effects. These account for any time invariant, parish specific factors which may affect the degree of clustering and therefore ensure only changes in average clustering within parishes is reflected in the coefficient associated with the post-1578 epidemics.

$$BPS_{it} = \alpha + \beta 1 Post1578_{it} + \beta 2 PopulationSize_{it} + \beta 3 PlagueBurials_{it} + \beta 4 Duration_{it} + \beta 5 PreBPS_{it} + ui + \varepsilon_{it}$$

Before analysing clustering during epidemics, we can use pre-plague clustering to confirm there was no significant change in clustering outside plague epidemics after 1578. Column 1 of table 3.7 shows the results of a ‘placebo’ test where the dependent variable is burials per surname prior to each plague epidemic. Holding everything constant, the post-1578 coefficient reveals a small, negative, and statistically insignificant difference between non-plague clustering before and after 1578. The only variable significantly associated with non-plague clustering is the number of burials in the sample. This is unsurprising given the more burials included, the higher chance an additional individual with the same name will be included. This result confirms the impression given in table 3.6 above, namely that there were no significant changes in the distribution of surnames appearing in burial registers over this period that might affect changes in clustering during plague epidemics.

Likewise, the regression results in columns 2 to 4 confirm the impression that there were significant changes in burial clustering in plague epidemics after 1578. In all three columns, burials per surname during plague epidemics is the dependent variable. Column 2 presents the results without including pre-plague burial clustering and fixed effects, and column 3 adds in fixed effects. Column 4 presents the results using the fully specified model. The coefficient associated with the post-1578 dummy rises slightly with each change in the specification. It remains positive and the statistical significance increases from the 10% to the 1% level in the full specification. Once other variables are controlled for, clustering within parishes increased by 0.08. Burials per surname prior to pre-1578 were equal to 1.31 so the coefficient represents a 6% increase or half a standard deviation (sd=0.16). In specifications 2 and 3 the absolute number of burials during the epidemic is once again positive and significant. This is no longer the case in specification 4 because this variable is sharing explanatory power with the non-epidemic clustering variable (with which specification 1 shows it to be co-linear). Despite the introduction of these and the other controls describing the characteristics of each epidemic, the regressions reveal the existence of a systematic change in burial clustering after 1578 that cannot be explained by changes in non-epidemic clustering.

The magnitude of the change in clustering after 1578 is much stronger outside London. This is demonstrated in the final 2 columns of table 3.7. Specification 5 is the same as specification 4 but only includes the 31 parishes and 87 epidemics in the dataset located outside the capital. Whilst the significance of the coefficient on the post-1578 dummy is the same as specifications 2 to 4, it doubles in magnitude from around 0.08 burials per surname to 0.16 burials per surname. Since pre-1578 mean burials per surname outside the capital was 1.33 and the standard deviation was 0.19, the post-1578 coefficient represents a 12%

increase, or 0.84 of a standard deviation. In contrast, burial clustering increased relatively little after 1578 for the sample of 25 London parishes. This is shown in specification 6 where the coefficient on the post-1578 dummy is 0.04 and is insignificant, even at the 10% level.

Could the systematic increases in clustering outside the capital after 1578 be the result of changes in the number of people fleeing the plague? If greater numbers of households fled with successive epidemics, the resulting burial patterns might contain greater numbers of repeated surnames. The much lower and insignificant post-1578 coefficient estimated for London parishes heavily suggests the non-metropolitan results are not the result of flight. Several scholars have found evidence for an increase in flight over the early modern period, particularly in London.[342] If changes in clustering were the result of changes in the composition of the population due to flight, we should find the largest increase in clustering in the London-only estimation. That we find no statistically significant evidence for an increase clustering in London (once controls are included), suggests flight did not cause the increase in burial per surname outside the capital.

In fact, since it was often only some household members who were removed from the city (most often women and children), it is more likely high levels of flight is masking the effect of household quarantine on burial clustering by suppressing the number of burials per surname in London parishes. Fewer people resident within each household will mean fewer people with the same surname were susceptible to being killed by plague. Another very possible (and indistinguishable) explanation, however, is that the London parishes were much less effective at implementation of plague responses than parishes outside the capital.

Table 3.7. Burials per Surname Fixed Effects Panel Regression Results

[342] Slack, *Impact*, 168; Cummins et al, *Living Standards*, 29

VARIABLES	(1) Pre-Epidemic Clustering	(2) Plague Clustering	(3) Plague Clustering	(4) Plague Clustering	(5) Plague Clustering (ex-London)	(6) Plague Clustering (London Only)
Post-1578	-0.0279	0.0646**	0.0763**	0.0845***	0.160***	0.0397
	(0.0177)	(0.0282)	(0.0288)	(0.0296)	(0.0542)	(0.0253)
Non-Epidemic Clustering				0.295	0.605*	-0.00979
				(0.200)	(0.318)	(0.187)
Log Parish Population	0.00288	0.00872	-0.00840	-0.00925	-0.0355	0.0213
	(0.0141)	(0.0234)	(0.0317)	(0.0332)	(0.0513)	(0.0286)
Log Epidemic Burials	0.0885***	0.0706**	0.0903**	0.0642	-0.0395	0.130***
	(0.0143)	(0.0308)	(0.0430)	(0.0485)	(0.0988)	(0.0306)
Epidemic Duration (Months)	-0.00161	-0.00414	-0.00674	-0.00626	0.000954	-0.00551
	(0.00645)	(0.00619)	(0.00885)	(0.00920)	(0.0239)	(0.00715)
Constant	0.839***	1.029***	0.998***	0.751***	0.852**	0.747***
	(0.0544)	(0.0962)	(0.133)	(0.165)	(0.335)	(0.139)
Observations	206	206	206	206	87	119
R-squared	0.261	0.133	0.133	0.153	0.169	0.310
Number of parishes	56	56	56	56	31	25

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: Parish-level fixed effects are used in all specifications apart from specification 2.

Assessing the Strength of Quarantine Enforcement

But whilst we can use burials per surname to provide a relative sense of implementation quality across parishes (as we did in chapter 3), it is more challenging to assess absolute success. This is because we lack an objective, ‘ideal’ standard against which we can compare the changes in clustering revealed here. The closest we can get is to understand the changes in clustering associated with the most extensively documented implementations. One of the best documented cases is Salisbury in 1604. Detailed lists survive for this epidemic which show payments to quarantined households in all three of the main parishes.[343] In the one parish, St Thomas’s, where an Easter book (like that of Christchurch, Bristol) also survives, around 28% of all households were quarantined throughout the epidemic.[344] These quarantine records are exceptionally complete, showing the continuous process of quarantining and releasing households throughout the epidemic. Fortunately, the dataset used in this chapter includes two of the three main parishes of Salisbury, St Edmund’s and St Martin’s. Though burials during the 1604 epidemic – along with an earlier epidemic in 1565 - are only observed in St Edmunds.

St Edmund’s parish in Salisbury was the largest by area and by population, as indicated by average non-epidemic burials. Inflating the number of households (440) in the 1603 Easter book for St Thomas’ parish by the ratio of average burials in St Edmunds and St Thomas’ (1.4) suggests there were about 616 households in St Edmunds parish during the 1604 epidemic.[345] At the height of the epidemic, between the 29th of July and the 6th of August, 54 quarantined households were receiving financial relief from the parish.[346] This therefore

[343] Slack, *Impact*, 178, 271, 320; Wright, S J. Family Life and Society in Sixteenth and Early Seventeenth Century Salisbury. Unpublished PhD Thesis. (University of Leicester, 1982), 12
[344] Wright, *Family Life*, 12-13
[345] For easter book figures see: Wright, *Family Life*, 12-13
[346] Wiltshire and Swindon archives (Chippenham), G23/1/112

suggests around 8% of all households were quarantined at one time, though there may have been more who did not receive relief. As expected, burial clustering was higher in this epidemic than in the 1560s. Burials per surname increased from 1.28 to 1.53. This represents a within-parish increase in burials per surname of 0.25 or 20%. If we use the coefficient estimated in the model to adjust for non-epidemic clustering, the difference between the levels of clustering reduces to 0.17, a 13% increase.[347] The estimate of the post-1578 coefficient for the sample of parishes outside London was 0.16 (12% increase). This suggests the increase in clustering in St Edmund's parish reflects the average response outside the capital. Whilst the Salisbury quarantine records are rare, they seem to represent a typical 17th century plague response outside London.

However, the levels of burial clustering in Salisbury during the 1666 epidemic demonstrate the difficulties of relying on the richness of the documentary evidence as an indication of the strength and success of, or compliance with, the quarantine system. For 1666, we can observe changes in clustering in St Martin's, as well as St Edmund's parish. Both parishes witnessed more extreme increases in burials per surname. Between the 1560s and the 1660s, burials per surname increased from 1.28 to 1.76 (38%) in St Edmunds and from 1.38 to 1.88 (36%) in St Martins. After adjustments for non-epidemic clustering, the differences are 0.71 or 55% for St Edmund's and 0.44 or 32% for St Martin's. The average increase estimated in the regression model was between a third and a quarter (12% vs 32%-55%) the size of that found at Salisbury in the last major epidemic in 1666. This suggests many household quarantine responses outside London were only partial, even during well documented and ostensibly comprehensive implementations like Salisbury's in 1604. The continued increase in St Edmunds could indicate processes of learning by the authorities and (or) the public as greater efforts were made to control the plague.

An alternative approach to understanding the significance of these results is to compare the degree of clustering to estimates of the severity of mortality. In the previous chapter, we found some evidence for a negative association between clustering and levels of mortality. There is no evidence of an association between clustering (whether absolute or excess) and severity (total burials over average pre-plague burials) in this larger sample. This suggests the partial implementation of household quarantine was not associated with a decline in mortality, only a change in its distribution with burials becoming more concentrated in fewer households. That said, it should be remembered this analysis only measures clustering in epidemics that have been identified as highly severe using the plague identification approach outlined in chapter 2. Household quarantine may have limited the spread of plague if used on a small number of infected households at the start of an outbreak. If the outbreak was averted because of household quarantine, then the epidemic would not feature in this analysis. This selection problem is unavoidable given the approach to identifying enforcement but does mean we can only provide a partial answer concerning mortality outcomes. If plague caused a

[347] Total burials increased from 365 to 419. The model predicts this would have increased burials per surname by only 0.01. Clustering prior to each epidemic increased from 1.37 to 1.41. The model predicts this would have increased burial clustering during the epidemic by 0.04.

major epidemic, continued use of quarantine at the levels of enforcement witnessed in Salisbury in 1604 were insufficient to reduce mortality.

Table 3.8. Mean Excess Burial Clustering vs % National Incidence in 7 Major Plague Surges

National Surge Years	Mean Excess Burials per Surname	Settlements Affected
1543-1546	0.11	8.0%
1562-1565	0.13	2.7%
1592-1594	0.17	2.0%
1623-1626	0.19	3.7%
1665-1667	0.21	2.8%
1636-1637	0.24	1.4%
1602-1606	0.25	4.1%

Perhaps unsurprisingly, then, there is also no evidence average levels of enforcement were associated with the degree to which plague spread across England in each plague outbreak. Table 3.8 displays mean excess burials per surname alongside the estimates of plague's pervasiveness in each major plague surge, discussed in chapter 2. The outbreaks are ranked from lowest to highest in terms of excess burial clustering. There is no systematic correlation between the degree of enforcement and the pervasiveness of plague. The plague surge with the lowest clustering, the outbreak of the 1540s, did also witness the highest levels of pervasiveness. However, the surge with the highest clustering witnessed the second highest pervasiveness. Between the 1560s and the 1660s, average excess clustering increased by 62%, yet pervasiveness was essentially the same in both outbreaks. Of course, it could be that an association between quarantine and the spread of plague is being masked here by the many other factors affecting both the clustering and pervasiveness estimates. Yet, this evidence suggests that the enforcement of household quarantine did not affect the geographical spread of plague during major epidemics.

Conclusion

Using automated surname linkage, I have significantly expanded the investigation begun in the previous chapter into the enforcement of household quarantine in early modern England. This approach has proven capable of replicating the results found using hand linkage and more detailed records in early modern Bristol. The magnitude of average increases in burial clustering (outside London) indicates considerable investment in the enforcement of quarantine. For London, it has often been argued that the household quarantine system failed during major epidemics.[348] The lack of a statistically significant change in clustering in London after 1578 appears to confirm this, though we cannot rule out flight as an additional factor leading to lower clustering overtime.

348 Slack, *Impact*, 278-282

The survival of the Salisbury quarantine lists recording disbursements to infected households and watchmen shows a remarkable level of administration and financial redistribution in 1604. The rarity of these documents means it has been difficult to assess how representative the responses they describe were other towns in early modern England. The regression results from table 3.7 imply the Salisbury response was surprisingly representative. The average increase in burials per surname in the non-metropolitan sample is the same as the increase in Salisbury. This confirms the central finding of chapter 3 that local communities invested heavily in their attempts to control and limit the spread of plague.

Using names recorded in parish burial registers, has allowed us to go beyond the direct documentary evidence to recover the true extent to which confinement was maintained. This shows that even with significant investment the authorities struggled to maintain strict quarantines in many cases. Whilst clustering increased significantly in Salisbury in 1604, the magnitude of the change was much higher in the same town in 1666. The earlier response (and by implication, responses in many other English towns) seems to have been hampered by a combination of slow identification of infected households and low-level evasion among those supposed to be confined. Rich evidence of the implementation process does not necessarily demonstrate successful enforcement. This highlights the utility of studying parish registers to understand changes in population behaviour alongside documents created by officials implementing plague responses.

That average excess clustering increased gradually between the 1540s and the 1590s may suggest some local authorities were precocious in enforcing household quarantine prior to the publication of the plague orders in 1578. This confirms Slacks impression from the documentary sources that even by 1550 the importance of quarantine was widely accepted.[349] Overall, the clustering results show those attempts left a significant imprint on the patterns of mortality during epidemics. Burials became more concentrated in affected households. Contemporaries who argued household quarantine led to additional deaths within the household are vindicated by this research.

For London, I could detect no statistically significant increases in clustering. There are at least three explanations for this which are also potentially complementary. One is that increasing levels of flight exerted an opposing influence on burial clustering and therefore obscured the effects of household quarantine in the burial registers. Another is that enforcement was much more challenging in a large city where the epidemic was often particularly severe.[350] It could also be important that London's governing institutions were less centralised than smaller towns like Salisbury and even Bristol where in both cases there is evidence suggesting the quarantine response was managed from the centre, not the

[349] Slack, *Impact*, 204
[350] See chapter 2; Slack, *Impact*, 279

parishes.[351] It is likely all these factors contributed to the much smaller and insignificant increase in clustering for London parishes.

The findings for Salisbury in 1666 help to explain why, despite vigorous enforcement, there is no association between household quarantine enforcement and trends in mortality or the spread of plague between settlements at the national level. The average increase in clustering was only a quarter the size of the most extreme changes observed in Salisbury, suggesting household quarantine was generally only partially maintained. This fits with contemporary descriptions of people using backdoors to their houses and leaving through windows and indicates these practices were quite common.[352] Despite the known use of watchmen to ensure householders remained quarantined, many appear to have circumvented the regulations.[353] This likely reduced the efficacy of household quarantine, though understanding fully why household quarantine failed to contain plague requires a level of certainty about the transmission mechanisms of plague that historians are far from attaining.

Two pieces of evidence from this chapter contribute to the outstanding debate over transmission mechanisms. Since Roger Schofield identified burial clustering as a key variable for diagnosing historic epidemics, it is worthwhile considering these briefly. One of his central claims is that diseases that spread from a 'localised source of infection' will produce a more clustered pattern of mortality than disease spread directly between humans. Thus, bubonic plague spread from rats will produce more pronounced clustering than bubonic plague (or typhus) spread by human ectoparasites, and influenza will produce the most even distribution of mortality across households.[354] This chapter confirms excess clustering of plague was higher than influenza, even in the 1540s when few communities can have enforced quarantine. Being so early, the evidence from this epidemic is the best we have for the unaltered distribution of plague burials in early modern England. This suggests, plague did not spread like influenza – directly between people via water droplets.

And if the evidence points towards vector-based transmission, it also suggests rats were not the sole carrier of plague between households. If they were, the greater implementation (and consequent increase in clustering) would be associated with an overall increase in mortality during later epidemics since quarantining people would not have reduced the ability for plague to spread to new households. However, as already noted, I cannot identify an association between severity and the implementation of quarantine. Thus, quarantine appears to have prevented plague from spreading to some households which must mean people were at least partially responsible for transmission.

---

[351] For further evidence on the relationship between decentralised government and institutional fragmentation see: Slack, *Impact*, 282. The quarantine lists for Salisbury in 1604 cover all three of the central parishes, suggesting central oversight. For central administration in Bristol see chapter 3.
[352] E.g.Wrightson, *Ralph Tailor's*, 48-9
[353] E.g.Newman, *Shutt Up*, 820
[354] Schofield, *Anatomy*, 102-103; Schofield, *Last Visitation*, 616. It should be noted that Schofield identifies pneumonic plague with influenza in the earlier article and with typhus in the later one (where he apparently finds evidence for pneumonic transmissions).

All in all, this chapter presents strong evidence for vigorous if imperfect plague responses across early modern England. Contemporaries were responding to a disease which neither us nor they could fully understand. Whilst implementation was largely successful, the policy failed to meet its principal objective of controlling the disease. The only clear short-term consequences were great expense, administrative burdens, social disruption, and the concentration of mortality in fewer households. Still the long-term consequence of these attempts to resist disease was the emergence of a pattern of public health response that would be redeployed against new threats for the next 400 years.

Chapter 5. Pesthouses in Early Modern England

Introduction

Against a backdrop of relatively consistent epidemiological patterns over the early modern period, the English state began enforcing a novel policy of household quarantine to limit the impact of plague. Whilst some local governments were precocious, the introduction of national regulations in 1578 caused most local authorities to implement household quarantine for the first time. Yet the Elizabethan Plague Orders only set out a minimum level of response. They also encouraged local governments to develop and implement their own initiatives.[355] In this chapter, I investigate the use of pesthouses (isolation hospitals), one of the most important and misunderstood initiatives they employed.

Historians sometimes assume pesthouses were rarely used in early modern England.[356] By conducting the first systematic survey of the printed primary and secondary literature, I show local authorities established pesthouses widely in the years around 1578 and continued to use them in subsequent outbreaks. That they did, demonstrates a high level of proactivity among English local governments in adopting measures used in neighbouring English and continental towns. Despite the peculiarly centralised English state, municipal governments still independently innovated. Only in 1666, did the central government change the Plague Orders to reflect this, finally placing pesthouses at the centre of English plague policy.[357]

The establishment and functioning of English pesthouses has received very little scholarly attention. Their most thorough treatment consists of two paragraphs in Paul Slack's *The Impact of Plague in Tudor and Stuart England* where they are characterised as an alternative to isolating plague victims at home. Slack describes pesthouses as 'fashionable schemes [that] never had any chance of success.' Chronically underfunded and poorly conceived, pesthouses invariably failed during major outbreaks forcing the authorities to 'fall back on' household quarantine 'with some relief.'[358] This view is mirrored by two historians of London plague responses who describe pesthouses as 'absurdly' and 'hopelessly' inadequate due to their limited capacity.[359]

Evaluations of the success or adequacy of English pesthouses rests on a particular conception of their purpose as comprehensive alternatives to household-based quarantine – the model developed and most fully pursued in the great Italian cities like Venice, Milan, Florence, and Rome. There, medical police managed sophisticated surveillance and contact tracing systems with permanent isolation hospitals ('lazarettos') acting as the central repositories for confirmed and suspected plague victims. In contrast, English pesthouses have been described as little 'more than temporary wooden shacks, quickly thrown up and as quickly burned

[355] *Orders, thought meete*, item 14
[356] Henderson, *Florence under siege*, 130
[357] 1666 Rules and Orders of Privy Council for the prevention of the infection of the plague.
[358] Slack, *Impact*, 277
[359] Wilson, *Plague in Shakespeare's*, 82-83; Bell, *The Great Plague*, 192

down.'[360] They have been written off by historians who interpret them as failed imitation of Italian examples.

Yet, positive contemporary evaluations of pesthouses suggest English authorities did not intend pesthouses to function according to Italian models but rather as complements to the system of household-based isolation. Jacob Cool, a Dutch merchant who witnessed pesthouses in operation alongside household quarantine in London in 1603, thought they were vitally important for the City.[361] James Bamford, in his 'Short Dialogue Concerning the Plagues Infection' (1603) had the preacher in the dialogue praise London's pesthouse as a 'right honorable and christian prouisiōn.'[362] It is particularly noteworthy that these remarks were made about the city of London pesthouse, which is most often considered to be a failure by historians.

Outside the capital, the parishioners of Tavistock, in Devon, described their pesthouse as 'verie useful and beneficial' during a late 17th century visitation.[363] Furthermore, there are numerous cases where, far from criticising their pesthouses after an epidemic, local authorities went to great lengths to ensure they would be available for future use.[364] When the Salisbury pesthouse burned down in 1627, the Mayor immediately constructed a new one, 'with all speed' despite most plague victims being quarantined in their houses.[365] The evident use of pesthouses alongside household quarantine, and their apparent success in the eyes of contemporaries, invites a thorough re-evaluation of their purpose as one part of broader English quarantine systems.

By investigating the purpose of pesthouses, we can learn more about the objectives behind state enforcement of early modern plague responses. Historians differ over whether they emphasise the authorities' objective to control and limit the spread of plague or ensure social order by controlling social groups prone to generating social instability during moments of crisis.[366] The most obvious function of pesthouses was isolation and those most often isolated appear to be the poor or 'the houseless, moneyless, and friendless' in Wilson's words.[367] Pesthouses across Europe have therefore been interpreted as sites for the 'incarceration' of the sick, poor, and marginal during plague epidemics.[368] Gunter Risse describes them as 'prison-like houses of death.'[369]

Whilst acknowledging the terror associated with prospect of pesthouse confinement, others have highlighted their use as important sites for the state provision of treatment and care.[370]

---

360 Slack, *Impact*, 277
361 Grell, *Plague in Elizabethan*, 426
362 Bamford, *A Short Dialogue*, 29
363 McConaghey, *Epidemiology*, 1296-7
364 See section on permanence below.
365 Slack, Poverty in Salisbury, p.125
366 Compare, for instance, Pullan, *Rich and poor* with Crawshaw, *Plague Hospitals*
367 Wilson, *Plague in Shakespeare's*, 84; Grell makes a similar point: Grell, *Plague in Elizabethan*, 425
368 Slack, *Impact*, 276-277
369 Risse, *Mending*, 190
370 Murphy, *Plague Hospitals*, 20

Alfani et al even argue high levels of care in a 'lazaretto' in Carmagnola in 1630 meant poor patients experienced better survival outcomes.[371] For these historians, plague hospitals, particularly in Italy and France, were not prisons, but 'public expression[s] of Christian charity.'[372] Yet, Jillings contrasts the care and treatment provided in Italian plague hospitals with the much more austere isolation facilities used in Scotland where no such services are in evidence.[373] A central aim of this chapter is therefore understand the extent to which English authorities used pesthouses as spaces of confinement to ensure social order or whether they were acting with more charitable motivations.

I argue English pesthouses were a vital element of plague responses and were used widely by the mid-17th century to provide care and treatment as well as to isolate the sick. They should be understood not as a substitute to household quarantine but as a complement to this broader system. Pesthouses arose to address the limited care options for sick individuals who, for several reasons, could not expect adequate support at home. Thus, the argument presented here both confirms and contrasts with Slack's assessment. Pesthouses were always incapable of isolating entire populations in the way they did in Italy. However, they were far from simply failed 'fashionable schemes.' Instead, they provided vital care to individuals whose isolation could not be managed within a system of household-based isolation which relied on the support of additional household members. This argument is developed in the following chapter by, first, describing and explaining the patterns pesthouse establishment in early modern England; second, by analysing their dual function as isolation facilities and as spaces for the provision of care and treatment; and third, by understanding the quantity and characteristics of the patients admitted.

The Existence of English Pesthouses

By 1666, pesthouses were a very common part of local authorities' responses to plague outbreaks in England. A survey of all printed primary, and secondary literature reveals 70 settlements had established a pesthouse.[374] On the other hand, it is difficult to find any examples of urban settlements that show no evidence of pesthouse use by the later 17th century. This suggests pesthouses were ubiquitous across English towns. All the major towns – London and Westminster, Norwich, York, and Bristol - had pesthouses. At the time of the last great outbreak of plague in 1665, London and Westminster had a total of five pesthouses across their parishes (see figure 4.1). Likewise, pesthouses had also become commonplace in regional towns. Printed sources are far less common for very small market towns, but where information survives these too were using pesthouses by 1666. Stamford and Grantham – both containing around 250 households in the 17th century – had established pesthouses to respond to plague.[375] Pesthouses could also be found in some villages such as Whickham in

[371] Alfani, G., Bonetti, M. & Fochesato, M. Pandemics and socio-economic status. Evidence from the plague of 1630 in northern Italy. *Popul. Stud*, 1–22 (2023)
[372] Henderson, *Florence under siege*, 227
[373] Jillings, *An Urban History*, 93–4
[374] The establishments in London and Westminster are treated here as two instances.
[375] Rogers, A (ed) The Making of Stamford (Welwyn Garden City, 1965), 60

County Durham where the parish register records all those who died of plague in the pesthouse located on the 'fell.' The final map of figure 4.2 presents all settlements with a known pesthouse by 1666 and it shows they were in use across early modern England.

Figure 4.1. Geographic Dispersion of Pesthouses in London and Westminster

The main wave of establishments came in the second half of 16th century and the first half of the 17th. This systematic survey has found no examples of pesthouse use prior to those found by Slack in the 1530s and so confirms his argument that pesthouse use in England begins in this decade. The second column of table 4.1 records the total number of settlements for which we have the first evidence of pesthouse use in each half century between 1500 and 1700. It reveals rising numbers of establishments in 16th century, followed by a high concentration in the first half of the 17th century with numbers tailing off after 1650. The highest number of new establishments – 34 – were in the first decade of the 17th century. However, interpreting this information is complicated by the problem of source survival. More sources become available over time and therefore more evidence of pesthouse use should also become available.

To address this, it is necessary to find evidence from previous epidemics that shows settlements did not use pesthouses in earlier outbreaks. For instance, we can be confident York used pesthouses for the first time in 1538 because the House Books of the city run continuously back to 1475 and on no previous occasion are pesthouses mentioned, despite at least two earlier outbreaks of plague in 1493 and 1501.[376] Negative evidence of this kind is only available for 11 settlements in the sample, with York the only example before 1550. The data reveals a similar pattern to the broader sample: a slow trickle of new establishments in earlier 16th century, the most activity in the last half of the 16th century, slightly reduced levels in the first half of the 17th century, and no new establishments thereafter. Using this data, the years between 1574 and 1610 stand out as particularly important. Taken together, these two approaches suggest, after a slow start from the 1530s, local authorities began using pesthouses in earnest towards the end of the 16th century, reaching a peak of new establishments in the 25 years either side of 1600. The remaining settlements that had never used pesthouses caught up so that by 1666 they were ubiquitous.

[376] Palliser, D. M. Epidemics in Tudor York. Northern Hist 8, 45–63 (1973), 46-47; Raine, A. ed., York Civic Records. Vol. II 1478-1505, Yorkshire Archaeological Society Record Series, 103 (1941), 103-105; 165-169

Table 4.1. English Settlements First Use of Pesthouse, 1500-1700

Time Period	*First Use by Settlement*	
	All	*Confirmed*
1500-1549	9	1
1550-1599	12	6
1600-1649	34	4
1650-1699	11	0

Note: For four settlements, we do not have a precise date for the establishment of the pesthouse so column 2 sums to 66, not 70.

Figure 4.2. The Geography of Pesthouse Establishment, 50-year periods, 1500-1699

1500-1549

1550-1599

1600-1649

1649-1699

The timing of pesthouse establishments in England is broadly comparable to its nearest neighbours, though it lagged towns further south in Europe by as much as 160 years. One of the earliest pesthouses in Europe was established as a temporary structure on an island controlled by the in the Mediterranean city state of Ragusa in 1377.[377] The process of establishment began in Italian towns in early 15th century in the Venetian Republic and by 1478, 9 of the leading Italian cities had founded 15 plague hospitals.[378] Elsewhere in southern Europe, Madrid established a pesthouse in 1438.[379] In France, 31 towns had established plague isolation facilities by 1536, when England's first evidence for pesthouses emerges.[380] The pattern of establishments within France shows it was the southern towns who pioneered the use of pesthouses.[381] Only in the 1520 and 1530s do northern towns and cities such as Tours, Amiens, and Paris establish pesthouses.[382] In fact, for towns cities across northern Europe, the mid to late 16th century marks the widespread establishment of pesthouses including in Scotland, Germany, Sweden, Finland, and the Low Countries.[383] The establishment of pesthouses in England was therefore comparable with its immediate neighbours.

Within England, pesthouses were established earlier in eastern and south-eastern settlements. Figure 4.2 maps the establishment of pesthouses in each half century between 1500 and 1700. The maps are cumulative, with lighter dots representing earlier establishments. The settlements that established pesthouses early are dispersed widely across the country and vary considerably in size, from the major administrative centre of York (8,000 population) to the minor port town of Liverpool (c.500 population). By the last quarter of the 16th century, pesthouse establishments are more common and a distinctive bias towards establishment in eastern and south-eastern settlements has emerged. All but three – Shrewsbury, Liverpool, and Carlisle - are located on or near the stretch of coastline between Southampton in the south and Berwick in the far north. Furthermore, of the 21 settlements known to have established a pesthouse by 1600, 18 are port towns or connected to the sea via navigable rivers. Whilst the eastern pattern of establishments attenuates by the first half of the 17th century, there is still a marked concentration around waterways with around 70% of settlements being directly connected to the river or coastal trade network by 1650. Thereafter, pesthouses are established even more widely so that by the time plague disappears they can be found in towns all over England.

Once settlements used pesthouses during plague outbreaks, they invariably used them again in the future. Permanent pesthouses existed in several towns and cities in early modern

---

377 Tomić and Blažina, *Expelling the Plague*, 106-107
378 Carmichael, *Plague Legislation*, 520; Crawshaw, *Renaissance Invention*, 162-163
379 Termes, *Madrid Hospitals*, 68
380 Murphy, *Plague Hospitals*, 3-4
381 Murphy, *Plague Hospitals*, 5
382 Murphy, *Plague Hospitals*, 3. I would like to thank Neil for pointing this out to me in a very informative set of comments he provided to an earlier draft of this chapter.
383 Jillings, *An Urban History*, 94; Waldis, *Hospitalisation*, 71–8; Kinzelbach, *Hospitals*, 217–28; Porter, *Cambridge Illustrated History*, 210; Stein, *Negotiating*, 82; Kallioinen, *Plagues and Governments*; Van Andel, *Plague Regulations*, 431.

England. The pesthouse in St Giles, Cripplegate was established in 1594 as a permanent facility and was used in every subsequent London epidemic.[384] The 'Five Chimnies' in Tothill fields, Westminster which was established in 1638 continued to be used until 1666.[385] The Mayor of Southampton endowed the town with 'almshouses' for use 'in tymes of pestilens swettinges or other generall visitacions of god' in 1563-4.[386] In Windsor in 1606 an alderman gifted to the town land on which pesthouses were to be constructed and maintained. The same building continued to be used as a pesthouse until 1666 and probably until a workhouse was built on the site in 1733.[387] The aptly named 'Forlorn Hope Pesthouse' established in Bristol in 1611 would continue to be used until the final outbreak in the town in 1665 and is still visible on James Millerd's map of 1673.[388] The Grantham pesthouse, constructed around 1584, still stands today and continued to serve the town throughout the second pandemic.[389]

Several settlements accumulated pesthouse capacity through time, buying or renting adjacent land and constructing additional rooms. The pesthouse in the Conduit Close in Reading grew into a whole complex of buildings between the 1620s and the 1640s. Likewise, the pesthouse in Bath Lane in Leicester expanded over time.[390] Measuring the expansion of permanent pesthouse structures is complicated by the practice of building additional temporary space during major outbreaks which was deconstructed once the epidemic was over. This happened in the parish of St Martin in the Fields, where to the permanent structure - in use as a pesthouse from 1631 – was added 34 'pesthouse' units in the major outbreak in 1636.[391] These were dismantled again once the epidemic had largely subsided.[392] The same happened at the London pesthouse in St Giles Cripplegate in 1604 when at least one parish, St. Michael's, Cornhill, spent £5 building an additional structure in the grounds of the permanent structure.[393] Nevertheless, there is clear evidence in some cases, like St Margaret's parish, Westminster in 1665 that 'new roomes' were being added to an original structure.[394]

The fabric of permanent structures was also maintained by local authorities in preparation for future outbreaks. For example, there are multiple examples of the vestry of St Giles in the Fields, Westminster, paying carpenters to 'mend' their existing pesthouse in the 1640s.[395]

---

[384] Grell, *Plague in Elizabethan*, 426; 432

[385] 'Pest house' (isolation hospital in times of plague), Tothill Fields, Westminster, London. Lithograph, c. 1840. Wellcome Collection Reference: 25270i. https://wellcomecollection.org/works/e6tnrcnb/items (accessed 30 September 2023)

[386] Wallis-Chapman, A B. (ed). The Black Book of Southampton. Volume 3 (Southampton, 1915), 124-5; https://odiham-society.org/projects/the-pest-house/

[387] Tighe, RR and Davis, JE. (eds) Annals of Windsor. Volume 2 (London, 1858)**,** 52-3

[388] Lattimer, J., The annals of Bristol in the seventeenth century (Bristol, 1900), 40, 333; also see: https://www.bristol.ac.uk/news/2021/september/plague-hospital-bristol.html#:~:text=In%20an%20effort%20to%20prevent,and%20placed%20under%20armed%20guard.

[389] https://www.lincstothepast.com/The-Pest-House-Allotment--with-certain-tenements/776967.record?pt=S

[390] Kelly, W. Visitations of the Plague at Leicester. *T Roy Hist Soc* **6**, 395–447 (1877), 439

[391] Columbus, *To be Had,* 17

[392] Columbus, *To be Had,* 19

[393] Wilson, *Plague in Shakespeare's*, 80

[394] Westminster Archives, 1665-6 Plague Expenditures MF Box E47 967, Item 10

[395] Columbus, *To be Had*, 14

Others like the Hull Corporation upgraded existing facilities outside of epidemic periods by, for instance, improving the availability of fresh water.[396] A particularly stark example of the acknowledged importance of maintaining existing pesthouses can be seen in the remarks of Matthew Day when the pesthouse in Windsor was repaired in 1659: 'We know not,' he wrote, 'how sone it maye pleasse God to send a visitacion.'[397] It turned out to be excellent timing – Windsor was hit 6 years later by the last major outbreak of plague in 1665.[398]

It was common for permanent structures to be leased after epidemics. Even the great pesthouse in St Giles Cripplegate in London was subdivided and let on yearly tenancies by the Keeper of the Pesthouse by 1701.[399] The rental agreements invariably contained provisions included for the use of the pesthouse by the community in future outbreaks. Numerous descriptions of leases survive that contain stipulations requiring tenants to depart at very short notice 'if it shall happen or chance hereafter... the Town and Borough... to be visited with the plague.'[400] Thus, when plague threatened Leicester in the 1620s, the Corporation agreed 'that the pest-houses shalbe cleared of the tenants that be in the houses presently, and they to be repaired and made fit for present use by the chamberlains.'[401] This was an efficient way of managing an asset the demand for which could be infrequent and unpredictable. Outside London, even very large towns might experience outbreaks once in every 10 or 15 years.

Rather than constructing purpose built pesthouses, some authorities drew on their existing property portfolios or borrowed suitable structures from their owners. In some cases, existing

---

[396] 'Hull in the 16th and 17th centuries', in *A History of the County of York East Riding: Volume 1, the City of Kingston Upon Hull*, ed. K J Allison (London, 1969), pp. 90-171. *British History Online* http://www.british-history.ac.uk/vch/yorks/east/vol1/pp90-171 [accessed 20 October 2022]; Columbus, *To be Had*, 10

[397] 'The royal borough of Windsor: The borough', in *A History of the County of Berkshire: Volume 3*, ed. P H Ditchfield and William Page (London, 1923), pp. 56-66. *British History Online* http://www.british-history.ac.uk/vch/berks/vol3/pp56-66 [accessed 18 May 2022].

[398] Ditchfield, *A History of the County of Berkshire: Volume 3*, 56-66

[399] 'Sessions Books: 1701', in *Middlesex County Records. Calendar of Sessions Books 1689-1709*, ed. W J Hardy (London, 1905), pp. 223-235. *British History Online* http://www.british-history.ac.uk/middx-county-records/session-bks-1689-1709/pp223-235 [accessed 11 May 2022].

[400] Guilding, J M. (ed). Reading Records: Diary of the Corporation. Volume III. Charles I (1630-1640) (London, 1896), 467; Stevenson, W H. (ed). The Records of the Borough of Nottingham. Volume IV. 1547-1625 (Nottingham, 1889), 281; Jones, A G E. 1958. The Great Plague in Ipswich 1665-1666. Proceedings of the Suffolk Institute of Archaeology and History. Volume 28, 77-89, 86; Kelly, *Visitations*, 426; 432; Dennett, J. (ed). Beverley Borough Records, 1575-1821. Yorkshire Archaeological Society Record Series. Volume 84 (Wakefield, 1933), 118; Groombridge, M.J. ed., Calendar of Chester city council minutes, 1603-1642, Lancashire and Cheshire Record Society, 106 (1956), 188; Bond, S. ed., The Chamber Order Book of Worcester, 1602-1650, Worcestershire Historical Society New Series, 8 (1974), 292; McConaghey, *Epidemiology*, 1296-7; 'Parishes: Putney', in *A History of the County of Surrey: Volume 4*, ed. H E Malden (London, 1912), pp. 78-83. *British History Online* http://www.british-history.ac.uk/vch/surrey/vol4/pp78-83 [accessed 6 June 2022]; Hardy, *Middlesex County* Records, 223-235; Columbus, *To be Had*, 16; LMA – London Pesthouse Rented in 1598, 1601, and 1602, the latter document provides for reverting the pesthouse to its proper use with 1 month's warning. See: CLA/008/EM/02/01/001/036r/04; CLA/008/EM/02/01/001/037v/05; CLA/008/EM/02/01/001/056r/06; CLA/008/EM/02/01/001/059r/01; Surrey History Centre, Mortlake Vestry Minute Book, 2414/4/2; https://www.lincstothepast.com/The-Pest-House-Allotment--with-certain-tenements/776967.record?pt=S

[401] Kelly, *Visitations*, 432. The same occurred in Cambridge in 1665. See: Williams, S. Plague and Poor Relief in Cambridge, 1665-1666. *Local Popul Stud* 47–55 (2020), 49

hospitals were used to accommodate plague victims for instance St Peter's Hospital, Bury St Edmunds, in 1637 and St Margaret's Hospital, Wooton, in 1638.[402] In other cases they were former religious buildings like the 'Trinities' in Beverley – a Preceptory of the Knights Hospitallers, dissolved in 1540 – and the former domestic buildings of the Franciscan Friary in Worcester which were used in the major outbreak in Worcester in 1630.[403] Occasionally military structures were used like the 'Tower' in Northampton – originally part of the Anglo-Norman defences of the town. Other towns utilised private dwellings or blocks of tenements such as those converted into pesthouses in Soho in 1636.[404] Where occupied, the tenants were recompensed for damage caused to property. In 1654, Captian Thomas Croft was given £3 by the town 'because his house and lands were spoiled by the infected people being put there in the time of God's visitation of the sickness.'[405]

Other local authorities erected temporary structures to deal with a single crisis. In some cases, plague victims and presumably their families were expected to erect their own 'huts' or 'cabins' in open areas, usually outside the affected settlement.[406] More commonly, though, the authorities would organise the construction of 'boarded houses.'[407] Entries in town chamberlain's accounts or order books show they were very often dismantled after the epidemic had ceased.[408] Sometimes the materials were stored for use in future epidemics. This was the case in Reading in 1629 and Oxford in 1647 where 'the boards and timber from the huts [were to be] kept for the use of the City.'[409] The materials might also be sold to recoup some of the losses incurred during the epidemic. After the epidemic in Worcester in 1625, the Corporation ordered 'the bordes of the said houses to bee kept safelie by Mr

---

402 Statham, M. The Book of Bury St Edmunds. (Baron Birch, 1996), 69; 'Gloucester: Hospitals', in *A History of the County of Gloucester: Volume 4, the City of Gloucester*, ed. N M Herbert (London, 1988), pp. 269-275. *British History Online* http://www.british-history.ac.uk/vch/glos/vol4/pp269-275 [accessed 11 May 2022].
403 Cox, J C. (ed). The Records of the Borough of Northampton. Volume II. (London, 1898), 39-40; Dennett, *Beverley Borough Records*, 118; A P Baggs, L M Brown, G C F Forster, I Hall, R E Horrox, G H R Kent and D Neave, 'Sites and Remains of Religious Houses', in *A History of the County of York East Riding: Volume 6, the Borough and Liberties of Beverley*, ed. K J Allison (London, 1989), pp. 180-183. *British History Online* http://www.british-history.ac.uk/vch/yorks/east/vol6/pp180-183 [accessed 18 April 2022]; Hughes, P. 1985. The History of Nos. 7-9 Friar Street otherwise known as The Grey Friars. Unpublished Research Report Conducted for the National Trust. I am grateful to Joe Tierney, Programming & Partnerships Officer at the Greyfriars House and Gardens for supplying me with a copy of this report; also see: Bond, *Chamber Order Book*, 240
404 Merritt, J F. The Social World of Early Modern Westminster (Manchester, 2005), 299-300
405 Power, M. ed., Liverpool Town Books 1649-1671, Lancashire and Cheshire Record Society,136 (1997), 51; other examples: Stevenson, *Nottingham Volume IV*, 311; Cox, *Records Volume II*, 237
406 Power, *Liverpool*, 16
407 Guilding, J M. (ed). Reading Records: Diary of the Corporation. Volume IV. Charles I and Commonwealth (1641-1654) (London, 1896), 201-2; for thatch: Jones, *Great Plague*, 82-3; Cooper, C H. Annals of Cambridge. Volume II (Cambridge, 1843), 321
408 Stevenson, W H. (ed). The Records of the Borough of Nottingham. Volume III. 1485-1547 (Nottingham, 1885), 387; Guilding, *Reading Records Volume IV*, 348; Mostyn, J A. The History and Antiquities of the County of Norfolk. Volume X (Norwich, 1781), 163; A P Baggs, W J Blair, Eleanor Chance, Christina Colvin, Janet Cooper, C J Day, Nesta Selwyn and S C Townley, 'Woodstock: Local government', in *A History of the County of Oxford: Volume 12, Wootton Hundred (South) Including Woodstock*, ed. Alan Crossley and C R Elrington (London, 1990), pp. 372-400. *British History Online* http://www.british-history.ac.uk/vch/oxon/vol12/pp372-400 [accessed 11 May 2022].
409 Guilding, J M. (ed). Reading Records: Diary of the Corporation. Volume II. James I - Charles I (1603-1629) (London, 1895), 469; Hobson, M.G and Salter, H.E. Oxford Council Acts. Volume II. 1626-1665 (Oxford, 1933), 148; Also see: Columbus, *To be Had*, 19

Chamberlaines, to the intent that soe much money may bee raised thereof.'[410] Aside from avoiding the costs of ongoing maintenance, deconstructing pesthouses made sense from a medical perspective. Contemporaries were convinced plague miasma could become attached to the materials used to construct pesthouses. Pulling them down was a perfect opportunity to air them and release the corrupted vapours.

Yet, even when the buildings were deconstructed, their sites were often used repeatedly. Midsummer Green in Cambridge and Portmeade Common in Oxford were used in every outbreak for which there is evidence of a pesthouse. So, too, was Collyhurst Common outside Manchester.[411] Thus, several parcels of land around English settlements came to be known as 'Pest House Field' or 'Pest House Common' in this period.[412] After local authorities had introduced pesthouses as part of their plague responses they continued to use them in future outbreaks, often utilising the same sites and materials, and in a good number of cases the same buildings which they maintained and expanded as needs arose.

The Establishment of English Pesthouses

What explains the frequency and chronology of pesthouse establishments in England? We know local governments funded, constructed, ran, and managed pesthouses because it is in municipal records – order books and financial accounts – that we can see these activities being organised. We also know local authorities were not legally required to establish pesthouses until 1666. National plague regulations from 1578 required local authorities to ensure the infected were isolated in their own homes with sufficient food and fuel to sustain them. Pesthouses became the mandatory isolation space for all infected people in the revised Plague Orders of 1666 which were published by the Privy Council under the 'King's special Command.' They ordered 'That each City and Town forthwith provide some convenient place remote from the same, where a pest-house, huts, or sheds may be erected, to be in readiness in case any Infection should breakout.' Moreover, 'if any house be Infected, the sick person or persons be forthwith removed to the said pest-house… for the preservation of the rest of the family.' Pesthouses were thus substituted for household quarantine as the centre piece of national plague regulations in 1666. Yet, as we have seen, the most intense wave of pesthouse establishments anticipated this shift in policy by around 60 years. If local authorities were not influenced by official regulations, what did influence their decision making?

Paul Slack argues pesthouses were established by local authorities in response to informal central government pressure.[413] The best supporting evidence for this comes from London

---

[410] Bond, *Chamber Order Book*, 201

[411] France, R. S. 1938. A History of Plague in Lancashire. *Transactions of the Historic Society of Lancashire and Cheshire* 90, 79; 156

[412] Edward Walford, 'Golden Street and neighbourhood', in *Old and New London: Volume 4* (London, 1878), pp. 235-246. *British History Online* http://www.british-history.ac.uk/old-new-london/vol4/pp235-246 [accessed 11 May 2022]; also see the map of pesthouse location in Stepney.

[413] Slack, *Impact*, 203-4

where on several occasions the Privy Council directly pressured the Mayor and Aldermen of the city to establish pesthouses. On the first occasion, during the 1583 epidemic, the Privy Council commanded the Corporation to enforce household quarantine regulations but relayed 'Her Majesty's surprise that no house or hospital had been built without the City, in some remote place, to which the infected people might be removed.'[414] The Corporation responded by identifying suitable land for the establishment of a pesthouse in St Giles Cripplegate but the building was not constructed until 1594.[415] In the epidemic of 1625, the Privy Council urged the Corporation to ensure the infected were being removed to this now recently extended facility.[416] Early in the epidemic of 1630, the Privy Council was again pressing the Mayor and Aldermen to make full use of their pesthouse as a 'better and more effectual course' than household quarantine and sent further instructions for erecting a new facility modelled on the great pesthouse of Paris.[417] On this occasion, instructions for establishing pesthouses were also sent to the Justices of the Peace in Westminster, Middlesex, and Surrey.[418] The Council went further in the case of Greenwich - where the King was to be in residence - by identifying a suitable 'new tenement on Black Heath' and writing to the owner requisitioning it for use as a pesthouse.[419]

Yet, there is little evidence the central government encouraged the establishment of pesthouses outside of London and its immediate neighbours. In 1630, when the Privy Council was coordinating the establishment of pesthouses around London, it was only requiring the traditional Plague Orders – which favoured household quarantine - to be published 'throughout the Countyes of England.'[420] Slack finds evidence for central influence over the establishment of pesthouses outside London in the correlation between the geography of early establishments and centres of royal power with Shrewsbury, York, Windsor, and Berwick all establishing facilities between 1537 and 1545.[421] But if royal councillors were pressuring these settlements to establish pesthouses, then it is necessary to explain, firstly, why the Privy Council does not apply the same pressure to London for another 40 years and, secondly, why far less strategically important settlements such as Liverpool, Nottingham, Durham, and Newcastle all establish pesthouses in the 1530s and 1540s as well.[422] A full survey of the geography of establishments reveals no sign politically powerful, militarily strategic, or even just more populous settlements were precocious in establishing pesthouses in early modern England. The evidence therefore suggests town governments were generally acting independently of direct central influence.

---

[414] Overall, W H and Overall, H C. Analytical Index to the Series of Records Known as the Remembrancia 1579–1664. Volume 1 (London, 1878), 497
[415] Wilson, *Plague in Shakespeare's*, 77
[416] Overall, W H and Overall, H C. Analytical Index to the Series of Records Known as the Remembrancia 1579–1664. Volume 4 (London, 1878), 57; Wilson, *Plague in Shakespeare's*, 77-8
[417] Acts of the Privy Council of England Volume 45, 1629-1630. Originally published by Her Majesty's Stationery Office, London, 1960, 313
[418] *Acts of the Privy Council Volume 45*, 312; 314-5
[419] *Acts of the Privy Council Volume 45*, 356
[420] *Acts of the Privy Council Volume 45*, 310
[421] Slack, *Impact*, 203
[422] Slack, *Impact*, 204

All this begs the question: what did inspire town governments? Why did so many choose to establish pesthouses when they did – in the 25 years either side of 1600? No conclusive answer can be provided but I have identified four factors that must collectively have influenced them considerably. First, it is important to emphasise the continuities in the policy of pesthouse isolation and medieval public health measures, particularly lazar houses (for the accommodation of lepers). Lazar houses were a common feature of towns in medieval England. At least 300 were founded in extra mural locations between 1100 and 1300.[423] Whilst Lepers were not excluded in the same way as plague victims – lepers being permitted to enter towns and beg for alms during the day – the concept of removing the sick to special extra mural facilities was far from alien to early modern magistrates. Thus, when Thomas More describes his ideal city in *Utopia (1516)* he gives 'every town four hospitals, that are built without their walls, and are so large that they may pass for little towns; by this means, if they had ever such a number of sick persons, they could lodge them conveniently, and at such a distance that such of them as are sick of infectious diseases may be kept so far from the rest that there can be no danger of contagion.' Though he is not explicit, it seems likely More was thinking of isolating victims during epidemics, including epidemics of plague.

In some cases, the old Lazar houses were actually used later to isolate plague victims, as they were in Italian towns.[424] St Peter's Hospital in Bury St Edmunds which already before the dissolution admitted patients infected with 'any contagious disorder' was, by the late 16th century, used as an isolation facility for those infected with plague.[425] Despite the almost total disappearance of leprosy by the 16th century, the 'Lazar Houses' of Great Yarmouth continued to operate under the leadership of a custodian appointed by the corporation and are known to have been used as a plague pesthouse in 1637.[426] Further possible connections between medieval hospitals and later pesthouses can be seen in London, Leicester, and Gloucester.[427] Yet in most cases it is possible to interpret the use of former hospitals as an expedient rather than part of a direct continuation of medieval isolation practices. Former hospitals were often conveniently placed, suitably sized buildings available for use by local authorities during a crisis.[428]

The growth of plague literature and its wider dissemination with the expansion of printing constitutes a second factor pushing local governments towards the establishment of pesthouses. The first example of printed plague literature dates to 1486 – a decade after Caxton's first pressing of a book in English. By 1604, at least 153 plague tracts had been

---

[423] Rawcliffe, *Urban Bodies*, 318
[424] Crawshaw, *Renaissance Invention*, 165-6; Risse, *Mending*, 202
[425] 'Hospitals: St Peter, Bury St Edmunds', in *A History of the County of Suffolk: Volume 2*, ed. William Page (London, 1975), pp. 134-135. *British History Online* http://www.british-history.ac.uk/vch/suff/vol2/pp134-135 [accessed 16 June 2022]; Statham, *Book of Bury*, 69
[426] Manship, H. The History of Great Yarmouth. Volume 1 (Great Yarmouth and London, 1854), 433 – 4
[427] London – the Bridewell hospital apparently accepted plague cases in 1603. From Creighton, *History*, 488; Leicester – in 1611, the authorities in Leicester paid to prepare the 'old hospital' in the 'Newarke' for use as an isolation facility. Kelly, *Visitations*, 426-7; Gloucester – in 1638 there as a pest house at St. Margaret's Hospital, Wotton. Herbert, *History of the County of Gloucester: Volume* 4, 269-275
[428] Stevens-Crawshaw reached the same conclusion in the cases of Ragusa, Venice, and Milan. See: Crawshaw, *Renaissance Invention*, 165-166

published. Whilst many were religious, two dealt specifically with the public health responsibilities of 'wise magistrates.' First was John Stockwood's '*OF The duetie of a faithfull and Wise Magistrate, in preseruing and deliuering of the common wealth from infection' (1584).*[429] This was followed in 1603 by Thomas Lodge's *A Treatise of the Plague.*[430] Both were dedicated to the Mayor and Aldermen of the City of London and both agreed pesthouses were 'most necessary in great Citties,' dedicating chapters to describing their proper design and function. Two further texts - published in 1603 and 1636 - suggested pesthouses were a 'right honorable and christian prouision' though they did not explicitly recommend their establishment. It is impossible to assess the extent to which these medical tracts affected popular opinion about the importance of pesthouses. However, that the playwright, Thomas Nashe, was already in 1592 lamenting the lack of a pesthouse in London hints at wider public awareness.

Nashe's comments also reveal an appreciation that pesthouse provision – as we have seen – was expanding across Europe. 'In other lands,' he wrote, 'they have hospitals, whither their infected are transported, presently after they are stricken… We have no provision but mixing handover head, the sick with the whole.'[431] In fact, both Stockwood and Lodge were also implicitly promoting continental plague responses. Both texts were translations of European originals from Germany and France, respectively. The Privy Council may also have been thinking of European comparisons when they rebuked the Mayor and aldermen of London for their lack of pesthouse provision in 1583. They pointed out, 'other cities of less antiquity, fame, wealth, and reputation had provided themselves with such places.'[432] Many magistrates in other English towns and cities must also have been aware of the increasing use of pesthouses on the Continent. If they did not encounter printed descriptions, they may have been inspired by the many medical practitioners who received training in the great centres of European learning in France and Italy. Two quintessential examples of such men are Cesare Adelmare and Sir Theodore de Mayerne. Both were royal physicians, Adelmare to Elizabeth I and de Mayerne to Charles I, and both recommended the use of pesthouses over household quarantine with reference to continental models.[433]

Medical texts and practitioners aside, some local magistrates probably witnessed first-hand the use of pesthouses in north-western European trading cities in the Low Countries and Germany.[434] This may explain why it was eastern settlements closely connected with navigable rivers and ports that first established pesthouses in England. The eastern ports like Yarmouth, Lynn, and Boston were closely integrated into trading networks of north-western Europe. The establishment of pesthouses in any of these trading towns must have quickly come to the attention of influential traders in England. Of course, as we saw in chapter 2, the

[429] von Ewich, *Duetie of a Faithfull*
[430] Lodge, T. A Treatise of the Plague: containing the nature, signes, and accidents of the same.... (London, 1603) https://wellcomecollection.org/works/yndphx4x (accessed 30 September 2023)
[431] Nashe, T. A Latter-Day Appeal from Christs Tears over Jerusalem in Henry Craik, ed. English Prose. Volume 1. Fourteenth to Sixteenth Century. (London, 1916)
[432] Overall and Overall, *Remembrancia Volume 1*, 497
[433] Quoted from Henderson, *Florence Under Siege*, 183 – original in National Archives; Slack, *Impact*, 218
[434] Van Andel, *Plague Regulations*, 431; Risse, *Mending*, 203-205

close trading connections of eastern ports with the continent also made them particularly susceptible to the plague itself. Familiarity with epidemics may therefore also have influenced magistrates in these areas to establish pesthouses. That said, vulnerability to epidemics cannot explain the timing of establishments in the years around 1600 given that the epidemiological pattern had existed at least since the early 16th century and almost certainly during previous centuries as well. That the establishment of pesthouses in England coincides with patterns in north-western Europe suggests new ideas about how to respond to plague began travelling through the networks the disease itself had long exploited.

After the 1530s and 1540s, English magistrates did not need to look beyond the channel to find examples of pesthouse provision as they could begin to find examples in other English towns as well. A third factor influencing the establishment of pesthouses in English towns is inter-town competition. By the 16th century, urban magistrates had a keen sense of civic pride and public health provision and long been associated with a well-functioning, properly governed community.[435] The emergence of pesthouses, particularly in larger communities and above all in London in 1592 must have persuaded magistrates to adopt similar policies when they experienced an outbreak of plague. The flush of establishments during the very widespread epidemic beginning in 1603 probably reflects the desire of local authorities to emulate London, York, or Bristol during one of their own, less common brushes with the plague. The quasi-random pattern of incidence probably helps to explain the similarly complex pattern of pesthouse establishments.

However, the emergence of a national quarantine policy between 1578 - 1604 is a fourth and highly significant factor that cannot be ignored when attempting to explain pesthouse establishment in England. Somewhat paradoxically, it is precisely the period when the policy of household quarantine was first adopted as part of the 1578 Plague Orders and subsequent parliamentary legislation in 1604, that we find the highest concentration of pesthouse establishments. Seven of the eleven establishments for which evidence of no previous pesthouse use survives occurred between 1578 and 1611. Furthermore, it is the urban epidemics with the best evidence of household quarantine enforcement – such as Reading and St Martin in the Fields in the 1630s – that we also find the best evidence for the rigorous use of pesthouses. This suggests local authorities did not conceive of pesthouses simply as alternatives to household quarantine. Instead, household quarantine legislation appears to have incentivised the establishment of pesthouses as a complementary feature of local government plague responses. As I argue in subsequent sections, this is likely because pesthouses acted as providers of care in instances where the care responsibilities placed on fellow householders by the policy of household quarantine could not be fulfilled either because no other householders existed, or they were themselves incapacitated due to the epidemic.

[435] Rawcliffe, *Urban Bodies*, 59

The Purpose of English Pesthouses

Now we have considered when, where, and why pesthouses emerged we can turn to the question of how they were used. Contemporary tracts argued pesthouses should be used both for isolating the sick and for caring for them whilst they were ill. They also stressed the link between pesthouse location, design, and construction and the quality of isolation and care functions. To prevent further infections, pesthouses were to be located away from areas of settlement and busy thoroughfares, ideally downwind so miasma would not be blown towards the susceptible population.[436] At the same time, the authorities were to design pesthouses that minimised the accumulation of miasma because 'beeing receyued in that impure ayre, layde vppon foule and stincking beddes, [the sick] shall seeme to bee choaked, and to dye violently.'[437] Thus, pesthouses should be built in exposed locations, facing north-east so 'the heate of the midday warme it not too much, and that in summer it may haue competent fresh ayre' from northerly winds (supposedly the driest).[438] Accompanying the pesthouse should be gardens containing herbs, flowers, and fruit trees, a fresh spring and a river to carry away waste.[439] Suitable building materials would also minimise the accumulation of miasma. Wood and stone were to be preferred over clay or straw because 'infection hang more longer in them.'[440] Finally, the staff at pesthouses should include not just general overseers for the sick but trained professionals – physicians, surgeons, apothecaries, and ministers - capable of dealing with both spiritual and medical remedies.[441] The ideal pesthouse was therefore one that served both as a repository for the infected and as a facility for their care and treatment.

The actual characteristics of English pesthouses reflect the desire to use them as isolation facilities. They were invariably built outside population centres, sometimes in empty spaces around city walls but often in far more distant locations.[442] This is displayed in James Millerd's 1673 map of Bristol which depicts the pesthouse in the top right-hand corner as an

[436] von Ewich, *Duetie of a Faithfull*, 61; 66-7; Lodge, *Treatise*, chapter 9
[437] von Ewich, *Duetie of a Faithfull*, 62
[438] Lodge, *Treatise*, chapter 9; von Ewich, *Duetie of a Faithfull*, 63
[439] von Ewich, *Duetie of a Faithfull*, 62
[440] von Ewich, *Duetie of a Faithfull*, 61
[441] A Treatise of the Plague, chapter 9
[442] Hughes, T. The Plague in Carlisle 1597/98. Transactions of the Cumberland and Westmorland Antiquarian and Archaeological Society (1971) Series: 2, Volume 71, p.52; Wrightson, *Ralph Tailor's*, 51; Raine, A. ed., York Civic Records. Vol. V, 1548-58, Yorkshire Archaeological Society Record Series, 110 (1946), 30; Stevenson, *Nottingham Volume IV*, 300; Power, *Liverpool*, 16; Merritt, *Social World*, 299-300; Mostyn, *History and Antiquities Volume X*, 163; National Archives, 2414/9/314-323; Parish register of Whickham St Mary, County Durham contains several burials from 1610 which have the phrase 'died on the Fell of the plague' beside them; Hughes, *Plague in Carlisle*, 52; https://www.klmagazine.co.uk/articles/plague; 'Calne: Local government', in *A History of the County of Wiltshire: Volume 17, Calne*, ed. D A Crowley (London, 2002), pp. 94-100. *British History Online* http://www.british-history.ac.uk/vch/wilts/vol17/pp94-100 [accessed 6 June 2022]; Cooper, *Annals Volume II*, 523; Cooper, C H. Annals of Cambridge. Volume III (Cambridge, 1845), 227-8, 415; 'Salisbury: St Martin's parish', in *A History of the County of Wiltshire: Volume 6*, ed. Elizabeth Crittall (London, 1962), pp. 79-81. *British History Online* http://www.british-history.ac.uk/vch/wilts/vol6/pp79-81 [accessed 27 June 2022]; Herbert, *History of the County of Gloucester: Volume 4*, 269-275; Kelly, *Visitations*, 426; Hobson and Salter, *Oxford Council Volume II*, 101; Griffin, N. 1967. Epidemics in Loughborough, 1539-1640. Transactions of the Leicestershire Archaeological and Historical Society. Volume 43, 30

isolated building far from the centre of the city and, in fact, understates the distance of the building so that it could be included (see figure 4.3).[443] In some cases, the site's isolation was further emphasised by the building of banks or ditches around the pesthouse or the utilisation of a site already possessing these characteristics.[444] In 1574, the Cambridge authorities spent £14 18s 4d enclosing the land around the pesthouse with ditches. At a time when unskilled labourers were paid around 7 d per day, this represents a sizable investment.[445]

As well as their distant locations, the importance of ensuring the sick remained in the pesthouse is suggested by some surviving payments for improving doors and purchasing padlocks to secure them. It is also perhaps important that the authorities regularly employed men as 'warders,' 'watchmen,' or door keepers – sometimes several of them – who were stationed at pesthouses.[446] In St Martin in the Fields, several of these doorkeepers had entered the pesthouse as plague victims. One, Thomas Thorne, spent 4 weeks in the pesthouse as a patient and then a further 7 weeks as doorkeeper.[447] There was clearly a strong desire to ensure those brought to the pesthouse could not leave until they were deemed to have recovered and were no longer contagious.

Though, if there is much to suggest isolation was a key function of English pesthouses, there is also plenty of evidence for the provision of care and treatment. Whilst the choice of locations was not determined by wind-exposure but by local conditions, there are regularities in the building materials used when pesthouses were constructed afresh. These structures – called 'cabins', 'shedds', 'huts', 'lodges', or 'boarded houses' were invariably timber framed with stone bases and either timber or brick walls. Surviving examples conform to the dimensions – rectangular, with high ceilings - suggested by contemporary authors. [448] The Reading Corporation specified in their orders for the construction of pesthouses that they should be 'of 26 foote in length and 14 or 15 foote in breadth.'[449] When authorities used existing buildings, they tended to use large, stone structures like towers or old monastic buildings. [450] There are even three instances, Leicester in 1624, Windsor in 1665, and Soho in

---

443 https://www.bristol.ac.uk/news/2021/september/plague-hospital-

444 Cooper, *Annals Volume II*, 321; Woods, A. The History and Antiquities of Oxford. Volume II. (ed) John Gutch (Oxford, 1786), 356; Dennett, *Beverley Borough Records*, 139; Baggs et al, *A History of the County of York East Riding: Volume 6*, 180-183

445 Cooper, *Annals Volume II*, 321

446 Payments to watchmen can be found in: Wiltshire and Swindon archives (Chippenham), G23/1/112 and Westminster Archives, SMF 1636, F4514

447 Westminster Archives, SMF 1636, F4514

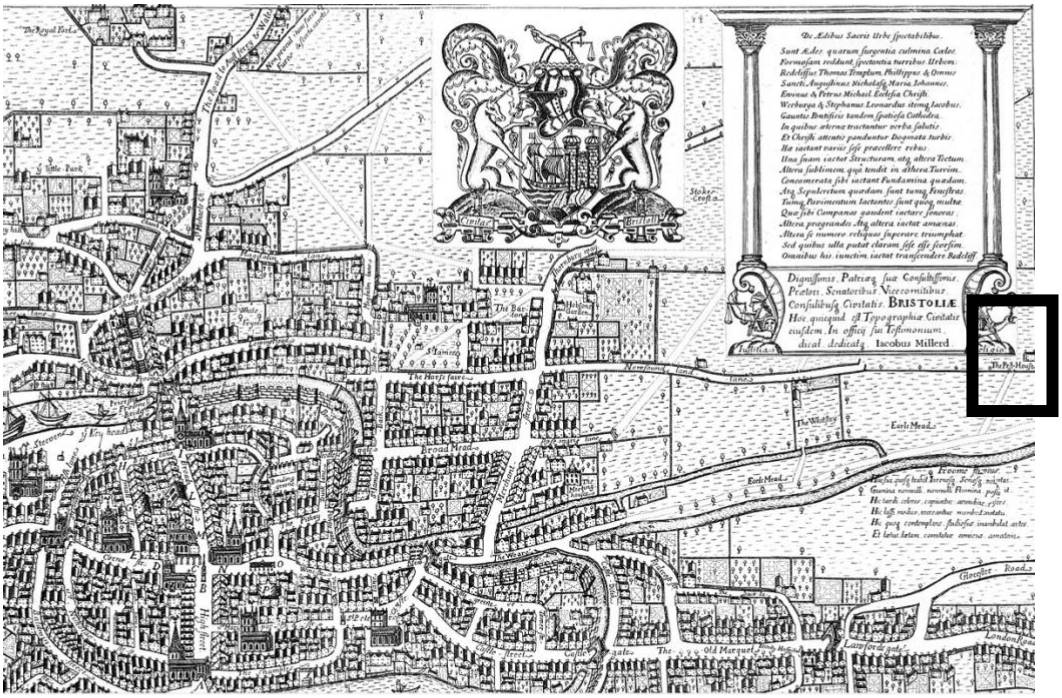
448 https://historicengland.org.uk/listing/the-list/list-entry/1084875?section=official-list-entry; https://historicengland.org.uk/listing/the-list/list-entry/1099203?section=official-list-entry; https://historicengland.org.uk/listing/the-list/list-entry/1029803?section=official-list-entry; https://historicengland.org.uk/listing/the-list/list-entry/1043209?section=official-list-entry; https://historicengland.org.uk/listing/the-list/list-entry/1257052?section=official-list-entry; https://historicengland.org.uk/listing/the-list/list-entry/1462454?section=official-list-entry ; Guilding, *Reading Records Volume IV*, 204

449 Guilding, *Reading Records Volume IV*, 204

450 Bond, *Chamber Order Book*, 240; 292; Cox, *Records Volume II*, 239-40; Simpson, J. 1880. Stamford: The plagues of 1605 and 1625. *Notes Queries* s6-II, 524; Hughes, *Plague in Carlisle*, 59

1665, where we have evidence for the existence of gardens for the sick to enjoy.[451] Moreover, it is clear local authorities were keen to ensure sufficient supplies of fresh water. In Hull, water supply to the pesthouse was upgraded in 1638 to improve cleanliness and in London in 1636, 336 yards of new lead pipe was laid to provide water to the pesthouse in Old Street.[452]

Figure 4.3. Excerpt of James Millerd's 1673 Map of Bristol with Pesthouse (RHS)



Note: Alex Beard and Evan Jones were the first scholars to notice the inclusion of the pesthouse in Millerd's map. See: https://www.bristol.ac.uk/news/2021/september/plague-hospital-bristol.html

The payments to staff employed at pesthouses further confirm they functioned as providers of care as well as ensuring isolation of patients. Nurses were more commonly employed than watchmen. A single large facility like the one in the 'Conduit Close' in Reading could employ 5 or more nurses at once. Even in the relatively small settlement of Carlisle, one nurse and 4 assistants were employed in 1597. When Elizabeth Fletcher, 'a stranger' was found in the parish of St Margret, Westminster, in 1665, the parish paid two men to carry her to the pesthouse and employed 'a nurce to attend her' while she was there. On a separate occasion the parish gave £4 for 'A Poor Person sent by Justice Godfrey to ye Pesthouse at Westm[inster] for her Maintenence 7 weeks for a nurce warder bedd & bedding.' People with enough wealth had to pay for their own 'surgery, women keepers, and other extraordinary charges' in London in 1603 and likewise in Newcastle in 1636.[453] That they decided to do so suggests they valued the care provided.

451 Rutland and Leicestershire Archives, BR/III/2/79, ff.22; Walford, *Old and New Volume 4*, 235-246; Tighe and Davis, *Annals of Windsor*, 316-7
452 Allison, *History of the County of York East Riding: Volume 1*, 90-171; Columbus, *To be Had*, 10
453 Wilson, *Plague in Shakespeare's*, 181-2; Wrightson, *Ralph Tailor's*, 103

Though the presence of nurses in pesthouses is widely attested to, it is often very difficult to tell what functions they performed. The names of nurses recorded in account and minute books makes one thing clear enough, though: nurses were in variably women. The Oxford Corporation were merely expressing the accepted gender distinctions for plague -related occupations when they ordered a taxation to pay for 'watchmen, women to attend the sick, [and] men to bury the dead.'[454] Perhaps unsurprisingly, given the danger inherent in the role, most plague nurses were also poor, likely having taken up the position after their regular work was disrupted by the epidemic.[455] Plague nurses were also often survivors of the disease.[456] In 1636, Margaret Lowe was first a patient and then a nurse at the St Martin in the Fields pesthouse.[457] As far as we can tell, these women were responsible for all aspects of domestic life within the pesthouse, just as they were when attending plague victims in their own homes. We know the main responsibilities of domestic plague nurses in London and Cheshire were food preparation, laundry, and cleaning.[458]

The few available sources confirm these as typical roles in the pesthouse as well. In Reading in 1637 the pesthouse was run by a 'woman keeper and Merifield's wench' who, when the epidemic was over were released form their duties, 'she havinge done her best endevour to ayre and clense all the beddes and beddinge and other thinges in both the houses.'[459] One pesthouse building containing 10 people in Newcastle 1636 was staffed by publicly funded 'watchmen' and 'cleansers' as well as privately funded 'keepers.'[460] The designation of 'cleanser' also suggests similar responsibilities to the plague nurses in Cheshire and Reading. Yet it is highly likely pesthouse nurses served also a more important if less easily defined role in providing comfort and reassurance to often desperately ill people. In Westminster in 1665 the recognition of this role is implied by the description of nurses' function simply as 'watching.'[461]

As well as nurses, pesthouses regularly employed physicians and surgeons to attend the sick.[462] There are numerous examples of all medical practitioners being rewarded handsomely at the end of an epidemic.[463] A surgeon called Thomas Smith was paid £30 per annum for attending the sick at the City of London pesthouse in 1625.[464] Apothecaries too were sometimes employed and were paid for the provision of 'Physick Druggs' to the patients.[465] In contrast to Stockwood's description of 'howe indiscretlye they whiche are

---

[454] Salter, H.E. Oxford Council Acts. Volume I. 1583-1626 (Oxford, 1928), 331
[455] Thorpe, *At the mercy*, 37-39
[456] Thorpe, *At the mercy*, 37-39
[457] Westminster Archives, SMF 1636, F4514
[458] Pelling, M. *The Common Lot: Sickness, Medical Occupations and the Urban Poor in Early Modern England*. (New York, 1998), 197; Thorpe, *At the mercy*, 38-39
[459] Guilding, *Reading Records Volume III*, 384
[460] Wrightson, *Ralph Tailor's*, 51
[461] Westminster Archives, 1665-6 Plague Expenditures MF Box E47 967, Item 10
[462] Crowley, *History of the County of Wiltshire Volume 17*, 94-100; Bell, *The Great Plague*, 88-89; Cooper, *Annals Volume III*, 227-8; Grell, *Plague in Elizabethan*, 432
[463] Columbus, *To be Had*, 10-11
[464] Wilson, *Plague in Shakespeare's*, 83
[465] Columbus, *To be Had*, 9; Westminster Archives, 1665-6 Plague Expenditures MF Box E47 967, Item 10. The practice is confirmed in: von Ewich, *Duetie of a Faithfull*, 62; Wilson, *Plague in Shakespeare's*, 168; 181

sicke in these houses, are oftentimes prouided for of meate and drinke, and other necessaryes' the accounts of the pesthouse at Ipswich in 1665 show the patients received a rich and varied supply of food and drank ale brewed onsite.[466] The London authorities drew up a list of differentiated charges for patients for 'watching and attendance' 'phisick and surgerie', 'fyer in winter', and 'shrowde[s] ffor burial.'[467] English pesthouses were not simply for the incarceration of the sick, they were providers of institutionalised care.

The Patients in English Pesthouses

But to whom did they provide this care? To judge by the quantities expended on their construction, English pesthouses could also be substantial structures capable of accommodating many patients at once. In 1642-3, the parish of St Margret in Westminster expended c.£257 for a new complex of pesthouses, replacing the existing 'shedds.'[468] Twenty-three years later, they extended the facility, spending c.£90 on '10 new roomes at the Pesthouse' and an additional 'shedd.'[469] Whilst the total investment in the pesthouse is equivalent to only 3.5 weeks of all non-pesthouse expenditures at the height of the 1665 epidemic, this was still enough to employ 19 building craftsmen for a year. Running the pesthouse was also adding an extra £5 (c.5% of the total) to total weekly plague expenditures at the height of the 1665 epidemic. We know this facility was a sizable structure because two later prints have survived which show it had five chimneys along its length and enough height for a second floor (see figure 4.4).

---

466 Jones, *Great Plague*, 83
467 Wilson, *Plague in Shakespeare's*, 182-3
468 Westminster Archives, 1642-3 Churchwardens Accounts MF Box 965 E24
469 Westminster Archives, 1665-6 Plague Expenditures MF Box E47 967, Item 10

Figure 4.4. The Pesthouses in Tothill Fields, St Margaret Westminster[470]

The London pesthouse in the parish of St Giles Cripplegate had 42 hearths in 1665 and must therefore have been able to accommodate many times more patients than any other known pesthouse in the country.[471] Even if there were four hearths per chimney, this building would still be twice as big as the pesthouse in Westminster. When it was first designed in 1594, the city estimated the construction and maintenance of this pesthouse would cost £6,000.[472] The building work seems to have proceeded in stages with additions and repairs in 1597 and potentially extensive additional building work at some point between 1603 and 1615 when the pesthouse was described as a building tending 'to publique use and ornament.'[473] At least one more, smaller, and almost unknown, facility existed in London in 1665. It was managed by the Governors of the Incorporation of the Poor of Middlesex (within the bills) and cost £50 to construct. The physician responsible for the sick there claimed he treated 80 people, though many more had been 'swept away before I assumed the charge'[474]

470 'Pest house' (isolation hospital in times of plague), Tothill Fields, Westminster, London. Lithograph, c. 1840. Wellcome Collection Reference: 25270i. https://wellcomecollection.org/works/e6tnrcnb/items (accessed 30 September 2023)

471 'Hearth Tax: City of London 1666, St Giles (without) Cripplegate , Old Street South', in *London Hearth Tax: City of London and Middlesex, 1666* (2011), *British History Online* http://www.british-history.ac.uk/london-hearth-tax/london-mddx/1666/st-giles-cripplegate-old-street-south [accessed 30 September 2023]; Columbus, *To be Had*, 10

472 Wilson, *Plague in Shakespeare's*, 77-8

473 Wilson, *Plague in Shakespeare's*, 77-8

474 Maynwaringe, E. 'Nova medendi ratio: a short and easie method of curing. Exemplified by a ternary of radical medicines…' (London, 1666). https://wellcomecollection.org/works/uq2txn3z (accessed 30 September 2023); Barry, J. The 'Compleat Physician' and Experimentation in Medicines: Everard Maynwaring (c.1629–1713) and the Restoration Debate on Medical Practice in London. *Med Hist* 62, 155–176 (2018).

The records of pesthouse construction in Reading reveal a similar scale of investment. In 1639 the corporation spent £190 on '8 pest-houses with bricke and brick chimneys.'[475] By 1646, they were extending the facility, spending £45 on 'one house conteyninge two duellinges, with a brick chimney' and an additional £5 for the labour necessary to construct a 'boarded house, to be of 26 foote in length and 14 or 15 foote in breadth, with a double brick chimney in it and a peticion for 2 severall roomes.' [476] The records also suggest additional buildings had been constructed in 1646 and during an earlier epidemic in 1625 but do not reveal their cost.[477] By 1640, to this already substantial complex was added a 'little watche-house for the shelter of the watche-men and wardens of the visited people.'[478] Numerous other examples reveal considerable investments by municipal authorities, though it is often difficult to distinguish between the complete costs of constructing an entire pesthouse facility and the ad hoc costs of maintaining and extending existing sites.[479] This ad hoc extension during epidemics also further complicates the process of assessing the capacity of these institutions.

Despite these large investments, the burial data suggests pesthouses were not used to isolate the entire susceptible population as they were in several Italian towns. The ratio of burials occurring at the pesthouse to burials occurring in the rest of the settlement reflects the degree to which the infected were removed to isolation facilities. Slack argues in England it was usual for less than 10% of burials during an epidemic to occur at pesthouses, though in some exceptional cases the proportion could reach 25%.[480] In contrast, Henderson collects data for a series of Italian outbreaks – where the authorities attempted to isolate all the infected - which show the proportion of burials at the pesthouse reaching two-thirds.[481] In table 4.2, I reproduce Henderson's findings with two additional estimates for Carmagnola and Bologna along with all available English data (bold). Slack's original claims were based on the example of Norwich in 1665-6 (9%) and Worcester in 1637 (25%). This table adds a further 10 English outbreaks for which some information on burials occurring at the pesthouse survive. Whilst the English average is nearly three times Slack's estimate, the comparison confirms the generally lower proportion of burials occurring at English pesthouses compared with those in Italy. The average is 26% of burials in English towns and 41% in Italian towns. This suggests a minority of the infected every passed through English pesthouses during

[475] Guilding, *Reading Records Volume III*, 448
[476] The records contain two very similar entries a few days apart. Both describe very similar buildings, one cost £5 but the builder was allowed to keep the materials afterwards, the other cost £45 and there was no mention of the materials suggesting the corporation would keep them. See: Guilding, *Reading Records Volume IV*, 203-4
[477] 'as the houses formerly there built by him were' See: Guilding, *Reading Records Volume IV*, 203-4; Guilding, *Reading Records Volume II*, 244
[478] Guilding, *Reading Records Volume III*, 516
[479] Tighe and Davis, *Annals of Windsor*, 52-3; Kelly, *Visitations*, 439; Eleanor Chance, Christina Colvin, Janet Cooper, C J Day, T G Hassall, Mary Jessup and Nesta Selwyn, 'Early Modern Oxford', in *A History of the County of Oxford: Volume 4, the City of Oxford*, ed. Alan Crossley and C R Elrington (London, 1979), pp. 74-180. *British History Online* http://www.british-history.ac.uk/vch/oxon/vol4/pp74-180 [accessed 4 April 2022]
[480] Slack, *Impact*, 277
[481] Henderson, *Florence under siege*, 130

epidemics and points towards their less central position in English systems of plague response.

There are only a few instances where we know English authorities tried to make pesthouse isolation the default form of quarantine like Italian towns. This was the stated intention of a Cambridge magistrate in 1665, though perhaps as the scale of the outbreak became clear, he softened this policy, allowing those who could support themselves to quarantine at home.[482] There are a few examples of comprehensive pesthouse isolation, but these also tend to come from the start of outbreaks such as when the authorities in Dartmouth in 1627 very quickly removed the first 15 affected households to the pesthouse to try and avert a major epidemic.[483] The few authorities that attempted this did so when the number of cases was low. The long tail of very low English burial ratios seems to reflect what most authorities must have known: that pesthouses are too small to be used like those in Italy. That they still went to considerable lengths to prepare them for epidemics, suggests they were nonetheless valued as part of a broader public health response.

Still, if provision was limited, it may not have been as limited as the burial ratio comparisons suggest. Most of the English data is extracted from lists indicating the number of people who were buried at the pesthouse. This contrasts with the Italian data which often comes from estimates of mortality within the pesthouse. If some of those who died at English pesthouses were buried elsewhere, the burial ratios would underestimate the proportion of the infected population who were sent there. Some pesthouses were associated with mass burial pits like 'St Peter's Pit' next to the old St Peter's Hospital in Bury St Edmunds which was used as a pesthouse in 1637.[484] These special burial grounds were clearly used for some of those dying in the pesthouse. However, we know this was not always the case. When John Laverrock died in a Newcastle pesthouse in 1636 his body was wrapped in linen, placed in a coffin, and carried back to his parish church for his funeral.[485] Pesthouse burials are also identified in some of the rare instances where parish clerks provide additional information beside the names of burials in their registers, for instance in Stamford in 1603 and St Sidwell's parish in Exeter in 1625-6.[486] As Wrightson argues 'it would be mistaken to assume that the plague wholly deprived its victims of a "solemn funeral" or "Honourable burial."[487] Many of these honourable burials must have taken place at the parish church, not the pesthouse. Pesthouse burials would therefore under report pesthouse deaths.

Close comparison of the burial totals and pesthouse expenditures for Colchester in 1665 cast further doubt on burial lists as a reliable indicator of pesthouse capacity. Twenty-three deaths are recorded in the 'pesthouse' row of the contemporary burial totals.[488] Yet, we know there

---

[482] Williams, *Plague and Poor Relief*, 52-54
[483] J. Bruce (ed.), Calendar of State Papers Domestic, 1627–28 (London, 1858), 254–70; The same appears to have happened in Norwich: J. Bruce (ed.), Calendar of State Papers Domestic, 1629–31 (London, 1860), 226–39.
[484] Statham, *Book of Bury*, 69; Other examples: Jones, *Great Plague*, 82-3; Walford, *Old and New Volume 4*, 521-528
[485] Wrightson, *Ralph Tailor's*, 105
[486] For instance, in two parish registers in Stamford in 1602-3: Simpson, *Stamford*, 524; and in Wickham, St Mary in 1645
[487] Wrightson, *Ralph Tailor's*, 105
[488] Doolittle, I. G. The plague in Colchester-1579-1666. Essex Archaeol Hist Transactions Essex Archaeol Soc 4, 134–45 (1972), 145

were two pesthouses, the second of which cost around £90 to build, the masonry work and the glazing alone for the first pesthouse cost £2 17s. [489] Doolittle calculates Colchester received £2,700 in plague relief funds over the course of the outbreak.[490] So at least 3.5% of all plague money was spent building pesthouses. The full price of constructing the first pesthouse was clearly much higher than £2 17s paid for masonry and glazing. If it cost the same as the other pesthouse, the amount spent would be 6.6% of total plague funds. It seems very unlikely this amount of money would have been expended to isolate just 0.6% of all infected people in the town, as is implied by the burial totals. Burial proportions should therefore be treated as underestimates of the proportion of infected who were isolated outside their homes in English towns.

Table 4.2. % of Burials at Pesthouse in English and Italian Outbreaks

City	Epidemic Date	% Burials at Pesthouse	Notes
Whickham, St Mary[491]	**1645**	**86% (89/104)**	**Inferred from marginal notes in register**
Florence[492]	1630-1	67.5%	
Pistoia[493]	1630-1	66%	
St Martin in the Fields[494]	**1637**	**c.66% (up to 66 people at once)**	**Proportion of all quarantined people – not burials – in last phase of epidemic.**
Rome[495]	1656-7	61.8%	
Bologna[496]	1630	c.50%	
Shrewsbury[497]	**1650**	**49% (123/250)**	
Venice[498]	1575-7	41%	
Padua[499]	1575-7	24-30%	
Prato[500]	1630-1	27%	

489 https://friendsofhistoricessex.org/2020/04/23/responses-to-pandemic-examples-from-seventeenth-century-essex/
490 Doolittle, *Plague in Colchester*, 142
491 From marginal notes in parish register
492 Henderson, *Florence under siege*, 130
493 Henderson, *Florence under siege*, 130
494 J Merritt, *Social World*, 299-300
495 Henderson, *Florence under siege*, 130
496 Benedictow, *Morbidity*, 407
497 Creighton, *History*, 565
498 Henderson, *Florence under siege*, 130
499 Henderson, *Florence under siege*, 130
500 Henderson, *Florence under siege*, 130

Worcester[501]	**1637**	**25% (405/1620)**	
Carmagnola[502]	1630	24% (443/1885)	
Cambridge[503]	**8 December 1665**	**21% (4/19)**	
Venice[504]	1630-1	15%	
Manchester and Salford[505]	**1605**	**10-21% (up to 72 people at once)**	**Proportion of those defined as 'infected' – the no. infected is too high to tally with total burials, if normal case fatality rate is assumed. Some infected were probably suspected contacts (household members).**
Bath[506]	**1604**	**11% (8 of 72)**	
Norwich[507]	**1665-6**	**9% (217 / 2251)**	
Ipswich[508]	**1665**	**6.5% (70/1071)**	
Exeter, St Sidwells	**1625-6**	**6% (40/708)**	
Colchester[509]	**1665-6**	**c.0.6% (23/4145)**	
St Giles Without Cripplegate[510]	**1665**	**0.3%-1%**	**Columbus suggests extra mural parishes did not send patients to the pesthouse. That would push the burial ratio towards the higher end of the range.[511]**

Burials ratios may be underestimates of the proportion of the infected isolated in pesthouses for further reason. Where the data is available, the case fatality rate of pesthouse patients is much lower than reasonable estimates of plague case fatality rates. The chances of an untreated individual dying of plague is about 66%.[512] The chances of a patient in the pesthouse at St Martin in the Fields in 1636 dying was about 22%.[513] We know 123 people died in the Shrewsbury pesthouse in 1650 and at the end of the epidemic there were still 200 people alive and mostly recovering.[514] This implies a case fatality around 38%. Thus, the numerator and denominator of the burial ratios in table 4.2 must be inflated to differing extents to capture the proportion of the infected who were isolated in pesthouses. This

[501] Slack, *Impact*, 277
[502] Alfani et al, *Pandemics*, 3
[503] Cooper, *Annals Volume III*, 518
[504] Henderson, *Florence under siege*, 130
[505] Willan, *Plague in Perspective*, p.32
[506] Giuseppi, *Cecil Papers Volume 16*, 299-323
[507] Slack, *Impact*, 277
[508] Jones, *Great Plague*, 81; 88
[509] Doolittle, *Plague in Colchester*, 145
[510] Creighton, *History*, 662-663
[511] Columbus, *To be Had*, 11
[512] Kugeler, K. J., Staples, J. E., Hinckley, A., Gage, K. L. & Mead, P. S. Epidemiology of Human Plague in the United States, 1900–2012 - Volume 21, Number 1—January 2015 - Emerging Infectious Diseases journal - CDC. *Emerg. Infect. Dis.* 21, 16–22 (2015), 20
[513] Benedictow makes the same case for pesthouse patients in Italy: Benedictow, *Morbidity*, 406-7
[514] Creighton, *History*, 565

adjustment has a significant effect on the results. For instance, whereas the raw burial ratio for Bath suggests 11% of the infected were isolated, the adjusted ratio would be between 18% and 30%, depending on whether we use the pesthouse case fatality rate in Shrewsbury or St Martin's. Whilst the range is quite large, this does indicate burial ratios may substantially underestimate the proportion of the infected entering English pesthouses.

Measuring peak capacity levels instead of burial proportions also suggests pesthouses were used to isolate a substantial minority of the infected. John Ivie described 'eighty-seven poor souls' isolated at one time in the Salisbury pesthouse which burned down in 1627 in an outbreak which killed around 550 people.[515] In Cambridge in 1630, the pesthouse was probably home to around 60 people.[516] In St Martin in the Fields in 1637, about two-thirds of the 100 infected people where resident in the pesthouse at one time though at the peak of the outbreak in the previous year the proportion of the infected confined in the pesthouse was probably lower.[517] In St Margret's, Westminster, in 1665 at least 50 patients were present at the epidemic's peak, for whom the parish was expending about 5% of its plague related disbursements. In the 1605 outbreak in Manchester and Salford up to 72 people were resident in their pesthouses in a single week which equates to 21% of the infected population at that point in time.[518] Where the figures are available, it is clear parishes were attempting to enforce household quarantine for the majority of the infected and only a minority -though often sizable – were confined to the pesthouse.

Since the London pesthouse is often held up as the most extreme example of restricted capacity, the supporting evidence deserves special consideration. Defoe claimed the city of London pesthouse had capacity for 200 – 300 people in 1665.[519] Whilst this fits with the evidence from the burial totals (from which he may have obtained his estimate), it jars with some of the other evidence. First, the cost of building this facility were around 17 times higher than the cost of building and extending Westminster facility (£6000/£347). A crude application of this ratio to the known capacity of the Westminster facility implies a capacity of around 1000 people. Second, when reflecting on the limited capacity of pesthouses in 1665, Lord Craven (who managed the plague response in the city) never refers to St Giles Without Cripplegate. This intriguing since he provides estimates for the other three main facilities: St Martin's had space for 90 people; St Margaret's and St Giles in the Fields both had capacity for 60 people.[520] Moreover, when describing London's general quarantine response, he claims 'Such infected who were removeable were sent to the pesthouses, and others who could not have been shut up.'[521] The numbers of infected who were removeable,

---

515 Burial registers for St Edmund's parish = 293 and St Thomas' parish = 106. The figure for St Martin's has been estimated at 150 based on the relative size of each parishes population.

516 40 booths were erected on Midsummer Green. It seems unlikely each 'booth' held only a single individual. In Newcastle in 1636 some 'lodges' had capacity for 10; in St Martin in the Fields in the same year at least 66 people could fit inside their 46 isolation buildings. See below.

517 Merritt, *Social World*, 299-300

518 Willan, *Plague in Perspective*, p.32

519 Wilson, *Plague in Shakespeare's*, 80

520 Bell, *The Great Plague*, 88-89; 192

521 Bell, *The Great Plague*, 315

even if only in the intramural city parishes, must have been considerably higher than 200-300 people at the height of the epidemic. This again implies much greater capacity that historians have assumed. Yet without further research, it is impossible to be exact about the role of the city pesthouse in 1665 or, indeed, in other major epidemics.

Together, the evidence on building costs, burial ratios, case fatality rates, and peak capacity levels points toward a greater role for English pesthouses than historians have realised. Still, it is clear household quarantine almost always remained the key element of English plague responses. But if pesthouses only took in a minority of the sick, there is little evidence that this was because they quickly became overwhelmed leading to a return to household quarantine practices.[522] The authorities seem to have managed admittance levels from the start, only accepting sustainable numbers of patients. The sources for Worcester in 1637 and St Margaret's, Westminster, in 1665 reveal pesthouses operated throughout epidemics whilst serving only a subset of the population. In both cases, the number of patients in the pesthouse peaked at the same time as burials in the rest of the parish, suggesting no threshold was reached beyond which new admissions ceased. That said, in the case of St Martin in the Fields in 1636, there is a more noticeable levelling off in the growth rate of households at the pesthouse during the peak months of the epidemic suggesting spaces were limited.[523] Still, the pattern of patient turnover shows the St Martin's pesthouse continued operating throughout the epidemic. The general picture is of admissions being restricted so that only certain parts of the population were admitted.

Though many of the patients of pesthouses were poor, it was not their poverty that distinguished them from those who were quarantined at home as has sometimes been argued.[524] Contemporaries regularly referred to those quarantined in both ways as 'poore visited' people.[525] Moreover, in most cases financial relief payments were made both to quarantined households and pesthouse patients.[526] Columbus identified only 1 of the 27 payments to the 'poor visited' in St Dunstan's parish, London, in 1603 as being for a person at the pesthouse.[527] One of the only examples of pesthouse admissions being related to wealth

---

[522] The only example I have found is the Mayor of Portsmouth who argues Portsmouth was too poorer town to build a suitably sized pesthouse. See: East, R. Extracts from Records in the Possession of the Municipal Corporation of the Borough of Portsmouth (Portsmouth, 1891), 617-620; Jennings suggests the Newark pesthouse was unable to cope with the number of cases in 1645-6 but provides no evidence to support this. See: Jennings, S. B. "A Miserable, Stinking, Infected Town": Pestilence, Plague and Death in a Civil War Garrison, Newark 1640-1649. *Midl Hist* 28, 51–70 (2013), 59

[523] Columbus, *To be Had*, 17

[524] Columbus, *To be Had*, 6; Grell, *Plague in Elizabethan*, 426; Merritt, *Social World*, 299-300

[525] Referring to pesthouse patients: Merritt, *Social World*, 299-300; Slack, P.(ed). 1975. Poverty in Early Stuart Salisbury. Wiltshire Record Society.8vo, pp.viii, 183, 125; Cooper, *Annals Volume II*, 321. Referring to those quarantined at home: Thorpe, *At the mercy*, 39-40; T D Atkinson, Ethel M Hampson, E T Long, C A F Meekings, Edward Miller, H B Wells and G M G Woodgate, 'Wisbech: Epidemics, sanitation', in *A History of the County of Cambridge and the Isle of Ely: Volume 4, City of Ely; Ely, N. and S. Witchford and Wisbech Hundreds*, ed. R B Pugh (London, 2002), p. 261. *British History Online* http://www.british-history.ac.uk/vch/cambs/vol4/p261 [accessed 6 June 2022]; Raine, *York Civic Records Vol V*, 57; Guilding, *Reading Records Volume II*, 427

[526] Newman, *Shutt Up*, 817-8; Westminster Archives, 1665-6 Plague Expenditures MF Box E47 967, Item 10; France, *History of Plague*, 149-157; 158

[527] Columbus, *To be Had*, 12

comes from Cambridge in 1665 when the magistrate Thomas Sclater wrote in his diary that '[t]hose families that were suspected to bee infected and would not remove to the pesthouses mentained themselves' while, 'those at the pesthouses were mentand at the publique charge.'[528] However, this was not the norm. The existence of several people at pesthouses in Newcastle and Salisbury with sufficient funds to leave wills and pay for funerals further confirms financial relief was most often not the factor determining whether an individual entered the pesthouse.[529] It was the varying wealth of patients or patient's households which led the London pesthouse to institute differential rates for admission and care in May 1604. For instance, patients with parents and governors of 'abillitie' were to be charged 2p (33%) more for 'dyett' than the 'poore.'[530] Poverty was not the distinguishing characteristic of pesthouse patients.

Instead, the groups most likely to end up in the pesthouse were those for whom care within the home was least likely to be available. This was the case for servants and apprentices whose masters were keen to remove a source of infection from close contact with their own family.[531] This practice was most common for non-family household members. When blood relatives - spouses or children - became sick, they were cared for at home in the first instance.[532] In some cases masters paid the Master of the Pesthouse to take their servants in and even carried them to the pesthouse themselves.[533] By removing a sick servant or apprentice, the master might also avoid a plague death leading to a full household quarantine, though cases brought to the Westminster Sessions in the 1630s show masters were sometimes found out and ordered to shut up their households.[534] On other occasions, the removal of servants to the pesthouse was organised and paid for by the parish instead of the master. These may be servants who fell sick after being left by a fleeing family to look after their house and property.[535] With no fellow householders, the pesthouse would be the best place for them to receive care. Grell argues servants represented the majority of pesthouse patients.[536] This would explain why 72% of the adults in St Margaret's pesthouse in Westminster were women as women were much more likely to be servants.[537]

Yet we know patients were also often independent householders with no alternative source of care at home. Though little can be deduced from male names, of the 24 women 'at the

---

528 Williams, *Plague and Poor Relief*, 54
529 Wrightson, *Ralph Tailor's*, 105; 136; Wiltshire and Swindon archives (Chippenham), Item D4/5/6
530 Wilson, *Plague in Shakespeare's*, 182-3
531 Wheatley, H B. (ed), The Diary of Samuel Pepys — Complete. (Project Gutenberg, 2004) https://www.gutenberg.org/ebooks/4200 (accessed 30 September 2023), Saturday 22 July 1665; Thursday 3 August 1665; Thursday 1 March 1665/6; Columbus, *To be Had*, 12
532 'Middlesex Sessions Rolls: 1639', in *Middlesex County Records: Volume 3, 1625-67*, ed. John Cordy Jeaffreson (London, 1888), pp. 71-72. *British History Online* http://www.british-history.ac.uk/middx-county-records/vol3/pp71-72 [accessed 6 June 2022]
533 Cordy, *Middlesex County Records Volume 3,* 71-72; Newman, *Shutt Up*, 822
534 Cordy, *Middlesex County Records Volume 3,* 71-72; Newman, *Shutt Up*, 822
535 In 1665, the parish of St Margaret's Westminster paid 2 shillings for 'sending Capt Clayt[u]rns maid to ye pesthouse' See Westminster Archives, 1665-6 Plague Expenditures MF Box E47 967, Item 10
536 Grell, *Plague in Elizabethan*, 426
537 Westminster Archives, 1665-6 Plague Expenditures MF Box E47 967, Item 10. Random sample of weekly pesthouse lists from weeks 4, 9, 15, 19, and 24.

Cabins' in Manchester in August 1605, 22 are described as wives and are therefore unlikely to have been servants.[538] The reason for their admittance appears to be because they had recently lost their husband to plague. For nearly half the women (9/22) listed as 'wife of…' an earlier death of a husband can be traced to the parish register. That the order of the wives' names in the list correlates with the dates at which their husbands died suggests they moved there once the prospect of at-home care vanished. Some patients were sick adults who already lived alone (possibly elderly).[539] In St Margaret's, Westminster, two pesthouse patients, John Deakons and Margaret Teder, were briefly quarantined at home before the parish organised their removal to the pesthouse.[540] Neither were listed in the household quarantine lists with any other household members who might have looked after them, nor was any family available to take them to the pesthouse. The same was true of John Laverrock who died in the Newcastle pesthouse in 1636. His will suggests his closest living family member was a cousin.[541] In all these cases, the parish stepped in, organising their removal to ensure these isolated and seriously unwell individuals received basic care.

In extreme circumstances, children also found themselves in the pesthouse. The lists from St Margaret's, Westminster, show 10% of all patients were children.[542] There are also several examples of births taking place inside these facilities.[543] Mostly, children were taken to the pesthouse alongside a single, sick parent. But children were also taken there when no family members survived to look after them. The four children of Stephen Horner were looked after at the pesthouse in St Margaret's parish without any sign of the presence of adult family members.[544] The parish appears to have treated orphaned children similarly to sick strangers found on the streets of the parish. Two were found on the streets of Westminster and carried to St Margaret's pesthouse because there was nowhere else for them to go. Columbus argues the extramural parishes of St Botolph Aldgate and St Dunstan in the West only sent people 'without fixed address or of dubious status' to the City's pesthouse in St Giles Cripplegate in the 17th century.[545] The bulk of the people who ended up in the pesthouse were therefore in some sense marginal members of society, either because of their pre-epidemic situation or because of the damage caused by the epidemic itself. Members of surviving nuclear families were by far the least likely people to be admitted. The reason for this is clear: the official government regulations recommended household quarantine as the primary approach to isolation and care. Pesthouses were predominantly used for those who fell through the cracks of a system that relied on the household as the primary unit for mutual support.

[538] France, *History of Plague*, 45
[539] Newman, *Shutt Up*, 815
[540] Westminster Archives, 1665-6 Plague Expenditures MF Box E47 967, Item 109
[541] Wrightson, *Ralph Tailor's*, 103
[542] Westminster Archives, 1665-6 Plague Expenditures MF Box E47 967, Item 10. Random sample of weekly pesthouse lists from weeks 4, 9, 15, 19, and 248
[543] Westminster Archives, 1665-6 Plague Expenditures MF Box E47 967, Item 10; Newman, *Shutt Up*, 813
[544] Westminster Archives, 1665-6 Plague Expenditures MF Box E47 967, Item 10
[545] Columbus, *To be Had*, 11

Conclusion

Pesthouses were first established in the 1530s and by the 1666 they were ubiquitous in English towns and cities. This chapter, for the first time, records the speed and character of this process of adoption. The highest rate of new establishments occurred at the end of the 16th and beginning of the 17th centuries. This is surprising because it was not until 1666 that pesthouses were promoted through national plague regulations. Until this point, the national policy of household-based quarantine was the preferred plague response. The 1666 Plague Orders were not therefore innovative for demanding the construction of pesthouses but for substituting them for household quarantine as the default isolation strategy for the sick.

Local authorities established pesthouses independently of direct central government involvement, though many acted simultaneously during a period of heightened activity between 1570 and 1610. This coincides with the emergence and further elaboration of the national household quarantine regulations which suggests local authorities established pesthouses as an additional element in their newly developed plague responses. The abundant evidence that they continued to maintain pesthouses, lease them out when vacant, or store the materials required for the reconstruction of temporary buildings shows how much local authorities valued these facilities and undermines Slack's claim that English pesthouses were used in an ad hoc fashion.[546]

Contemporaries recognised pesthouses had both isolation and care functions, even if the latter has generally been overlooked by historians. Pesthouses employed watchmen but more medical practitioners including nurses, surgeons, physicians, and apothecaries. They bought padlocks and new gates, but also food, ale, medicines, and bedding. They were constructed in isolated locations but designed with the purpose of preventing the accumulation of miasmas. The provision of care was just as important as isolation as a function of pesthouses in most towns up to 1666 at which point local authorities were required to isolate the entire infected population in the manner of Italian towns.

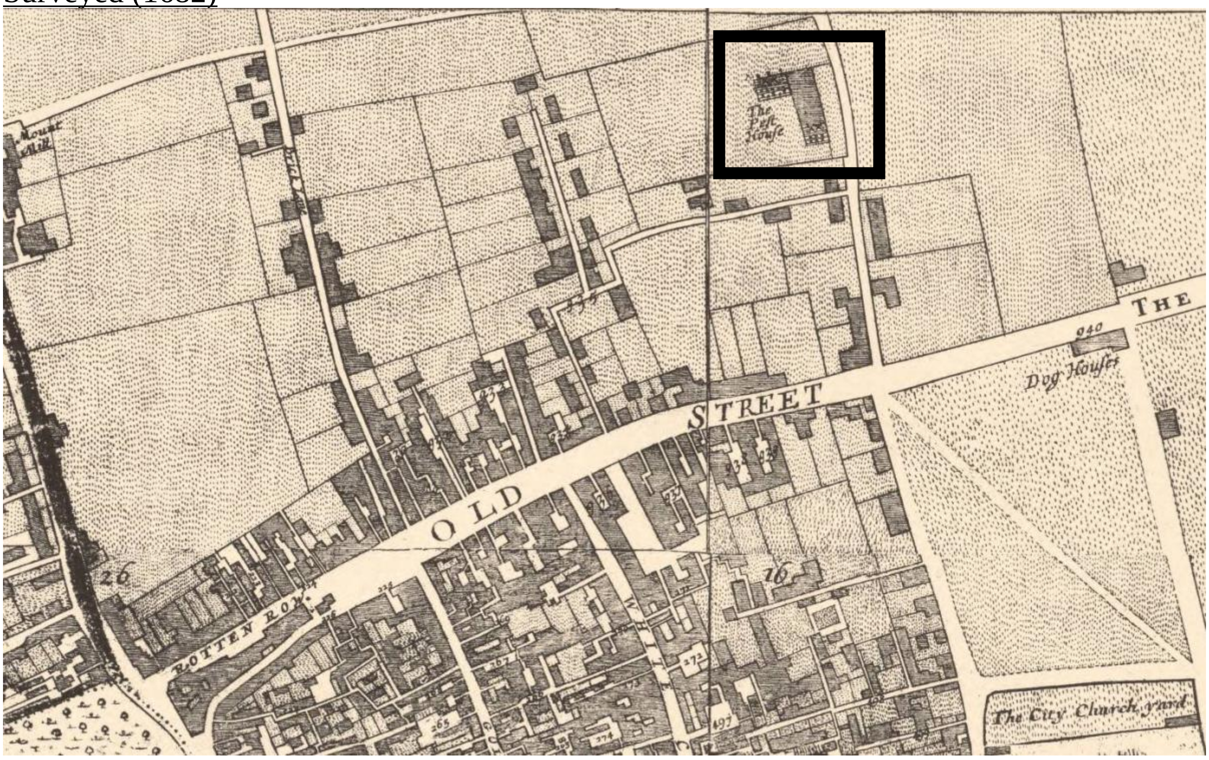
The size of pesthouses and their capacity has been underestimated by historians. Yet, although they could be very large, English pesthouses were only rarely large enough to accommodate the entire infected population like their Italian counterparts. Local authorities instead restricted entry to those who were least likely to receive at home care – servants, the elderly, single parents, orphans, and strangers. Pesthouses functioned as a corrective to the failures of household quarantine, a system which assumed the existence of a household unit and could not deal with 'marginal' cases. Seen from this perspective, pesthouses were far from failed fashionable schemes. They were not intended to be used as part of an advanced Italian-style public health system; they instead represent an achievement of local authorities in providing basic care to the marginal sick during traumatic epidemics.

546 Slack, *Impact*, 277

Figure 4.5. Location of Pesthouse in Stepney in Gascoigne's map (1702).

Source: https://www.theundergroundmap.com/wp/wp-content/uploads/2019/02/s1703.jpg

Figure 4.6. The London Pesthouse in William Morgan's Map Entitled 'London Actually Surveyed (1682)



Chapter 6. Conclusion

Plague was the most persistent cause of severe mortality crises in early modern England and the state responses adopted to control it were highly costly and disruptive. Using a combination of big-data and micro-historical approaches, I have investigated plague and plague responses in early modern England. There are five key findings: First, despite some variation in pervasiveness, plague dynamics were essentially static across early modern plague surges, mapping onto the prevailing human and natural environments in a consistent way. This is despite, second, evidence of vigorous and generally well-intentioned enforcement in many settlements sufficient to systematically change the distribution of burials across affected households. Third, the reason for this is partly epidemiological in that plague efficiently utilised the (mainly water-based) networks of transport and trade at the centre of which was London. And partly socio-political in the sense that, fourth, many parish institutions (especially those in London) lacked the capacity to enforce responses fully, creating disparities over time and space. Fifth, the provision of care and treatment through pesthouses was a more successful policy based on more limited and immediate objectives of helping those most vulnerable to the disruption of plague epidemics.

I began this thesis with three questions: 1. How substantial was plague's impact on mortality? 2. What was the relative importance of direct human interventions, passive economic and social systems, and the natural environment in shaping mortality during the Second Pandemic? 3. How vigorous and comprehensive were the public health responses and which measures were prioritised, why, by, and for whom? I will now briefly summarise my answer to each. A central aim of this thesis is to fuse the approaches and concerns of historical epidemiology and the history of public health. The results demonstrate that by doing so we can better appreciate the patterns of disease, processes of response, and the impact of those responses on the experience of historical epidemics.

In chapter 2, I identify and analyse 7 major surges in plague mortality. Their peak years were 1545, 1563, 1593, 1603, 1625, 1636, 1665. In line with Wrigley and Schofield's estimates, I find even in the worst of these years, plague at most doubled crude death rates, killing an additional 3% of the population.[547] As we saw in chapter 3, local mortality rates in a major city like Bristol could be substantially higher. The epidemics in 1565, 1575, and 1603-4 each killed around 20% of the population. The limited national impact was due to low pervasiveness. In early modern England, plague struggled to infect new settlements in the way it did in medieval England and 17th century Italy and the Low Countries.[548] Still, even at the national level, plague caused some of the most extreme mortality crises in the early modern period. Only influenza and harvest failures were comparable. Like harvest failures, and to a lesser extent influenza, the mortality impact was overwhelmingly felt in large, urban settlements. For all three, mortality was particularly high in London and Middlesex. The dataset analysed here mostly excluded the north of England. Future research should consider

[547] Wrigley and Schofield, *Population History*, 333
[548] Hatcher, *Plague*, 24-5; Alfani, *Plague in Seventeenth Century Europe*, 420; Curtis, *Was Plague*, 159

whether, as seems likely, the patterns extrapolate to the north. Even more importantly, researchers should also analyse the less pervasive and causally complex plague surges – like those during the civil war – which fell outside the scope of this work.

In this thesis, I confirm plague and harvest failures also caused particularly long mortality crises. Plague was unique among these for producing a high level of burial clustering within households.[549] This is true even before the introduction of household quarantine dramatically accentuated the pattern after the 1570s. It may be that the relative length of plague epidemics and their high frequency in places with fairly elaborate structures of government persuaded authorities that plague regulations could be effective. The concentration of mortality within some households must also have appeared to improve the chances of controlling plague, if only the members of those households could be separated effectively from the susceptible population.

Several historians have claimed human interventions aided in the retreat and disappearance of plague from Europe in the 17th and 18th centuries.[550] A central hypothesis is that stricter imposition of ship quarantines disrupted the spread of plague across Europe and to England, leading to its disappearance. Yet there is still uncertainty about whether a fresh importation of plague was necessary to cause each new plague surge in early modern England.[551] In chapter 2, I provide two key pieces of evidence that plague surges began with fresh importations. First, whilst London is the only proposed site for a persistent rodent plague reservoir in England, I show some surges began outside the capital. Only afterwards did London become an epicentre of these outbreaks due to its centrality in the transportation and trade network.

Second, whilst some historians fail to find an association between the incidence of plague and proximity to the port of London, I show port towns across England (as well as settlements closely connected by navigable rivers) were at a substantially greater risk of experiencing an outbreak. Together, this evidence supports contemporary claims, and those of many historians, that plague epidemics arrived by boat from the continent.[552] Whilst this does not prove future interventions disrupted that process effectively, it does suggest they had the potential to do so. To understand this further, future research should investigate the enforcement of measures to prevent the arrival of suspected ships imposed by national and local authorities (as well as the trading monopolies).

It is also possible that low pervasiveness of plague in early modern England by comparison with medieval and continental examples was the result of local preventative measures which blocked traffic to many settlements during national plague surges. We saw in the case of Bristol that whilst household quarantine was a new policy in the 1570s, preventative

---

549 Slack, *Impact*, 177; Schofield, *Anatomy*, 102-103; Schofield, *Last Visitation*, 616
550 Eckert, *Retreat*, 25-26l; Slack, *Disappearance*; Kallioinen, *Plagues and Governments*
551 Keeling and Gilligan, *Metapopulation dynamics*, 903–906; Cummins et al, *Living Standards*, 19; Twigg, G. Plague in London: spatial and temporal aspects of mortality in Epidemic Disease in London, ed. J.A.I. Champion (Centre for Metropolitan History Working Papers Series, No1, 1993), 4
552 Slack, *Impact*, 68; Shrewsbury, *History*, 371

measures such as quarantining arrivals from affected towns had been used in earlier outbreaks. The difficulty is knowing when these measures began. For Bristol, we only know of earlier measures because the authorities refer to them during later outbreaks. We know Gloucester adopted restrictions on movement in the 14th century and York was doing the same by the early 16th century.[553] More research is needed to understand how common these practices were in both towns and villages and how well they were enforced before it is possible to know whether they could explain the low levels of pervasiveness in England between the 1540s and 1660s.[554]

The relative difficulty with which plague travelled along English roads may be further evidence that controls on movement explain low pervasiveness. If plague could travel to more than 80% of settlements in Italy, the Rhineland, and the Low Countries in the 17th century, it must have travelled efficiently by road.[555] In England, settlements located on principal roads, but not navigable rivers experienced only slightly higher vulnerability to an outbreak than did other settlements. Settlements located on navigable rivers were twice as likely to be affected. One explanation for this could be that whereas road controls prevented the arrival of infected fleas, river controls failed to prevent the arrival of infected rats carried in the hulls of boats and ships.

Of course, if lower plague pervasiveness in England was the result of human interventions, this raises the question of why Italian responses were inadequate. Italian city states are widely regarded as the earliest and most effective adopters of plague responses. They spent vast sums on quarantining the infected, constructing permeant isolation facilities, and maintaining boards of health to prevent and manage plague.[556] They should have been better equipped than English authorities to prevent the spread of plague between settlements. However, it is difficult to find a convincing alternative explanation. Explanations based on temperature may work for Italy, but the Dutch and German (northern Rhineland) climates are similar to England's. The best evidence for levels of grain market integration does not suggest markets in Italy and the Low Countries were significantly more integrated, in fact England appears to be one of the most highly integrated markets in early modern Europe.[557] There is also good phylogenetic evidence that the strain of plague affecting England, Italy, and the Low Countries were genetically indistinguishable during contemporaneous surges.[558] One important difference is that urbanisation rates were higher in Italy, the Low Countries, and

---

[553] Mullett, C F. The Bubonic Plague and England: An Essay in the History of Preventative Medicine (Lexington, 1958), 31-2; 'Tudor York: Topography and population', in *A History of the County of York: the City of York*, ed. P M Tillott (London, 1961), pp. 117-122. *British History Online* http://www.british-history.ac.uk/vch/yorks/city-of-york/pp117-122 [accessed 17 March 2021].

[554] This research should investigate the intriguing emergence of domestic plague health certificates which, to my knowledge have never received scholarly attention. Some of the original certificates survive see, for instance, Kelly, *Visitations*, 411

[555] This is less true in the Low Countries where there is an extensive river network. Yet it is notable that this does not seem to lead to even higher pervasiveness than in Italy or Germany. Alfani, *Plague in Seventeenth Century Europe*, 420; Curtis, *Was Plague*, 161; Eckert, *Retreat*, 12

[556] Cliff et al, *Controlling the Geographical Spread*, 197

[557] Federico et al, *European Goods*, 293

[558] Seguin-Orlando et al, *No particular genomic features*, 1

the Rhineland.[559] Yet this would not explain the massive difference in incidence for small rural settlements, even when we only consider English villages within 25 miles of London. If the difference in levels of incidence was not due to human interventions, the true explanation remains elusive.

The restrictions on transport and trade may explain differences in the level of plague's pervasiveness in early modern England relative to other contexts. Even so, there is no sign greater enforcement of household quarantine after 1578 produced a declining trend in subsequent surges. Historians have used a range of sources to understand the enforcement of quarantine regulations. But none have been able to establish an independent and systematic evaluation of the extent to which they succeeded in changing population behaviour.[560] My systematic measurements of changing burial clustering over time in chapters 3 and 4 reveal English local authorities generally enforced quarantine with considerable vigour after 1578. Greater enforcement of household quarantine may have prevented people from moving between settlements, thus lowering pervasiveness. Slack found plague became generally less pervasive over time in Devon but not in Essex, leaving the national pattern undetermined.[561] I show in chapter 2 that for England there was no general trend towards less pervasive plagues after 1578. So, there is no sign the enforcement of household quarantine influenced the spread of plague between settlements at the national level.

That said, it is possible the limiting effects of household quarantine were countered by the greater opportunities for diffusion due to the extensive and intensive growth of trade and transport. Domestic trade intensified between the 1540s and 1660s, as the population rose, and agriculture became more specialised.[562] The navigable river network was also improved and extended over this period.[563] Both factors should have allowed plague to spread more pervasively across England. Indeed, the rising contribution of rural settlements to the total number of affected settlements with each successive plague surge between 1560s and 1660s, revealed in chapter 2, may reflect the greater integration of small settlements into trade networks. Whether expanding trade and transport did increase the potential for plague to spread to more settlements should be investigated in future research. If the answer is affirmative, it may be stricter enforcement of household quarantine is obscuring the existence of an overall rising trend.

Within settlements, I also found no evidence of a general association between greater enforcement of household quarantine and the severity of epidemic mortality. Historians have

---

[559] Vries, J. European Urbanization, 1500-1800. (London, 1984), 39. The figures for Belgium are the best proxy for the Rhineland.
[560] Newman, *Shutt Up*, 816–17; Bowers, *Plague and Public Health*, 57; Tomić and Blažina, *Expelling the Plague*, chapters 5–6; Eckert, *Structure*, chapter 4; Slack, *Impact*, 279-283; Wrightson, *Ralph Tailor's*, 48–9; Calvi, *Histories of a Plague Year*; Parets, *Journal of the Plague Year*; Brockliss and Jones, *The Medical World*; Henderson, *Florence under Seige*, chapter 5
[561] Slack, Impact, 104-105
[562] Federico et al, *European Goods*, 293-294; Kussmaul, A. Agrarian Change in Seventeenth-Century England: The Economic Historian as Paleontologist. *J Econ Hist* **45**, 1–30 (1985)
[563] Satchell, *Navigable Waterways*, 13-17; Barker, T C and Savage, C I. An Economic History of Transport in Britain. (London, 1974 [1959]), 22-24

uncovered a precipitous decline in the severity of plague epidemics in the wealthy central parishes of major English cities over the 17th century.[564] The deviation of burials from trend becomes less severe in wealthy central parishes but remains comparable across epidemics in poorer suburban ones. This has never been satisfactorily explained and cannot be due to changes in population density since populations in central parishes continued to rise during this period in an already densely populated area.[565] The Bristol evidence in chapter 3 shows an apparent correlation between severity and the enforcement of household quarantine, indicating declining severity in wealthy urban parishes was the result of household quarantine. Yet, in chapter 4, I fail to identify an association between enforcement and the severity within a wider sample of 56 mainly urban parishes located across early modern England. Future researchers would therefore be justified in discounting household quarantine as an explanation for declining urban severity.[566]

But the failure of household quarantine to reduce total epidemic mortality does not imply it had no effect on the spread of plague within parishes. The only way the number of burials in affected households (clustering) could increase systematically without a corresponding positive effect on total epidemic mortality is if the number of households affected declined. I find the number of burials overall remained the same whilst they became concentrated in fewer households. This implies the enforcement of household quarantine did lead to a reduction in the spread of plague between households. It is therefore possible household quarantine also reduced the spread of plague between settlements, especially where settlements were reachable only by road. If the infected were unable to move plague to new households within a settlement, they were equally unable to infect new households in other unaffected settlements. This leads us back to the point made above: to understand the full effect of household quarantine on the pervasiveness of plague, it necessary to gauge whether increasing trade and integration counteracted the effect of household quarantine at the national level.

Yet if the possibility remains that quarantine measures had some impact after 1578, they were clearly incapable of radically altering the patterns of diffusion which appear consistent across the early modern period. The evaluations of enforcement in chapters 3 and 5 show this was not because the authorities only targeted certain groups of infected people, specifically the poor and marginal, as some historians have suggested.[567] In the parish of Christchurch in Bristol, burial clustering increased as much among households of wealthy and middling citizens as it did among the poor and marginal. And whilst it certainly was marginal groups who were more likely to end up in the pesthouse, the defining characteristic of pesthouse patients visible in the historical record was their isolation and vulnerability. They were

[564] Slack, *Impact*, 121, 135; Cummins et al, *Living Standards*, 14
[565] See introduction for full discussion.
[566] Increasing levels of flight is among the most likely drivers that should be tested systematically. Progress could be made in this area by linking mothers listed in baptism registers with taxation documents like easter books and the hearth tax to understand whether declining baptisms during epidemics were caused by mortality or flight.
[567] Pullan, *Rich and poor*; Pullan, *Plague and perceptions*; Henderson, *Historians and Plagues*; Carmichael, *Plague and the Poor*, 125; Slack, *Impact*, p. 306

quarantined in pesthouses because they could not expect to receive care and support whilst quarantined at home – a problem created by household quarantine regulations. Whilst we know from other studies that some people were quarantined as a form of punishment, this tends to be where they were acting in ways that might lead to the further spread of plague.[568] The authorities' first priority was to control disease, and not to establish a system for the control of 'disorderly' people.

It is also clear people at all social levels contributed to plague responses, and in chapter 3 I suggest many acted out of a desire to protect their families and communities from a deadly threat. It is clear the national policy of household quarantine was devised by members of the central government, particularly privy councillors like Thomas Wolsey and William Cecil.[569] Yet, as Braddick emphasises, the early modern state could only function effectively in the counties, boroughs, and parishes with widespread cooperation of office holders who could show considerable discretion.[570] That household quarantines were enforced in so many parishes, and that pesthouses were ubiquitous by the 1660s in the absence of national regulations, suggests office holders were keen to cooperate.

The higher levels of enforcement in parishes with high concentrations of city magistrates in Bristol is evidence there was agreement between national and local office holders that plague could and should be controlled through quarantine. The enforcement of quarantine within the parishes and the contributions of ordinary people to the running of pesthouses points to wider support among the public. Of course, some of those who contributed did so because they required employment, and historians have found examples of active resistance to quarantine that should not be ignored.[571] But the scale of the responses heavily implies the existence of a large majority that supported these measures as well. The contribution of ordinary people to plague responses could be pursued further by tracing the names of parish officers, watchmen, nurses, and those in other plague related occupations across the multiple sources that survive for epidemics like Salisbury in 1604.[572]

The lack of a measurable national impact of quarantine cannot be explained by purposefully partial implementation or widespread reticence of broader constituencies of office holders to enforce the regulations. Instead, practical administrative and logistical difficulties ensured the system could not be fully executed. In chapters 3 and 4, I demonstrate whilst there was widespread enforcement, there was nonetheless variation in intensity that might explain why there was no radical decline in the proportion of settlements affected in later plague surges. Both within Bristol and across 21 settlements analysed in the following chapter, levels of enforcement varied widely. It is particularly interesting that even in Salisbury in 1604 – a rare case where detailed records show huge investments in implementation – we see changes in

[568] E.g Newman, *Shutt Up*, 827-8
[569] Slack, *Impact*, 207. Cecil's 'experiments' with household quarantine would be an excellent subject for future research.
[570] Braddick, *State formation*, 129-132
[571] Champion, *London's Dreaded*, 93-97; Slack, *Impact*, 298
[572] Specifically, the quarantine relief lists which feature in this thesis could be combined with the easter books for St Thomas's parish, and the parish registers. See: Wright, *Family Life*

clustering far below the maximum and essentially of average magnitude. The Salisbury comparison illustrates that whilst investments on a vast scale where common by the 17th century, the practical difficulties of ensuring all infected households were identified and effectively confined were too huge for the early modern state to overcome. The association between parish size and wealth with the degree of enforcement in Bristol also supports this. By connecting the Salisbury lists with other available sources, future researchers could reconstruct the comprehensiveness and timing of identification and enforcement as well as the association between outcomes and wealth.

The particularly weak responses implied by the patterns of burials in London emphasise the difficulties of effective enforcement in the central settlement of the national transportation network. The London parishes witnessed small and statistically insignificant changes in clustering after 1578. Whilst this might be partly because the impact of increasing levels of flight is disguising an effect in the wealthy central parishes, the results fit with qualitative evidence of a breakdown of quarantine in the capital during major outbreaks.[573] Lower levels of enforcement in the capital ensured plague would continue to disperse across the country. As we saw in chapter 2, even when London was not the sole port of origin of national plague surges, it propelled plague across the country through the networks of transport and trade. The inability to enforce quarantine ensured London could continue to act as the key foci of infection driving all 7 major plague surges.

A full evaluation of household quarantine would require us to know whether household quarantine would have limited the pervasiveness of plague surges if enforcement had been even stronger. The answer to this depends on how plague was transmitted to people. If plague was spread by rats and their fleas, then even a perfectly enforced system of household quarantine for all infected people might not prevent rats travelling between households and between settlements on ships, boats and, potentially, carts. However, if plague spread predominantly by human ectoparasites, household quarantine could have limited the ability for infected people and their closest contacts from spreading the plague. I do not pretend to offer a systematic answer to this very challenging and contentious question.[574] Yet, by bringing together the patterns of mortality described across the chapters in this thesis and combining this with some findings from recent studies, I can perhaps contribute something to the debate.

The weight of the evidence presented in this thesis points towards the importance of rat-flea transmission of plague to humans. The black rat is also known as the ship rat because ships and boats were one of its preferred habitats.[575] The much greater vulnerability of ports and settlements located on navigable rivers (revealed in chapter 2) therefore points towards the involvement of rats in human plague epidemics. The failure to find any association between

[573] Slack, *Impact*, 282
[574] See literature review in the introduction for a discussion.
[575] Harding, S., Tapson, M., Bar-Oz, G., Cvikel, D. & Marom, N. Stowaways: Maritime ecology of the oldest commensal ship rats (Rattus rattus) found on a Mediterranean shipwreck. *J. Archaeol. Sci.: Rep.* **49**, 103947 (2023)

settlement size and levels of severity seems to confirm the importance of rats. If plague spread between humans via human ectoparasites, then more densely populated settlements (towns were certainly more densely populated than villages) should have witnessed more extreme deviations in mortality.[576] This is the case with louse-borne typhus which spreads most successfully in dense human populations such as migrant camps and crowded urban areas because human lice can only travel very short distances from one host to the next.[577] Plague mortality was not dependent on population density at the settlement level.[578] Combined with the strong association with water, this indicates rats, not human ectoparasites, were predominantly responsible for the spread of plague to humans.

The analysis of burial clustering in plague outbreaks prior to 1578 in chapter 4 further implicates rats and their fleas. Even before household quarantine accentuated the trend, excess clustering was particularly high for plague epidemics compared to influenza and famine. Low case fatality might explain lower mortality clustering for influenza. Yet mortality from famine diseases such as typhus, dysentery and tuberculosis might all be fairly expected to cluster within particularly poor households where the inhabitants would be similarly exposed to the source of infection. Lower clustering during the 1596-8 harvest failure indicates deaths from plague were even more highly associated with the existence of a source of infection within households. Urban rats are highly territorial and travel only short distances from their nests.[579] The importance of rats in transmitting plague would explain the higher excess clustering for plague epidemics compared to famines.[580] It may also help to explain the finding in chapter 5 that case fatality rates in pesthouses was much lower than the population at large. Human ectoparasites were much more likely to be transferred to pesthouses with infected patients than were infected rats. If plague predominantly spread via human ectoparasites, pesthouses may have experienced higher death rates.

However, there are two findings that do not fit with the classic model of rat-flea transmission to humans. First, the pattern of outbreaks across early modern England does not fit with the classic assumptions of the rat-flea model.[581] These require rat epizootics to be in their advanced stages before rat-specific fleas will jump to humans and cause an epidemic. Since

---

[576] Benedictow, *Morbidity*, 421-423

[577] Burns et al, *Drought and Epidemic Typhus*, 442; Raoult, D. *et al.* Outbreak of epidemic typhus associated with trench fever in Burundi. *Lancet* **352**, 353–358 (1998), 353

[578] Neither was it at the level of urban parishes. Despite the population of central London parishes increasing over the 17th century (within a tightly defined and already highly developed area) other studies have found the severity of mortality fell. It also failed to rise in the London suburbs despite increasing density and the subdivision of housing into increasingly cramped tenements about which the authorities constantly complained in the 16th and 17th centuries. Cummins et al, *Living Standards*, 12-14; Baer, W. Housing for the Lesser Sort in Stuart London: Findings from Certificates, and Returns of Divided Houses. London Journal 33, 61–88 (2008), 62

[579] Byers, K. A., Lee, M. J., Patrick, D. M. & Himsworth, C. G. Rats About Town: A Systematic Review of Rat Movement in Urban Ecosystems. *Frontiers Ecol Evol* **7**, 13 (2019), 5

[580] I have also found a negative association between settlement size and excess clustering prior to 1578 (but not after) which future research find to be relevant to this discussion.

[581] Twigg, *Plague in London*, 4. For a useful description of the relationship between rat mortality and human mortality in Hong Kong during the 3rd Pandemic see supplemental material to Dean et al, *Human Ectoparasites*, 1

fleas only proliferate in the warmer months, settlements for which the rat population was infected late in the season will not experience epidemics until the following year when the weather warms up. At which point, many settlements should experience epidemics simultaneously. For settlements experiencing epizootics earlier in the season, the timing of human outbreaks in the same year will depend on the size and proximity of the rat population to humans and thus would appear random when only human cases are visible.

The rat-flea model would therefore predict a random dispersion of outbreaks early in the surge followed by many simultaneous outbreaks spread over a wide area at the start of subsequent plague seasons. The maps describing the timing of outbreaks in the major surge of 1602-1606 instead show outbreaks radiating out from the capital from 1603, with the average distance from London growing very consistently. The observed pattern therefore seems to indicate human epidemics could begin soon after plague arrives in a new settlement, without the requiring a preceding widespread rat epizootic.

The second piece of evidence that contradicts the classic rat-flea-human transmission model is the failure of household quarantine to cause an overall increase in parish-level mortality. As explained above, consistent severity of total mortality is only compatible with increased clustering if the number of households affected declined. Yet if plague was spread by rats that could move between households independent of human movement, the same number of households should have experienced primary plague infections.

One way these contradictory patterns could be resolved with the rat-flea explanation is if human movement aided the spread of plague between small rat populations located relatively close to one another. This was the model proposed by recent research analysing genetic diversity between local rodent populations during modern plague outbreaks in Madagascar.[582] As discussed above, rats are highly territorial, so they do not frequently mix with neighbouring populations. Mixing is even less likely if rats are sick with plague.[583] This would explain why household quarantine could reduce the spread of plague to some new households. It also helps explain other scholar's findings (that I confirm using the Bristol Christchurch Easter books) that plague did not affect neighbouring households, instead breaking out randomly along a street.[584]

Human involvement in spreading plague between rat populations would also explain how plague broke out so quickly in new settlements since only a small number of rats would need to be infected and die before plague jumped to humans and began an iterative and largely simultaneous process of human and rat transmissions. Since rat fleas are highly specific, the human transmission of plague between rat populations would not necessarily lead to

---

[582] Brouat, C. *et al.* Plague Circulation and Population Genetics of the Reservoir Rattus rattus: The Influence of Topographic Relief on the Distribution of the Disease within the Madagascan Focus. *Plos Neglect Trop D* **7**, e2266 (2013), 9
[583] Twigg, *Plague in London,* 4
[584] Slack, Impact, 125; Galanaud, P., Galanaud, A. & Giraudoux, P. Historical Epidemics Cartography Generated by Spatial Analysis: Mapping the Heterogeneity of Three Medieval "Plagues" in Dijon. *Plos One* **10**, e0143866 (2015)

widespread human-to-human transmission, especially since human fleas are such poor vectors for the transmission of plague.[585]

The implication of this hypothesis is that a thoroughly enforced household quarantine could have limited the spread of plague between settlements by road and between households where human movement would have been necessary to reach new rat populations. However, the contact of some rat populations within settlements and between them (where they exploited water transportation) would have ensured household quarantine could never have been completely effective.

Yet, for all the focus on the realised and potential effectiveness of household quarantine and pesthouse regulations in early modern England, this thesis has revealed stopping infection was not the only objective of local authorities in times of plague. Like early modern societies across Europe, English local governors also sought to ensure a degree of care and support was provided to the infected.[586] Many ordinary households were expected to care for one another if one of their number fell sick, though live-in nurses could be provided by the parish.[587] Like many French and Italian towns, one of the real achievements of English municipal plague responses was the local development of pesthouses to ensure the most isolated and vulnerable could expect some assistance from the state.

Plague was a dramatic and persistent threat to early modern societies, the responses they developed reduced the damage, if not by stopping the plague, then by easing the suffering. In this area, above all others, it is clear there was considerable and immediate success. And, in the longer term, the knowledge, methods, and institutions developed through the collective struggle with plague contributed to the more challenging goal of controlling infectious diseases. Pesthouses were redeployed against smallpox by the end of the 17th century; London mortality statistics were vital in the analysis of cholera in the 19th century; today the world is still reeling from the deployment of quarantine against covid-19. All of these began when societies used the state to fight the plague.

---

[585] Fleas proventricular valve in the foregut must become 'blocked' for effective transmission. This does not happen with human fleas, *Pulex irritans*: but does with the rat flea *Xenopsylla cheopis*: Hinnebusch, B. J., Bland, D. M., Bosio, C. F. & Jarrett, C. O. Comparative Ability of Oropsylla montana and Xenopsylla cheopis Fleas to Transmit Yersinia pestis by Two Different Mechanisms. *PLoS Neglected Trop. Dis.* **11**, e0005276 (2017)
[586] Alfani et al, *Pandemics*; Henderson, *Florence under siege,* 227; Thorpe, *At the mercy*; Murphy, *Plague Hospitals*, 20; Crawshaw, *Plague Hospitals*
[587] Thorpe, *At the mercy;* Champion*, London's Dreaded*, 93-97

Bibliography

Manuscript Sources

Bristol Archives, Parochial Registers: P.Xch/R/1/a, P.St_J/R/1/a, P.St MR/R/1/2, P.St_N/R/1/b, P.St_N/R/1/c, P.St_JB/R/1/a, P.AS/R/1/a, P.St_W/R/1, P.St_T/R/1/a, P.St_S/R/1/a

Bristol Archives, Common Council Proceedings, M/BCC/CCP/1/1. Vol 1. Fo. 78

Bristol Archives, Christchurch Easter Books, P.Xch/ChW/2/1-4

'Hearth Tax: City of London 1666, St Giles (without) Cripplegate , Old Street South', in *London Hearth Tax: City of London and Middlesex, 1666* (2011), *British History Online* http://www.british-history.ac.uk/london-hearth-tax/london-mddx/1666/st-giles-cripplegate-old-street-south [accessed 30 September 2023]

London Metropolitan Archives, CLA/008/EM/02/01/001/036r/04
London Metropolitan Archives, CLA/008/EM/02/01/001/037v/05
London Metropolitan Archives, CLA/008/EM/02/01/001/056r/06
London Metropolitan Archives, CLA/008/EM/02/01/001/059r/01

Maynwaringe, E. 'Nova medendi ratio: a short and easie method of curing. Exemplified by a ternary of radical medicines…' (London, 1666). https://wellcomecollection.org/works/uq2txn3z (accessed 30 September 2023).

National Archives, 2414/9/314-323

Orders, thought meete by Her Maiestie, and her priuie Councell, to be executed throughout the counties of this realme, in such townes, villages, and other places, as are, or may be hereafter infected with the plague, for the stay of further increase of the same (London, 1578?). https://wellcomecollection.org/works/c3h938yb (accessed 19 May 2022).

'Pest house' (isolation hospital in times of plague), Tothill Fields, Westminster, London. Lithograph, c. 1840. Wellcome Collection Reference: 25270i. https://wellcomecollection.org/works/e6tnrcnb/items (accessed 30 September 2023)

Rules and orders to be observed by all justices of peace, mayors, bayliffs, and other officers, for prevention of the spreading of the infection of the plague: Published by His Majesties special command (London, 1666). https://wellcomecollection.org/works/pfrmrkyv (accessed 29 September 2023)

Rutland and Leicestershire Archives, BR/III/2/79, ff.22

Surrey History Centre, Mortlake Vestry Minute Book, 2414/4/2

Westminster Archives, 1665-6 Plague Expenditures MF Box E47 967, Item 10

Westminster Archives, SMF 1636, F4514

Westminster Archives, 1642-3 Churchwardens Accounts MF Box 965 E24

Wiltshire and Swindon archives (Chippenham), Item G23/1/112

Wiltshire and Swindon archives (Chippenham), Item D4/5/6

<u>Printed Primary Sources</u>

Acts of the Privy Council of England Volume 45, 1629-1630. Originally published by Her Majesty's Stationery Office (London, 1960)

Bamford, J. *A Short Dialogue Concerning the Plagues Infection. Published to preserve bloud, through the blessing of God* (London, Richard Boyle, 1603). Early English Books Online, https://quod.lib.umich.edu/e/eebo/A03264.0001.001?view=toc (accessed on 26 Sep 2023)

Bond, S. (ed) *The Chamber Order Book of Worcester, 1602-1650,* Worcestershire Historical Society New Series, 8 (1974)

Bruce, J (ed.) *Calendar of State Papers Domestic, 1627–28* (London, 1858)

Bruce, J (ed.) *Calendar of State Papers Domestic, 1629–31* (London, 1860)

Bruce, J (ed) *Calendar of State Papers Domestic: Charles I, 1635* (London, 1865), *British History Online* http://www.british-history.ac.uk/cal-state-papers/domestic/chas1/1635 [accessed 29 September 2023].

Cooper, C H. *Annals of Cambridge*. Volume II (Cambridge, 1843)

Cooper, C H. *Annals of Cambridge*. Volume III (Cambridge, 1845)

Cox, J C. (ed). *The Records of the Borough of Northampton*. Volume II. (London, 1898)

Dennett, J. (ed). *Beverley Borough Records, 1575-1821*. Yorkshire Archaeological Society Record Series. Volume 84 (Wakefield, 1933)

East, R. *Extracts from Records in the Possession of the Municipal Corporation of the Borough of Portsmouth* (Portsmouth, 1891)

Fox, F. (ed) *Adams's Chronicle of Bristol* (Bristol, 1910)

Giuseppi, M S. (ed) *Calendar of the Cecil Papers in Hatfield House: Volume 16, 1604* (London, 1933). *British History Online* http://www.british-history.ac.uk/cal-cecil-papers/vol16/pp299-323 [accessed 9 January 2023].

Groombridge, M J. (ed) *Calendar of Chester city council minutes, 1603-1642,* Lancashire and Cheshire Record Society, 106 (1956)

Guilding, J M. (ed) *Reading Records: Diary of the Corporation.* Volume II. James I - Charles I (1603-1629) (London, 1895)

Guilding, J M. (ed) *Reading Records: Diary of the Corporation.* Volume III. Charles I (1630-1640) (London, 1896)

Guilding, J M. (ed) *Reading Records: Diary of the Corporation.* Volume IV. Charles I and Commonwealth (1641-1654) (London, 1896)

Hardy, W J. (ed) 'Sessions Books: 1701', in *Middlesex County Records. Calendar of Sessions Books 1689-1709* (London, 1905), pp. 223-235. *British History Online* http://www.british-history.ac.uk/middx-county-records/session-bks-1689-1709/pp223-235 [accessed 11 May 2022].

Hobson, M.G & Salter, H.E. *Oxford Council Acts*. Volume II. 1626-1665 (Oxford, 1933)

Hudd, A E. Two Bristol Calendars, *Transactions of the Bristol and Gloucestershire Archaeological Society*, 19 (1894)

Jeaffreson, J C. (ed) 'Middlesex Sessions Rolls: 1639', in *Middlesex County Records: Volume 3, 1625-67* (London, 1888), pp. 71-72. *British History Online* http://www.british-history.ac.uk/middx-county-records/vol3/pp71-72 [accessed 6 June 2022]

Latham, R. C. (ed) *Bristol Charters, 1506–1899* (Bristol, 1947)

Lattimer, J. *The annals of Bristol in the seventeenth century* (Bristol, 1900)

Leech, R., Barry, J., Brown, A., Ferguson, C., Parkinson, E. (eds) *Bristol Hearth Tax, 1662-1673*. British Record Society, vol. 135, Hearth Tax Series vol XI, 2018

Lodge, T. A *Treatise of the Plague: containing the nature, signes, and accidents of the same....* (London, 1603) https://wellcomecollection.org/works/yndphx4x (accessed 30 September 2023)

Nashe, T. A 'Latter-Day Appeal from Christs Tears over Jerusalem' in Craik, H. (ed). English Prose. Volume 1. Fourteenth to Sixteenth Century. (London, 1916)

Overall, W H and Overall, H C. *Analytical Index to the Series of Records Known as the Remembrancia 1579–1664*. Volume 1 (London, 1878)

Overall, W H and Overall, H C. *Analytical Index to the Series of Records Known as the Remembrancia 1579–1664*. Volume 4 (London, 1878)

Power, M. (ed) *Liverpool Town Books 1649-1671*, Lancashire and Cheshire Record Society,136 (1997)

Raine, A. (ed) *York Civic Records*. Vol. II 1478-1505, Yorkshire Archaeological Society Record Series (1941)

Raine, A. (ed) *York Civic Records*. Vol. V, 1548-58, Yorkshire Archaeological Society Record Series (1946)

Roberts, R A. (ed) *Calendar of the Cecil Papers in Hatfield House: Volume 12, 1602-1603* (London, 1910). *British History Online* http://www.british-history.ac.uk/cal-cecil-papers/vol12/pp239-252 [accessed 29 September 2023].

Salomons pest-house, or tovvre-royall (1630). Early English Books Online, https://quod.lib.umich.edu/e/eebo2/A69170.0001.001/1:1?rgn=div1;view=fulltext (accessed 28 Feb 2022).

Salter, H.E. *Oxford Council Acts*. Volume I. 1583-1626 (Oxford, 1928)

Shutting up infected houses as it is practised in England soberly debated (London, 1665), Early English Books Online, https://quod.lib.umich.edu/cgi/t/text/text-idx?c=eebo;idno=A60176.0001.001 (accessed on 28 Feb 2022)

Smith, L T. (ed) [Ricart, R] *The Maire of Bristowe is Kalendar* (Westminster, 1872)

Stevenson, W H. (ed). *The Records of the Borough of Nottingham*. Volume III. 1485-1547 (Nottingham, 1885)

Stevenson, W H. (ed). *The Records of the Borough of Nottingham*. Volume IV. 1547-1625 (Nottingham, 1889)

Tighe, RR & Davis, JE. (eds) *Annals of Windsor*. Volume 2 (London, 1858)

von Ewich, *Duetie of a faithfull and wise magistrate, in preseruing and deliuering of the eommon[sic] wealth from infection, in the time of the plague or pestilence*: two bookes, trans. J. Stockwood (1583). https://quod.lib.umich. edu/e/eebo/A00472.0001.001/1:1?rgn=div1;view=fulltext (accessed 28 Feb 2022)

Wallis-Chapman, A B. (ed) *The Black Book of Southampton*. Volume 3 (Southampton, 1915)

Wheatley, H B (ed), *The Diary of Samuel Pepys* (Project Gutenberg, 2004) https://www.gutenberg.org/ebooks/4200 (accessed 30 September 2023)

Williams, M., Bristol burgesses: freedom of the city, *Journal of the Bristol & Avon Family History Society*, 82 (1995)

<u>Secondary Literature</u>

Alfani, G. Plague in seventeenth-century Europe and the decline of Italy: an epidemiological hypothesis. *European Review of Economic History* 17, 408–430 (2013)

Alfani, G. & Murphy, T. E. Plague and Lethal Epidemics in the Pre-Industrial World. *Journal of Economic History* 77, 314–343 (2017)

Alfani, G. & Ó Gráda, C. eds. *Famine in European History*. (Cambridge, 2017)

Alfani, G., Bonetti, M. & Fochesato, M. Pandemics and socio-economic status. Evidence from the plague of 1630 in northern Italy. *Population Studies*, 1–22 (2023)

Allison, K J. (ed) 'Hull in the 16th and 17th centuries', in *A History of the County of York East Riding: Volume 1, the City of Kingston Upon Hull* (London, 1969), pp. 90-171. *British History Online* http://www.british-history.ac.uk/vch/yorks/east/vol1/pp90-171 [accessed 20 October 2022]

Allison, K J. (ed) *Beverley* (London, 1989), pp. 180-183. *British History Online* http://www.british-history.ac.uk/vch/yorks/east/vol6/pp180-183 [accessed 18 April 2022]

Appleby, A. B. Disease or Famine? Mortality in Cumberland and Westmorland 1580-1640. *The Economic History Review*, 403-432 (1973)

Appleby, A. B. The Disappearance of Plague: A Continuing Puzzle. *The Economic History Review* 33, 161–173 (1980)

Archer, I W. *The Pursuit of Stability: Social Relations in Elizabethan London*. (Cambridge, 2003)

Atkinson, T D., Hampson, E M., Long, E T., Meekings, C A F., Miller, E., Wells, H B., and Woodgate, G M G. 'Wisbech: Epidemics, sanitation', in *A History of the County of Cambridge and the Isle of Ely: Volume 4, City of Ely; Ely, N. and S. Witchford and Wisbech Hundreds*, ed. R B Pugh (London, 2002), p. 261. *British History Online* http://www.british-history.ac.uk/vch/cambs/vol4/p261 [accessed 6 June 2022]

Baer, W. Housing for the Lesser Sort in Stuart London: Findings from Certificates, and Returns of Divided Houses. *London Journal* 33, 61–88 (2008)

Baggs, A P., Brown, L M., Forster, G C F., Hall, I., Horrox, R E., Kent, G H R., Neave, D. 'Sites and Remains of Religious Houses', in *A History of the County of York East Riding: Volume 6, the Borough and Liberties of Beverley*, (London, 1989) pp. 180-183. *British History Online* https://www.british-history.ac.uk/vch/yorks/east/vol6/pp180-183 [accessed 4 June 2024]

Baggs, A P., Blair, W J., Chance, E., Colvin, C., Cooper, J., Day, C J., Selwyn, N., Townley, S C., 'Woodstock: Local government', in *A History of the County of Oxford: Volume 12, Wootton Hundred (South) Including Woodstock*, ed. Alan Crossley and C R Elrington (London, 1990), pp. 372-400. *British History Online* http://www.british-history.ac.uk/vch/oxon/vol12/pp372-400 [accessed 11 May 2022].

Barker, T C & Savage, C I. *An Economic History of Transport in Britain*. (London, 1974 [1959])

Barry, J. The 'Compleat Physician' and Experimentation in Medicines: Everard Maynwaring (c.1629–1713) and the Restoration Debate on Medical Practice in London. *Medical History* 62, 155–176 (2018)

Basing, P. & Rhodes, D., English plague regulations and Italian models: printed and manuscript items in the Yelverton collection. *The British Library Journal* Vol. 23 (1997)

Bell, W G. *The Great Plague in London in 1665* (London, 1924)

Benedictow, O. J. Morbidity in Historical Plague Epidemics. *Population Studies* 41, 401–431 (1987)

Benedictow, O J. *Plague in the Late Medieval Nordic Countries: Epidemiological Studies* (Oslo, 1992)

Benedictow, O J. *The Black Death 1346-1353. The Complete History* (Martlesham, 2004)

Benedictow, O. J. Epidemiology of Plague: Problems with the Use of Mathematical Epidemiological Models in Plague Research and the Question of Transmission by Human Fleas and Lice. *The Canadian Journal of Infectious Diseases and Medical Microbiology* 2019, 1–20 (2019)

Benedictow, O J. *What Disease Was Plague? On the Controversy over the Microbiological Identity of Plague Epidemics of the Past* (Leiden, 2010).

Biraben, J. Certain demographic characteristics of the plague epidemic in France, 1720-22. *Daedalus* 97, 536–545 (1968)

Bos, K I. et al., 'A Draft Genome of Yersinia pestis from Victims of the Black Death', *Nature*, 4128 (2011), 506–10.

Braddick, M. J., *State formation in early modern England, c. 1550–1700* (Cambridge, 2000)

Bramanti, B., Dean, K R., Walløe, L., Stenseth, N. C. The Third Plague Pandemic in Europe. *Proceedings of the Royal Society B: Biological Sciences* 286, 1-8 (2019)

Britnell, R. The Black Death in English towns. *Urban History* 21, 195–210 (1994)

Brockliss, L. W. B & Jones, C., *The Medical World of Early Modern France* (Oxford, 1997)

Brouat, C., Rahelinirina, S., Loiseau, A., Rahalison, L., Rajerison, M., Laffly, D., Handschumacher, P., Duplantier, J M. Plague Circulation and Population Genetics of the Reservoir Rattus rattus: The Influence of Topographic Relief on the Distribution of the Disease within the Madagascan Focus. *PLOS Deglected Tropical Diseases* 7, e2266 (2013)

Burns, J. N., Acuna-Soto, R., Stahle, D. W. Drought and Epidemic Typhus, Central Mexico, 1655–1918 - Volume 20, Number 3—March 2014 - Emerging Infectious Diseases journal - CDC. *Emerging Infectious Diseases* 20, 442–447 (2014)

Byers, K. A., Lee, M. J., Patrick, D. M., Himsworth, C. G. Rats About Town: A Systematic Review of Rat Movement in Urban Ecosystems. *Frontiers in Ecology and Evolution* 7, 1-12 (2019)

Calvi, G. *Histories of a plague year. The social and the imaginary in Baroque Florence*, translated by Dario Biocca and Bryant T. Ragan Jr (Oxford, 1989)

Carmichael, A. Plague Legislation in the Italian Renaissance, *Bulletin of the History of Medicine*, 508-525 (1983)

Carmichael, A. *Plague and the Poor in Renaissance Florence* (Cambridge, 1986)

Carmichael, A. 'Plague Persistence in Western Europe: A Hypothesis' in Green, M (ed). *Pandemic Disease in the Medieval World: Rethinking the Black Death* (Kalamazoo and Bradford, 2014)

Champion, J., *London's Dreaded Visitation: The Social Geography of the Great Plague in 1665* (London, 1995)

Chance, E., Colvin, C., Cooper, J., Day, C J., Hassall, T G., Jessup, M., Selwyn, N., 'Early Modern Oxford', in *A History of the County of Oxford: Volume 4, the City of Oxford*, ed. Crossley, A & Elrington, C R (London, 1979), pp. 74-180. *British History Online* http://www.british-history.ac.uk/vch/oxon/vol4/pp74-180 [accessed 4 April 2022]

Christensen, P. In these perilous times: plague and plague policies in early modern Denmark, *Medical History*, 47:4, 413-450 (2003)

Cipolla, C., *Fighting the Plague in Seventeenth-century Italy* (Madison, 1980)

Clark, G. The long march of history: Farm wages, population, and economic growth, England 1209–18691. *Economic History Review* 60, 97–135 (2007)

Cliff, A. D., Smallman-Raynor, M. R., Stevens, P. M. Controlling the geographical spread of infectious disease: plague in Italy, 1347-1851. *Acta Medico-historica Adriatica Amha* 7, 197–236 (2009)

Cohn, S K. *The Black Death Transformed: Disease and Culture in Early Renaissance Europe*. (London, 2002)

Cohn, S. K., Pandemics: waves of disease, waves of hate from the Plague of Athens to A.I.D.S, *Bulletin of the Institute of Historical Research*, 85, 535-555 (2012)

Cohen, S. The Historian and the Laboratory: The Black Death Disease. in *The Fifteenth Century XII: Society in an Age of Plague* (eds. Clark, L. & Rawcliffe, C.) (2013)

Columbus, A. 'To Be Had for a Pesthouse for the Use of This Parish': Plague Pesthouses in Early Stuart London, c. 1600–1650. *Urban history*, 1-21 (2022)

Crawshaw, J S., *Plague Hospitals: Public Health for the City in Early Modern Venice* (Farnham, 2012)

Crawshaw, J. S. The Renaissance Invention of Quarantine. *The Fifteenth Century XII Society in an Age of Plague* (2013)

Creighton, C. 2013 [1891]. *A History of Epidemics in Britain from A.D 664 to the Extinction of Plague*. Volume 1. Project Gutenberg https://www.gutenberg.org/cache/epub/42686/pg42686-images.html

Crittall, E. (ed) 'Salisbury: St Martin's parish', in *A History of the County of Wiltshire: Volume 6* (London, 1962), pp. 79-81. *British History Online* http://www.british-history.ac.uk/vch/wilts/vol6/pp79-81 [accessed 27 June 2022]

Crowley, D A. (ed) 'Calne: Local government', in *A History of the County of Wiltshire: Volume 17, Calne* (London, 2002), pp. 94-100. *British History Online* http://www.british-history.ac.uk/vch/wilts/vol17/pp94-100 [accessed 6 June 2022]

Cummins, N., Kelly, M., Gráda, C. Ó. Living standards and plague in London, 1560–1665. *Economic History Review* 69, 3-34 (2016)

Curtis, D. R. Was Plague an Exclusively Urban Phenomenon? Plague Mortality in the Seventeenth-Century Low Countries. *Journal of Interdisciplinary History* 47, 139-170 (2016)

Davenport, R J & Smith, R. The early history of public health from an evolutionary perspective. 2019. Online: https://www.openaccessgovernment.org/history-of-public-health/74610/

Davenport, R. J., Satchell, M., Shaw-Taylor, L. M. W. The geography of smallpox in England before vaccination: A conundrum resolved. *Social Science and Medicine* 206, 75–85 (2018)

Dean, K R., Krauer, F., Walløe, L., Schmid, B V. Human ectoparasites and the spread of plague in Europe during the Second Pandemic. *Proceedings of the National Academy of Sciences of the USA* 115, 1304-1309 (2018)

Dean, K R., Krauer, F., Schmid, B V. Epidemiology of a bubonic plague outbreak in Glasgow, Scotland in 1900. *Royal Society Open Science* 6, 1-11 (2019)

Ditchfield, P H. & Page, W. (eds) 'The royal borough of Windsor: The borough', in *A History of the County of Berkshire: Volume 3* (London, 1923), pp. 56-66. *British History Online* http://www.british-history.ac.uk/vch/berks/vol3/pp56-66 [accessed 18 May 2022]

Drancourt, M., Aboudharam, G., Signoli, M., Dutour, O., Raoult, D. Detection of 400-year-old Yersinia pestis DNA in Human Dental Pulp: An Approach to the Diagnosis of Ancient Septicemia, *Proceedings of the National Academy of Sciences of the USA*, xcv, 2637–12640 (1998)

Doolittle, I. G. The plague in Colchester-1579-1666. *Transactions of the Essex Archaeological Society* 4, 134–45 (1972)

Doolittle, I G. "The Effects of the Plague on a Provincial Town in the Sixteenth and Seventeenth Centuries." *Medical History* 19, no. 4, 333-341 (1975)

Dyer, A. The English Sweating Sickness of 1551: An Epidemic Anatomized. *Medical History* 41, 362–384 (1997)

Earn, D J D., Ma, J., Poinar, H., Dushoff, J., Bolker, B M. Acceleration of plague outbreaks in the second pandemic. *Proceedings of the National Academy of Sciences of the USA* 117, 27703–27711 (2020)

Eckert, E A. Boundary formation and diffusion of plague: Swiss epidemics from 1562 to 1669. *Annales de Démographie Historique*, 49-80 (1978)

Eckert, E A., *The Structure of Plagues and Pestilences in Early modern Europe: Central Europe, 1560-1640* (Basel, 1996)

Eckert, E A. The Retreat of Plague from Central Europe, 1640-1720: A Geomedical Approach. *Bulletin of the History of Medicine* 74, 1–28 (2000)

Eisen, R J., Dennis, D T., Gage, K L. The Role of Early-Phase Transmission in the Spread of Yersinia pestis. *Journal of Medical Entomology* 52, 1183–1192 (2015)

Ell, S. R. Immunity as a Factor in the Epidemiology of Medieval Plague. *Clinical Infectious Diseases* 6, 866-879 (1984)

Ermus, C. The Spanish Plague That Never Was: Crisis and Exploitation in Cádiz During the Peste of Provence. *Eighteenth-century Studies* 49, 167-193 (2016)

Ermus, C. The Plague of Provence: Early Advances in the Centralization of Crisis Management. Environment & Society Portal, Arcadia (2015), no. 9. Rachel Carson Center for Environment and Society

Federico, G., Schulze, M S., Volckart, O. European Goods Market Integration in the Very Long Run: From the Black Death to the First World War. *Journal of Economic History* 81, 276–308 (2021)

Flinn, M W. Plague in Europe and the Mediterranean Countries. *Journal of European Economic History*. 8, 1, 131-148 (1979)

Foucault, M. *Discipline and Punish: The Birth of the Prison* (New York, 1979)

France, R S. A History of Plague in Lancashire. *Transactions of the Historic Society of Lancashire and Cheshire* 90 (1938)

Galanaud, P., Galanaud, A., Giraudoux, P. Historical Epidemics Cartography Generated by Spatial Analysis: Mapping the Heterogeneity of Three Medieval "Plagues" in Dijon. *PLOS One* 10, 1-24 (2015)

Gallardo-Albarrán, D. Sanitary infrastructures and the decline of mortality in Germany, 1877–1913. *Economic History Review* 73, 730–757 (2020).

Geltner, G. Public Health and the Pre-Modern City: A Research Agenda. *History Compass* 10, 231–245 (2012)

Geltner, G. The Path to Pistoia: Urban Hygiene Before the Black Death. *Past and Present* 246, 3–33 (2019)

Gordon, A. The Paper Parish: The parish register and the reformation of parish memory in early modern London. *Memory Studies* 11, 51–68 (2018)

Grell, O P. Plague in Elizabethan and Stuart London: The Dutch response. *Medical History* 34, 424–439 (1990)

Griffin, N. Epidemics in Loughborough, 1539-1640. *Transactions of the Leicestershire Archaeological and Historical Society*. Volume 43, 24-34 (1967)

Guellil, M. et al. A genomic and historical synthesis of plague in 18th century Eurasia. *Proceedings of the National Academy of Sciences of the USA* 117, 28328–28335 (2020)

Gunn, S J., Grummitt, D., and Cools, H. *War, State, and Society in England and the Netherlands 1477-1559* (Oxford, 2007)

Haensch, S. et al., Distinct Clones of Yersinia pestis Caused the Black Death, *PLOS Pathogens*, vi, 1-8 (2010)

Harding, S., Tapson, M., Bar-Oz, G., Cvikel, D., Marom, N. Stowaways: Maritime ecology of the oldest commensal ship rats (Rattus rattus) found on a Mediterranean shipwreck. *Journal of Archaeological Science. Rep.* 49, 103947 (2023)

Harding, V. And one more may be laid there: the Location of Burials in Early Modern London. *London Journal* 14, 112–129 (2013)

Harper, K. *Plagues Upon the Earth: Disease and the Course of Human History* (Princeton, 2021)

Harrison, M. Disease, diplomacy and international commerce: the origins of international sanitary regulation in the nineteenth century. *Journal of Global History* 1, 197–217 (2006)

Hatcher, J. *Plague, Population, and the English Economy, 1348-1530* (London, 1977)

Henderson, J., Historians and plagues in pre-industrial Italy over the longue durée, *History and Philosophy of the Life Sciences,* 25, 481-499 (2003)

Henderson, J. *Florence under siege: Surviving plague in an early modern city* (New Haven, 2019)

Henderson, J. The invisible enemy: Fighting the plague in early modern Italy, *Centaurus* 62, 263-274 (2020)

Herbert, N M. (ed) 'Gloucester: Hospitals', in *A History of the County of Gloucester: Volume 4, the City of Gloucester* (London, 1988), pp. 269-275. *British History Online* http://www.british-history.ac.uk/vch/glos/vol4/pp269-275 [accessed 11 May 2022].

Heyman, P., Simons, L., Cochez, C. Were the English Sweating Sickness and the Picardy Sweat Caused by Hantaviruses? *Viruses* 6, 151–171 (2014)

Hinde, A. A review of methods for identifying mortality "crises" using parish record data. *Local Population Studies*, 86, 82-92 (2010)

Hindle, S. *The State and Social Change in Early Modern England, c.1550-1640* (Basingstoke, 1999)

Hinnebusch, B J., Bland, D M., Bosio, C F., Jarrett, C O. Comparative Ability of Oropsylla montana and Xenopsylla cheopis Fleas to Transmit Yersinia pestis by Two Different Mechanisms. *PLOS Neglected Tropical Diseases* 11, e0005276 (2017)

Høiby, N. Pandemics: past, present, future. *APMIS* 129, 359-360 (2021)

Hughes, P. 1985. The History of Nos. 7-9 Friar Street otherwise known as The Grey Friars. Unpublished Research Report Conducted for the National Trust.

Hughes, T. The Plague in Carlisle 1597/98. *Transactions of the Cumberland and Westmorland Antiquarian and Archaeological Society* (1971) Series: 2, Volume 71

Huguet-Termes, T. 'Madrid hospitals and welfare in the context of the Habsburg empire' in Huguet-Termes, T., Arrizabalaga, J., Cook, H J. (eds), *Health and medicine in Habsburg Spain: agents, practices, representations* (London, 2009)

Jennings, S. B. A Miserable, Stinking, Infected Town: Pestilence, Plague and Death in a Civil War Garrison, Newark 1640-1649. *Midland History* 28, 51–70 (2013).

Jillings, K. *An Urban History of the Plague: Socio-Economic, Political and Medical Impacts in a Scottish Community, 1500–1650* (Abingdon, 2018)

Jones, A G E. The Great Plague in Ipswich 1665-1666. *Proceedings of the Suffolk Institute of Archaeology and History*. Volume 28, 77-89 (1958)

Kallioinen, M., Plagues and governments: the prevention of plague epidemics in early modern Finland, *Scandinavian Journal of History,* 31 (2006)

Keeling, M. J. & Gilligan, C. A. Metapopulation dynamics of bubonic plague. *Nature* 407, 903–906 (2000)

Keller, M. *et al.* Ancient Yersinia pestis genomes from across Western Europe reveal early diversification during the First Pandemic (541–750). *Proceedings of the National Academy of Sciences of the USA* 116, 12363–12372 (2019).

Kelly, M. & Gráda, C Ó. Living standards and mortality since the middle ages. *Economic History Review* 67, 358–381 (2013)

Kelly, W. Visitations of the Plague at Leicester. *Transactions of the Royal Historical Society* 6, 395–447 (1877)

Kent, J R. The centre and the localities: state formation and parish government in England, circa 1640–1740. *The Historical Journal* 38, 363–404 (1995).

Kinzelbach, A M. Hospitals, medicine and society: southern German imperial towns in the sixteenth century, *Renaissance Studies*, 15, 2, 217-228 (2001)

Konkola, K. More Than a Coincidence? The Arrival of Arsenic and the Disappearance of Plague in Early Modern Europe. *Journal of the History of Medicine and Allied Sciences* 47, 186–209 (1992)

Krauer, F., Viljugrein, H., Dean, K. R. The influence of temperature on the seasonality of historical plague outbreaks. *Proclamations of the Royal Society: B Biological Sciences* 288, 20202725 (2021)

Kugeler, K J., Staples, J E., Hinckley, A., Gage, K L., Mead, P S. Epidemiology of Human Plague in the United States, 1900–2012 - Volume 21, Number 1. *Emerging Infectious Diseases.* 21, 16–22 (2015), 20

Kussmaul, A. Agrarian Change in Seventeenth-Century England: The Economic Historian as Paleontologist. *Journal of Economic History* 45, 1–30 (1985)

Laudisoit, A. *et al.* Plague and the Human Flea, Tanzania. *Emerging Infectious Diseases* 13, 687–693 (2007)

Litchfield, R B. *Florence Ducal Capital, 1530-1630* (New York, 2008). Available Online: https://hdl.handle.net/2027/heb90034.0001.001.

Little, L K. Plague Historians in Lab Coats*. *Past and Present* 213, 274-282 (2011)

Lobel, M D., & Carus-Wilson, E M. *The Atlas of Historic Towns. Volume Two: Bristol, Cambridge, Coventry, Norwich* (London, 1975)

MacKay, R. *Life in a Time of Pestilence: The Great Castilian Plague of 1596–1601* (Cambridge, 2019)

Malden, H E. (ed) 'Parishes: Putney', in *A History of the County of Surrey: Volume 4.* (London, 1912), pp. 78-83. *British History Online* http://www.british-history.ac.uk/vch/surrey/vol4/pp78-83 [accessed 6 June 2022]

Manship, H. *The History of Great Yarmouth*. Volume 1 (Great Yarmouth and London, 1854)

McConaghey, R M S. Epidemiology in Devon*. *British Medical Journal* 2, 1296-1299 (1957)

Merritt, J F. *The Social World of Early Modern Westminster* (Manchester, 2005)

Mokyr, J. & Grada, C O. What do people die of during famines: the Great Irish Famine in comparative perspective. *European Review of Economic History*, 6, 339-363 (2002)

Moote, A L. & Moote, D C. *The great plague: the story of London's most deadly year* (London, 2004)

Morelli, G. et al., Yersinia pestis Genome Sequencing Identifies Patterns of Global Phylogenetic Diversity, *Nature Genetics*, xlii, 1140-1143 (2010)

Mostyn, J A. *The History and Antiquities of the County of Norfolk*. Volume X (Norwich, 1781)

Mullett, C F. *The Bubonic Plague and England: An Essay in the History of Preventative Medicine* (Lexington, 1958)

Munkhoff, R. Searchers of the Dead: Authority, Marginality, and the Interpretation of Plague in England, 1574–1665. *Gender History* 11, 1–29 (1999)

Munkhoff, R. Poor women and parish public health in sixteenth-century London. *Renaissance Studies* 28, 579–596 (2014)

Murphy, N. Plague Hospitals, Poverty and the Provision of Medical Care in France, c. 1450–c.1650. *Journal of Social History*, 825-853 (2021)

Namouchi, A. et al. Integrative approach using Yersinia pestis genomes to revisit the historical landscape of plague during the Medieval Period. Proc National Acad Sci 115, 201812865 (2018)

Nelkin, D. & Gilman, S L. Placing Blame for Devastating Disease, *Social Research* 55, 361-378 (1988)

Newman, K. Shutt Up: Bubonic Plague and Quarantine in Early Modern England, *Journal of Social History*, 45, 809-834 (2012)

Omran, A R. The Epidemiologic Transition: A Theory of the Epidemiology of Population Change. *The Milbank Quarterly* 83, 731–757 (2005)

Page, W. (ed) 'Hospitals: St Peter, Bury St Edmunds', in *A History of the County of Suffolk: Volume 2* (London, 1975), pp. 134-135. *British History Online* http://www.british-history.ac.uk/vch/suff/vol2/pp134-135 [accessed 16 June 2022]

Palliser, D M. Epidemics in Tudor York. *Northern History* 8, 45–63 (1973)

Palmer, R J. The Control of Plague in Venice and Northern Italy 1348–1600 (Univ. of Kent Ph.D. thesis, 1978)

Parets, M. & Amelang, J S A. *Journal of the Plague Year: The Diary of the Barcelona Tanner Miquel Parets*, 1651 (New York, 1991)

Pelling, M. *The Common Lot: Sickness, Medical Occupations and the Urban Poor in Early Modern England*. (New York, 1998)

Pollitzer, R. 1954. Plague. World Health Organization, Geneva.

Porter, R. Cleaning up the Great Wen: public health in eighteenth-century London. *Medical History* 35, 61–75 (1991)

Porter, R. (ed.) *Cambridge illustrated history of medicine* (Cambridge, 1996)

Pullan, B. *Rich and Poor in Renaissance Venice* (Oxford, 1971)

Pullan, B. ‘Plague and Perceptions of the Poor in Early Modern Italy’ in T. Ranger and P. Slack eds *Epidemics and Ideas* (Cambridge, 1992)

Raoult, D. *et al.* Outbreak of epidemic typhus associated with trench fever in Burundi. *Lancet* 352, 353–358 (1998)

Rawcliffe, C. *Leprosy in Medieval England* (Woodbridge, 2006)

Rawcliffe, C. *Urban bodies: communal health in late medieval towns and cities* (Woodbridge, 2013)

Risse, G B. *Mending Bodies, Saving Souls: A History of Hospitals* (Oxford, 1999)

Roger, E C. 'To Be Shut Up': New Evidence for the Development of Quarantine Regulations in Early-Tudor England. *Social History of Medicine* 33, 1077–1096 (2019)

Rogers, A. (ed) *The Making of Stamford* (Welwyn Garden City, 1965)

Roosen, J. & Curtis, D R. Dangers of Noncritical Use of Historical Plague Data. *Emerging Infectious Diseases* 24, 104-107 (2018)

Rothenberg, G E. The Austrian Sanitary Cordon and the Control of the Bubonic Plague: 1710–1871. *Journal of History of Medicine and Allied Sciences* XXVIII, 15–23 (1973)

Sacks, D. *The Widening Gate: Bristol and the Atlantic Economy, 1450-1700* (Berkeley, 1991)

Sacks, D. & Lynch, M. 'Chapter 12. Ports 1540-1700' in Clark, P (eds). *The Cambridge Urban History of Britain*: Volume 2, 1540-1840. Vol. 2. (Cambridge, 2008)

Satchell, M. Navigable waterways and the economy of England and Wales: 1600-1835. [Unpublished] (2017) Available: https://www.campop.geog.cam.ac.uk/research/projects/transport/onlineatlas/waterways.pdf [Accessed 29.09.2023]

Schmid, B V. *et al.* Climate-driven introduction of the Black Death and successive plague reintroductions into Europe. *Proceedings of the National Academy of Sciences of the USA* 112, 3020-3025 (2015)

Schofield, R. 'An Anatomy of an Epidemic: Colyton, November 1645 to November 1646' in *The Plague Reconsidered: A New Look at Its Origins and Effects in 16th and 17th Century England*, (eds) Slack, P., and the Cambridge Group for the History of Population Social Structure (Matlock, 1977)

Schofield, R. The last visitation of the plague in Sweden: the case of Bräkne-Hoby in 1710–11, *Economic History Review* 69, 600-626 (2016)

Schuenemann, V J. et al., Targeted Enrichment of Ancient Pathogens Yielding the pPCP1 Plasmid of Yersinia pestis from Victims of the Black Death, *Proceedings of the National Academy of Sciences of the USA*, cviii (38), E746-E752 (2011)

Seguin-Orlando, A. *et al.* No particular genomic features underpin the dramatic economic consequences of 17th century plague epidemics in Italy. *Iscience* 24, 102383 (2021)

Seifert, L. *et al.* Genotyping Yersinia pestis in Historical Plague: Evidence for Long-Term Persistence of Y. pestis in Europe from the 14th to the 17th Century. *PLOS One* 11, e0145194 (2016)

Shrewsbury, J F D. *A History of Bubonic Plague in the British Isles*. (Cambridge, 1970)

Simpson, J. Stamford: The plagues of 1605 and 1625. *Notes and Queries* s6-II, 524–524 (1880)

Slack, P. A. Reviewed Work(s): A History of Bubonic Plague in the British Isles by J. F. D. Shrewsbury. *The English Historical Review*, vol. 87, 112-115 (1972)

Slack, P. (ed) *Poverty in Early Stuart Salisbury*. Wiltshire Record Society Series. (Devizes, 1975)

Slack, P. ‘The Local Incidence of Epidemic Disease: The Case of Bristol 1540-1650’, in *The Plague Reconsidered: A New Look at Its Origins and Effects in 16th and 17th Century England*, eds Slack, P., and the Cambridge Group for the History of Population Social Structure (Matlock, 1977)

Slack, P. Books of Orders: the Making of English Social Policy, 1577–1631. *Transactions of the Royal Historical Society* 30, 1–22 (1980)

Slack, P. The Disappearance of Plague: An Alternative View. *Economic History Review* 34, 469-476 (1981)

Slack, P. *The Impact of Plague in Tudor and Stuart England*. (London, 1985)

Slack, P. Responses to plague in early modern Europe: the implications of public health. *Social Research* 55, 433–53 (1988)

Slack, P. *Poverty and Policy in Tudor and Stuart England*. (London, 1988).

Slack, P. Government and Information in Seventeenth-Century England. *Past and Present* 184, 33–68 (2004)

Slack, P. Measuring the national wealth in seventeenth-century England. *Economic History Review* 57, 607–635 (2004)

Slack, P. Perceptions of plague in eighteenth-century Europe†. *Economic History Review*, vol.75, 138-156 (2021)

Sonnino, E. “Cronache della peste a Roma: Notizie dal Ghetto e lettere di Girolamo Gastaldi (1656–1657).” Roma Moderna e Contemporanea 14, no. 1-3 (2006)

Sontag, S., *Illness as Metaphor* (London, 1979)

Spyrou, M A. *et al.* Historical Y. pestis Genomes Reveal the European Black Death as the Source of Ancient and Modern Plague Pandemics. *Cell Host and Microbe* 19, 874–881 (2016)

Spyrou, M A. *et al.* Analysis of 3800-year-old Yersinia pestis genomes suggests Bronze Age origin for bubonic plague. *Nature Communications*. 9, 2234 (2018)

Spyrou, M A. et al. Phylogeography of the second plague pandemic revealed through analysis of historical Yersinia pestis genomes. *Nature Communications* 10, 1-13 (2019)

Statham, M. *The Book of Bury St Edmunds*. (Baron Birch, 1996)

Stein, C. *Negotiating the French pox in early modern Germany* (Aldershot, 2008)

Susat, J. *et al.* Yersinia pestis strains from Latvia show depletion of the pla virulence gene at the end of the second plague pandemic. *Scientific Reports* 10, 14628 (2020)

Szreter, S. The Importance of Social Intervention in Britain’s Mortality Decline c.1850–1914: a Re-interpretation of the Role of Public Health. *Social History of Medicine* 1, 1–38 (1988)

Thorpe, L. ‘At the mercy of a strange woman’ Plague Nurses, Marginality, and Fear during the Great Plague of 1665. In Hopkins, L & Norrie, A, (eds) *Women on the Edge in Early Modern Europe*. (Amsterdam, 2022)

Tilly, C. *Coercion, Capital, and European States, AD 990-1990.* (Cambridge, 1990)

Tillott, P M. (ed) 'Tudor York: Topography and population', in *A History of the County of York: the City of York* (London, 1961), pp. 117-122. *British History Online* http://www.british-history.ac.uk/vch/yorks/city-of-york/pp117-122 [accessed 17 March 2021]

Tognotti, E. Lessons from the History of Quarantine, from Plague to Influenza A. *Emerging Infectious Diseases* 19, 254–259 (2013)

Tomić, Z B. & Blažina, V. *Expelling the Plague: The Health Office and the Implementation of Quarantine in Dubrovnik, 1377–1533* (Montreal, 2015)

Twigg, G. Plague in London: spatial and temporal aspects of mortality in Epidemic Disease in London, ed. Champion, J A I. Centre for Metropolitan History Working Papers Series, No.1, (1993)

Valliant, R., Dever, J. A., Kreuter, F., Practical Tools for Designing and Weighting Survey Samples. *Statistics for Social and Behavioral Sciences* 565–603 (2018)

Valtueña, A A. *et al.* The Stone Age Plague and Its Persistence in Eurasia. *Current Biology* 27, 3683-3691.e8 (2017)

Van Andel, M. Plague regulations in the Netherlands, *Janus* (1916)

Vries, J. *European Urbanization, 1500-1800*. (London, 1984)

Waldis, V. Hospitalisation und Absonderung in Pestzeiten – die Schweiz im Vergleich zu Oberitalien, *Gesnerus*, 39 (1982)

Walford, E. 'Golden Street and neighbourhood', in *Old and New London: Volume 4* (London, 1878), pp. 235-246. *British History Online* http://www.british-history.ac.uk/old-new-london/vol4/pp235-246 [accessed 11 May 2022]

Wallis, P. A Dreadful Heritage: Interpreting Epidemic Disease at Eyam, 1666–2000. *History workshop Journal* 61, no. 1, 31–56 (2006)

Wallis, P. Plagues, Morality and the Place of Medicine in Early Modern England, *English Historical Review*, 121, 1-24 (2006)

Watts, S J. *Epidemics and History: Disease, Power, and Imperialism*. (New Haven, 1997)

Weiser, P B. 'Modern Death, Decent Death, and Heroic Solidarity in *The Plague*', in Weiser, P B. (ed.), *Camus's The Plague: Philosophical Perspectives* (New York, 2023)

Welford R. *History of Newcastle and Gateshead* Volume 3 (London: Walter Scott, 1887)

Whittles, L K. & Didelot, X. Epidemiological analysis of the Eyam plague outbreak of 1665-1666. *Proceedings of the Royal Society B: Biological Sciences* 283, 20160618 (2016)

Willan, T S. The Plague in Perspective: The Case of Manchester in 1605. *Transactions of the Historic Society of Lancashire and Cheshire* 132, 29-40 (1982)

Williams, S. Plague and Poor Relief in Cambridge, 1665-1666. *Local Population Studies* 47–55 (2020)

Wilson Bowers, K. *Plague and Public Health in Early Modern Seville*. (Rochester, 2013)

Wilson, F P. *Plague in Shakespeare's London*. (Oxford, 1927)

Woods, A. *The History and Antiquities of Oxford* Volume II. (ed) John Gutch (Oxford, 1786)

Wright, S J. Family Life and Society in Sixteenth and Early Seventeenth Century Salisbury. Unpublished PhD Thesis. (University of Leicester, 1982)

Wright, S. J. Easter Books and Parish Rate Books: a new source for the urban historian, *Urban History*, 12, 30-45 (1985)

Wrightson, K. *Ralph Tailor's Summer: A Scrivener, His City and the Plague* (New Haven, 2011)

Wrigley E A. *People, Cities and Wealth: The Transformation of Traditional Society* (Oxford, 1986)

Wrigley, E A., Schofield, R., Lee R D., Oeppen J. *The Population History of England, 1541-1871: a Reconstruction.* (Cambridge, 1989)

Yue, R P H., Lee, H F., Wu, C Y H. Navigable rivers facilitated the spread and recurrence of plague in pre-industrial Europe. *Scientific Reports* 6, 34867 (2016)

Appendix 1

Evaluating the Quality of the 'Family History Society' Dataset

Introduction.

English parish registers are an almost incomparably rich source for demographic historians. Still, the thousands of survivals contain an equally huge variety of problems. Some relate to the quality of the physical documents: damp, rodents, mishandling, vandalism, and countless other contingencies has led to the destruction of some or all of the information they hold. Defective record keeping in the parish also reduced the stock of available information, the process of transcribing and digitising by family historians likewise. The effect of these problems is that some monthly burial counts contained within the dataset gathered from family history societies and ancestry.com (hereafter FHS dataset) list fewer burials than actually occurred. The true burial record is obscured by these factors we can collectively term 'under-registration.' The aim of chapter 2 is to identify and analyse outbreaks of plague by identifying periods where burials were abnormally high. To do this we require a tolerably close estimate of normal burials. We must therefore remove these blemishes from the data in order to prevent us deriving a false sense of how many burials actually occurred.

This appendix sets out my approach to dealing with the problem of burial under registration in the FHS burial dataset. The data contains around 10 million observations. Evaluating each parish register by hand is therefore out of the question. I have written a computer code which can search through each burial series and identify monthly entries which appear abnormal. The aim of this appendix is to explain what that code does and to justify the decisions I have made along the way. Some tables and figures have been included which provide examples of how the code works.

The problem of under-registration in parish registers was addressed by Wrigley and Schofield in 'The Population History of England' and their approach is elaborated in detail in appendix 12 of that book.[588] Whilst the approach presented here does contain some innovations, it draws heavily on Wrigley and Schofield and where I have experimented with the parameters they used, I have generally found their choices to be most optimal.

In outline, the strategy is to estimate a trend line for each burial series which represents average burials at that point in time. This is used to transform the data into a form that is normally distributed regardless of the quantity of burials recorded on a monthly basis (monthly burial counts approximate a Poisson distribution). The data can then be evaluated using the properties of the normal distribution which are easy to work with. The findings from this evaluation are then used to identify the periods that contain abnormal burial activity when the data is considered once again as monthly burial counts. This process is repeated with the findings from the first round being used to adjust the position of the trend line which

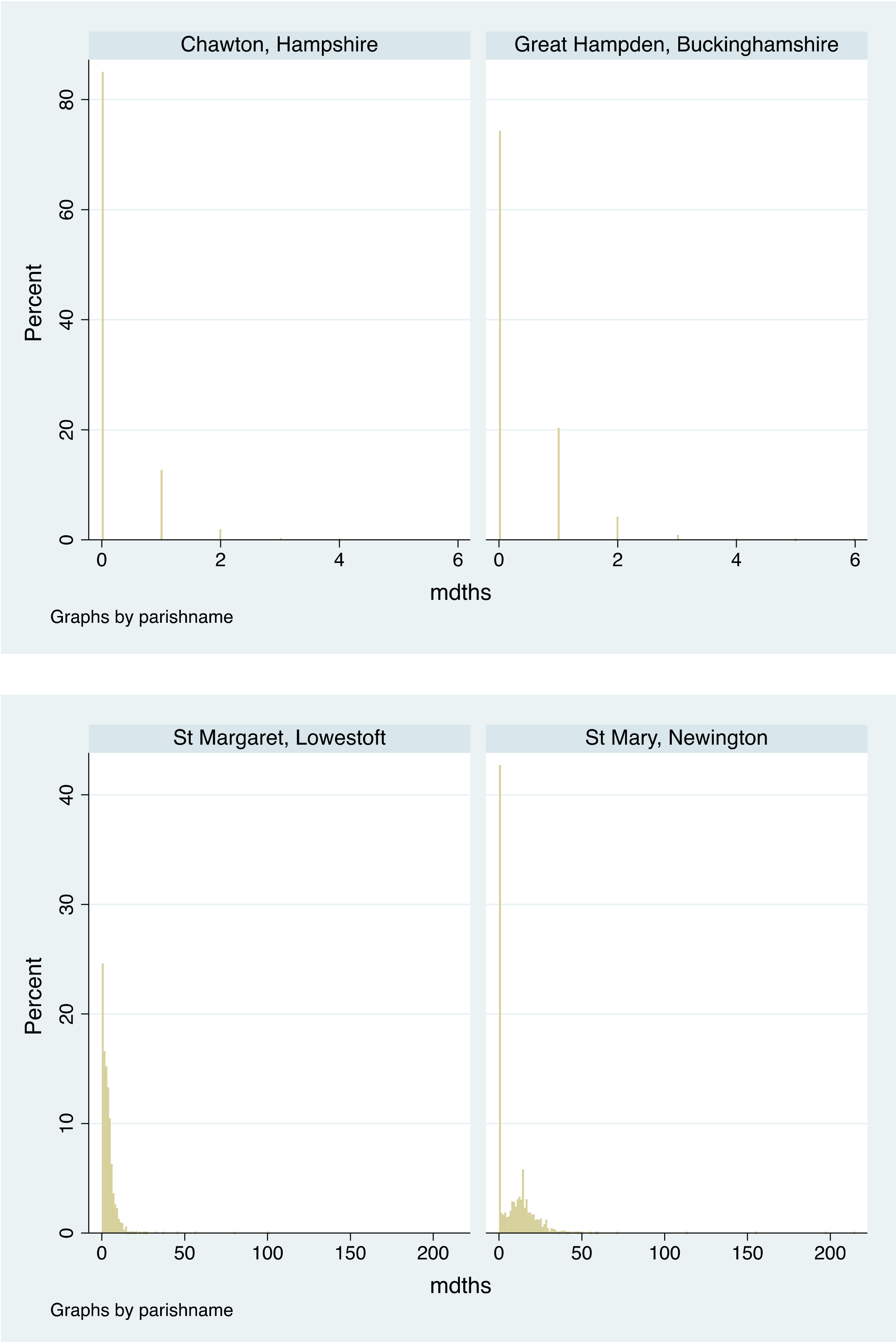
[588] Wrigley and Schofield, *Population History*, 697-704

in turn affects the way the data is transformed in the second round. The outcome of the second round is a ‘cleaned’ count of monthly burials in which all periods of under-registration have been converted to blanks, leaving only monthly counts that are judged to be sound.

Characteristics of Burial Peaks and Troughs.

The burial data used here was copied from parish registers and aggregated to a monthly level. It is non-negative and can take maximum monthly values which are theoretically equal to the population size. For small parishes, many months can pass between each burial, leaving genuine zero values in the monthly aggregated totals. In larger parishes there tends to be a much more constant stream of burials. In all parishes there can be periods of a month or more in which burials run very far above their average. This is most often caused by an epidemic but wars, accidents, or the closure of a nearby church are some of the alternative explanations for this. These stylised facts are reflected in the distribution of monthly burial counts around the mean. Figure A.1.1 presents the distribution of burial counts for four parishes in the FHS dataset. The series are in size order. Chawton in Hampshire, is a small village (0.18 burials per month on average); Great Hampden, Buckinghamshire (larger, with 0.33 burials per month); St Margaret’s is a parish in the town of Lowestoft, Suffolk (3.8 burials per month); and the large suburban parish of St Mary, Newington in Surrey, near London (9 burials per month on average). They cover the whole range of sizes in the FHS dataset with the median series size being closest to Great Hampden in Buckinghamshire.

Figure A.1.1. Distributions of Monthly Burial Counts for Four Parishes in the FHS Dataset



As the average burials per month increases, the distributions become more normally distributed. Over eighty percent of the counts in the Chawton series equal zero; this drops to around 25% for St Margaret, Lowestoft. By the time we reach St Mary, Newington we are beginning to see the emergence of a normal distribution, centred around the value of 15. Burial counts are heavily right skewed though this characteristic fades as the average number of burials per month increases. [589]

The high proportion of very low or zero counts hampers our ability to identify under-registration. We can see this by comparing the St Mary Newington distribution with the other three. Since the St Mary series is grouped around the value of 15, with the probability of a monthly count recording a lower or higher value than this decreasing as we move further from the centre, the very high proportion of counts with a value of zero (around 45%) immediately looks anomalous. Judging by the rest of the distribution, it is highly unlikely these zero values would be recorded if the register reflected only the actual burial record. In such a large population it would be rare for even one month to go by in which no one died, and it would not happen 45% of the time. With the other parishes, under-registration it is much harder to spot. Since it is so common for a monthly count to contain a low or zero value, we cannot distinguish between months in which registration was sound and those in which it was defective.

This is the central problem we will have to overcome: firstly, the distribution of monthly burial counts is highly right skewed and so months of defective registration cannot be identified. Secondly, the degree to which the distribution is skewed falls as the average number of burials per month increases. The other, far more tractable problem, we face is the effect of burial peaks. These must also be removed from the data in order to estimate a trend reflecting average burials during periods with normal levels of mortality. Regardless of the level of average burials, these events always fall on the extreme right of the burial distribution. Compare the series for St Margaret, Lowestoft and St Mary, Newington. Despite the former being much more heavily skewed, in both cases the burial peaks fall far above the mean. A threshold can therefore be set which identifies these events by virtue of their extremity. We need to transform the data so that under registration appears equally extreme.

<u>The 'Test Period'.</u>

We can recognise the worst cases of under-registration in burial data by eye not because some individual months record very low or zero values, but instead because these low levels persist for many consecutive months. We should therefore transform the data, so several months are considered together as a larger unit. Since the average for all series in the dataset is above zero, there must be some number of consecutive months for which the average is highly likely to equal the series average and for which a value very far from the series mean is highly unlikely. If we were to draw random samples from the series and calculate the mean for each, as long as we selected a high enough sample size (measured in months) we could

[589] This characteristic of burial counts means their distribution can be approximated using the Poisson distribution with the Lambda parameter being equal to average monthly burials. The smaller Lambda, the greater the degree to which the distribution is right skewed, as Lambda rises the closer the burial series will be to the normal distribution. Cummins et al, *Living Standards*, 16

create a distribution of sample means that would be normally distributed around the series mean.[590]

We would have to consider the sample size selected very carefully. If it contained a very high number of months, the resulting means would all be very close to the series average and would be normally distributed. However, this would come at the cost of missing some periods of anomalous burial counts as they would be 'averaged out' within these large samples. With very small sample sizes the opposite problem would occur. We would create samples that measured the average of small enough units to precisely identify anomalous periods. Though the closer the sample size gets to a single month the less the distribution of sample means will resemble the normal distribution and the closer it will resemble the distribution of the monthly count data - it will be increasingly right skewed.

So, we would ideally choose the sample size that optimises this trade off. The sample would be as small as possible whilst still resembling the normal distribution. At this point anomalous samples – for instance only those consecutive months where no burials at all are recorded due to under registration – would stand out clearly at the extreme ends of the distribution around the mean which would equal the series mean. However, in attempting this optimisation, we are forced to confront the fact that the distribution of burial counts change as the mean of the series increases. For St Mary, Newington we could choose a sample size that was very short as even the monthly counts are close to normally distributed. For Chawton or Great Hampden would need a much larger sample size but if we applied this large sample size to the St Mary series, we would miss many periods of abnormal activity as they would be averaged out.

We therefore need a variable sample size (i.e a sample for which the number of months included varies) which depends on the average number of burials per month within each series. Since this average fluctuates over time such that the distribution of burial counts in sub-periods of the same series may resemble to a greater or lesser degree the normal distribution, we also need the sample size to be sensitive to the particular point in time in the series from which the sample is to be drawn. Wrigley and Schofield propose calculating a moving average of the monthly burial count and then using this to find a sample size in months which is large enough to contain an absolute and fixed number of burial events. We will call this the event target. Since the event target is fixed, the sample size in months varies according to the level of the average. It can therefore very between series with different average numbers of burials per month and also over time within a given series as this running average changes. Since we need to evaluate all months in all series, a running sample is taken from the data with the size of that sample calculated by the running average and with every month passing through the sample as it progresses along the series. Wrigley and Schofield call this sample the test period. In a moment we will discuss the most appropriate size for the

[590] This proposition lies at the centre of the Central Limit Theorem which states that, regardless of the population distribution, the means of samples drawn from that distribution will be normally distributed, themselves with a mean equal to the population mean.

event target but first, I will explain how the running average was calculated in such a way as to minimise the effect of very short but extreme burial events.

LOWESS Regression.

Identifying anomalous burial counts using an average taken from the same data presents a circular problem. The very events we are trying to identify are likely to bias the average we need to use to identify them. My solution to this problem is to use a method designed to minimise the effects of outliers on the calculation of the average. This calculation is called 'LOWESS Regression' or 'locally weighted scatterplot smoothing' regression.[591] This procedure is implemented in Stata using the 'lowess' command, using the 'mean' option to produce the smoothed running mean.[592] Like ordinary least squares regression, the aim of this procedure is to calculate a fitted value for every point in the data set. However, instead of fitting a straight line through the whole dataset such that the distance from all actual datapoints is minimised, LOWESS fits straight lines to subsets of the data. Also, instead of weighting all distances between the actual and the fitted points equally, as is the case with OLS, LOWESS calculates different weights for each distance. It combines the fitted points from each regression performed on the different subsets of the data. Then a second round of adjustments are made to the resulting trend so the larger the distance between the fitted and the actual data point value, the less influence that data point will have on the final location of the trend line which connects the fitted values.[593]

The subsets of the data used in the first stage of the LOWESS calculations are defined with reference to a single 'focal' datapoint. A 'band width' is selected which determines the proportion of the data included in each subset and the process moves forward one data focal point at a time estimating the position of that focal point using all the closest data points to the focal data point so that the proportion of the total data points included is equal to the band width selected. The closer the data point to the focal point along the x-axis, the greater the weighting in the regression that is then performed. As the process moves along the data, one point at a time, a new regression line is fitted at every data point. The size of the band width thus influences the degree to which the resulting trend represented 'local' conditions in the data. Whilst the LOWESS calculation is very good at minimising single anomalous events, it is less good at overcoming the bias created by long runs of anomalies. To minimise their effect it is necessary to select a large band width so that whilst the closest data points will always be given the highest weighting, their overall influence on the positioning of each line will be minimised by the inclusion of data points which contain sound data but are further away. In the second iteration of the process, when many of the anomalous events have been identified and removed from the LOWESS calculations, we can lower the bandwidth so that the resulting trend more closely reflects 'local' conditions in the data.

[591] The procedure is set out in detail by Cleveland here: *Cleveland, W.* (1979). Robust Locally Weighted Regression and Smoothing Scatterplots Journal of the American Statistical Association 74(368), 829-836
[592] https://www.stata.com/manuals13/rlowess.pdf
[593] *Cleveland, W.* (1979). Robust Locally Weighted Regression and Smoothing Scatterplots Journal of the American Statistical Association 74(368), 830

Figure A.1.2. Example Test Period Distributions at Event Target of 5

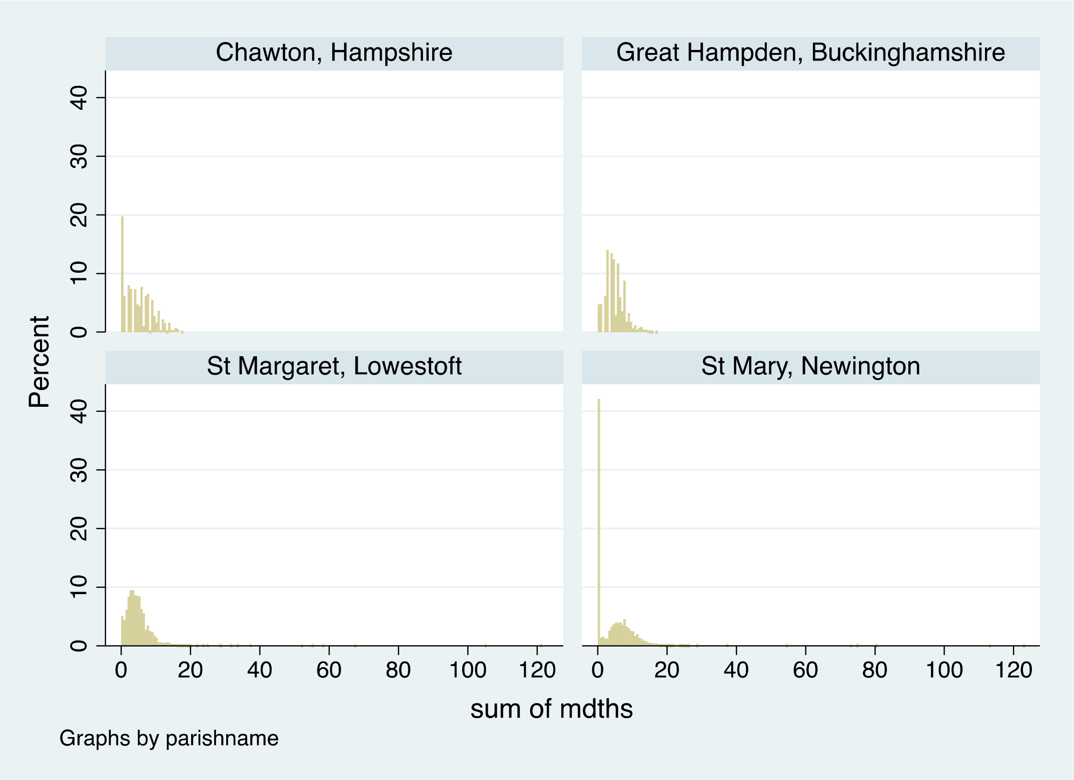


Figure A.1.3. Example Test Period Distributions at Event Target of 10

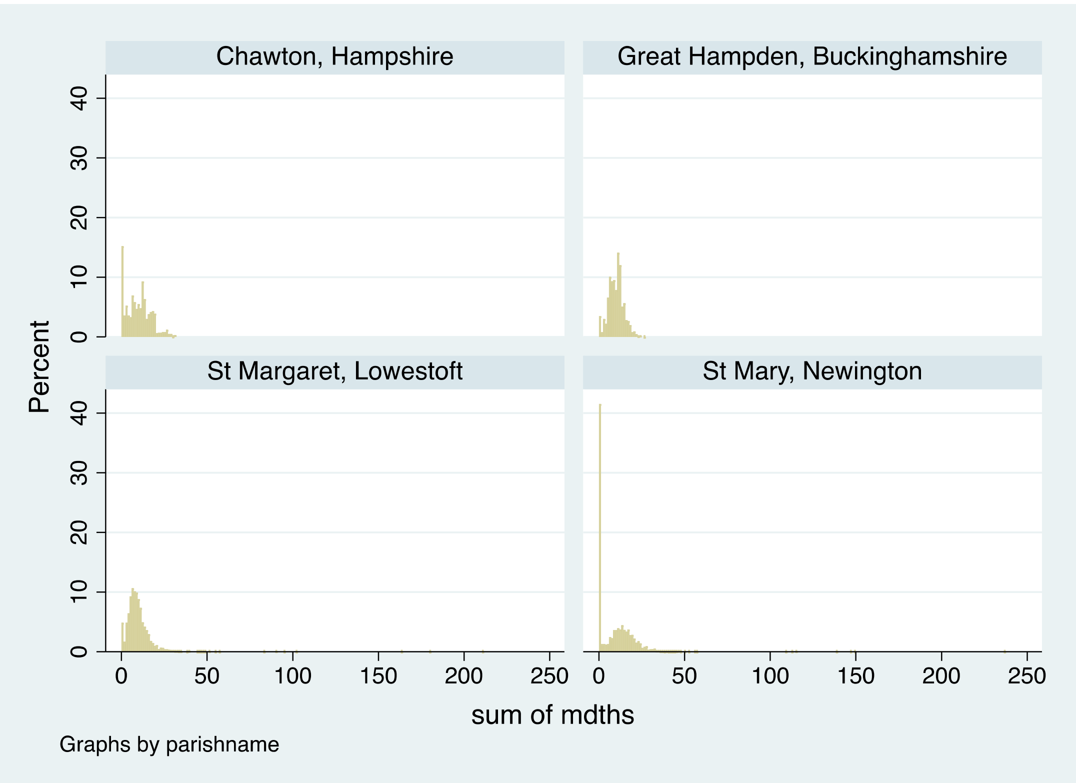


Figure A.1.4. Example Test Period Distributions at Event Target of 15

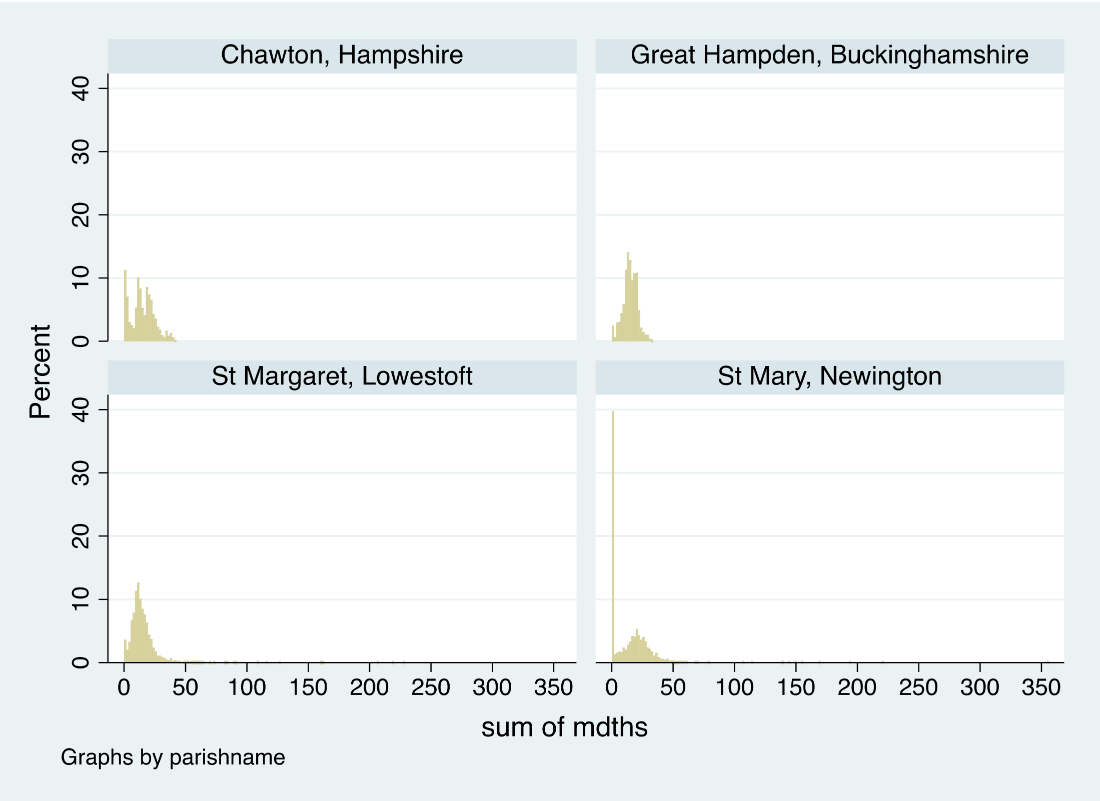


Figure A.1.5. Example Test Period Distributions at Event Target of 20

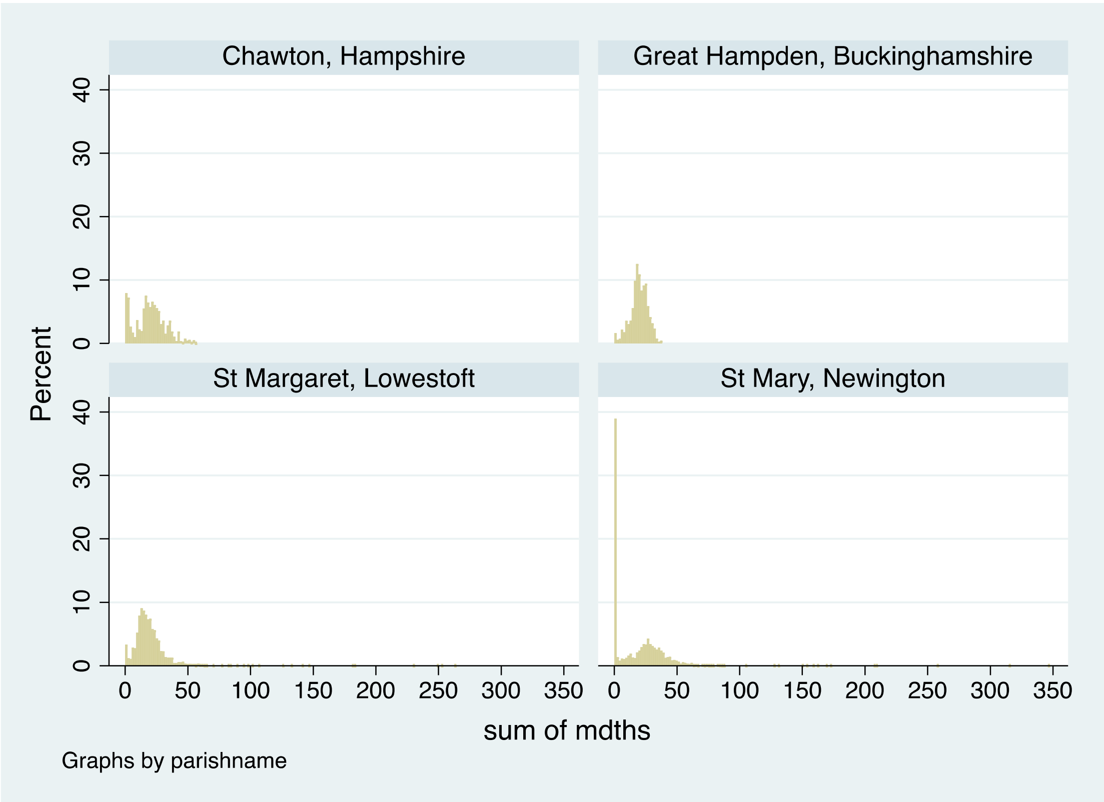
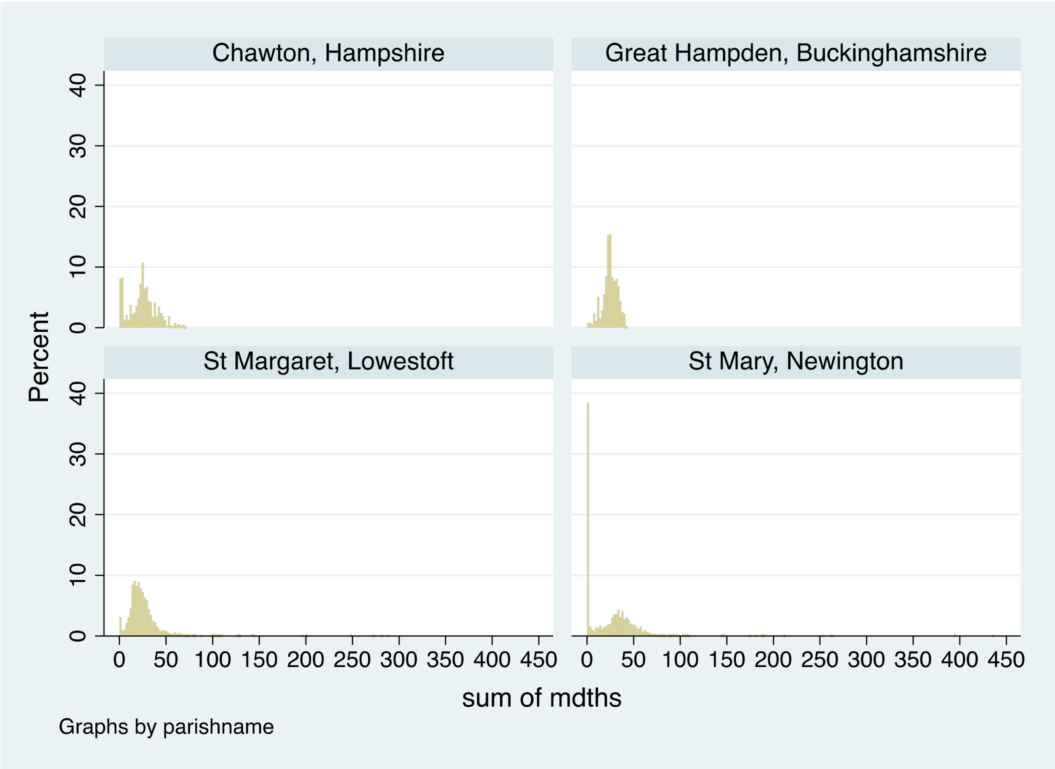


Figure A.1.6. Example Test Period Distributions at Event Target of 25



Selecting an Event Target.

The absolute event target divided by average monthly burials will provide us with the length of the test period in months. We can then advance one month at a time through each series, adjusting the test period size as trend mean burials change over time and recording the actual total number of burials found in each test period. As discussed, when deciding on an absolute event target, we are faced with a trade-off between false positives and false negatives. Ideally the target would be just large enough that the resulting totals approximate the normal distribution but not so large that we miss smaller runs of under registered data.

Figures A.1.2 to A.1.6 display this trade off visually by plotting histograms containing the totals taken from test periods of size 5 to 25 from four series from the FHS dataset. The series are in size order from the smallest, Chawton in Hampshire, a small village, to the largest, St Mary Newington, a London suburb. They cover the whole range of sizes in the FHS dataset with the median series size being closest to Great Hampden in Buckinghamshire. In all cases, I ran a LOWESS regression for the series with a bandwidth of 90% in order to calculate the expected number of months in a test period.
As the target increases from 5 to 25, the distributions of the test period totals converge to normal distributions. This process is slowest for the series with the smallest number of burials per month, Chawton. At a target of 5, the Chawton distribution is still markedly right skewed. However, by the time we reach 25 the series is normally distributed.

Increasing the target also reduced the proportion of test periods that return extremely low totals, at or near zero. Twenty percent of the Chawton distribution is comprised of zero totals at a target of 5 but only 7.5% at 25. The same can be seen in the other series as well. The larger the target, the longer the estimated test period size with a given mean. Thus, the less likely that the period of under registration is long enough to fill an entire test period and the more likely it will slip through unnoticed. That said, those test periods which still return a total at or near zero can be more confidently identified as under registered. Conversely, with a lower target, we should be less confident in the task of distinguishing between test periods with low totals that are the result of normal random fluctuations and those which are caused by other exogenous factors.

Figures A.1.2 to A.1.6 suggest Wrigley and Scofield were correct in choosing an event target of 20. This appears to be the lowest point at which all the series have converged to approximately normal distributions. We will thus follow them in selecting 20 as the event target here as well.

Finding the Z-Score Parameters.

The distributions in figure A.1.5 all contain some evidence of abnormal burial activity, at both the upper and lower extremes. This is most apparent in the case of St Mary Newington where almost 40% of test period totals equal zero and the largest test period total equals almost 350. The other three distributions also contain evidence of periods of abnormal burial activity though this is least apparent for the Great Hampden series.

Ideally, to identify periods of under registration, we would want to know the properties of these distributions in the absence of extreme test period totals. If we could know this, the mean of each series should equal the target level of 20. This is because we have defined the test period in such a way that on average it will contain 20 events. We cannot predict in advance what the standard deviations of these series would be. If we could, we would then be able to calculate z-scores for each test period total which would reveal how far from the mean each total was in units of standard deviations. We could then use these scores to identify instances where the test period total was so abnormally low or high that it falls within the range of events that could only be expected to occur 1% of the time. This would correspond to all events that fall more than 2.575 standard deviations either side of the mean.

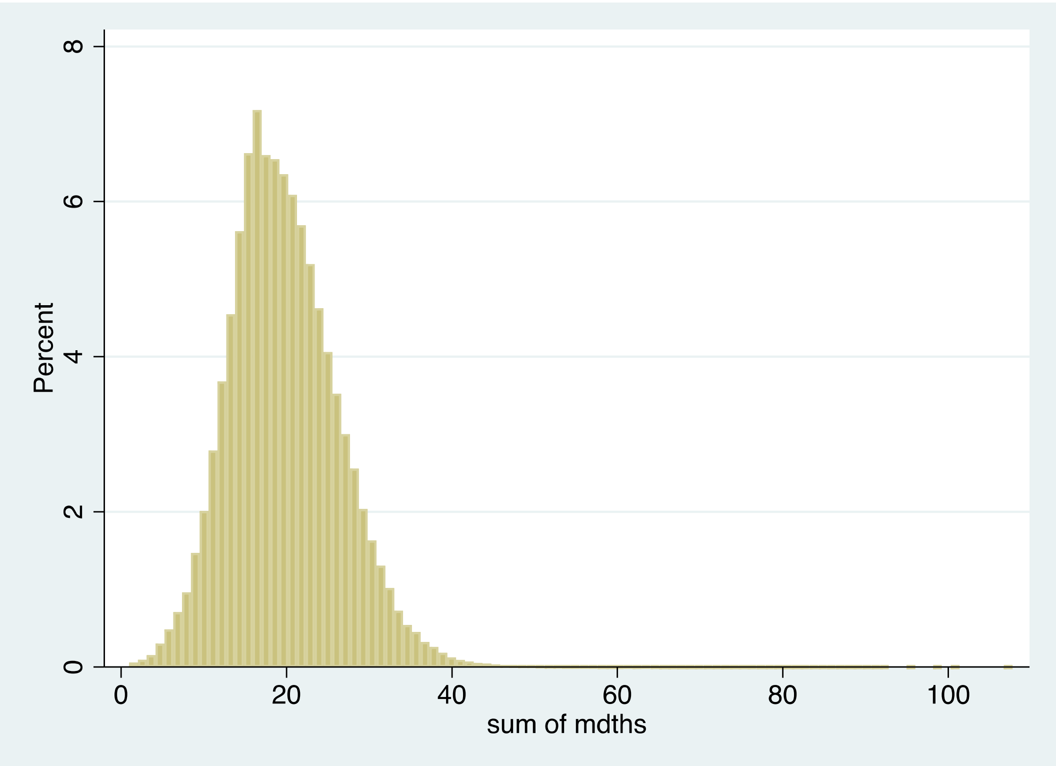
Any test period total with a value that is more extreme than this could be identified as a period in which burial activity could be said with high confidence to be anomalous. We cannot use the actual standard deviation of each series distribution in the FHS dataset because these are biased by the very totals we wish to identify as anomalous. Wrigley and Schofield tackled this problem by taking samples from a large number of parish register series of varying sizes. They found that the distributions of test period sums had standard deviations that were all around 6.5, regardless of the size of the series.[594]

[594] Population history, 701

To confirm this result, the series that comprise the full FHS dataset were whittled down using two fields of information. First, a series was only included if it contained at least 150 years of active data. Then, the proportion of active months with a zero burial count was calculated for each series and plotted against the average number of burials in that series. The correlation between these two statistics was found to be very high (0.94) so a series of local regressions were used to provide a constant and coefficient that could in turn be applied to the average burials figure for each series. Those series which contained a greater proportion of zero burial counts than would be predicted given the level of average burials were dropped.

Test periods were then calculated for the 611 parish burial series which remained. Any series that was found to contain a test period with a total of zero was then dropped from the data as we can say with some certainty that this suggests under registration. The standard deviation of the test period totals for all remaining series was then calculated and any series which was found to contain more than the average number of test periods that sat outside the lower and upper 99^{th} percentile (2%) were also dropped. These steps resulted in only 193 of the highest quality parish burial series remaining. Figure A.1.7 presents the distribution of all test period sums for the 193 series combined. The mean of the distribution is 19.8 and the standard deviation is 6.6. This is almost exactly the same as that found by Wrigley and Schofield. It seems sensible, therefore, to use these figures in the calculation of test period z-scores for the whole FHS dataset.

Figure A.1.7. Test Period Sums from the 193 Highest Quality Series in the FHS Dataset



Identifying Abnormal Test Periods.

We can now proceed as if we do know what the standard deviations of each constituent burial series would be in the absence of abnormal burial activity. The standard deviation derived from the high quality FHS burial series will stand as an approximation for the true figure and, as I pointed out above, we know the true mean of these distributions will be 20 since we defined them in such a way that this would be the case.

The aim is to identify test periods for which the actual sum of burials lies beyond the bounds of what would be expected in all but the most unusual of circumstances. Here we will define this to mean the actual total will be either so high or so low that it would only be expected to occur 1% of the time. If a test period total is found to fall more than 2.575 standard deviations from the mean it will be identified as unusual.

Each month that comprises a suspect test period must also be identified as suspect. We have no more precise information at this stage which will allow us to identify months of sound and unsound burials within a test period which has been flagged. Table A.1.1 presents the results of this process for the four example burial series we have been using so far. The table suggests a high proportion of months in the Chawton and the St Mary Newington series have been identified as suspect (37% and 54% respectively).

Table A.1.1. Proportion of Months Within Test Periods Identified as Suspect in First Iteration

Series Name	*% of Months in Suspect Test Periods*
Chawton	37%
Great Hampden	5%
St Margaret, Lowestoft	16%
St Mary, Newington	61%
Total	29%

The similar outcomes of these two series were not caused by the same process. The high proportion of months identified as suspect in these two parishes reflect not only the distribution of test periods but also their length. For small parishes the proportion of months identified will be greater than for larger parishes with a similar proportion of suspect test periods because their test periods are so much longer. In this example, St Mary has an average test period length of 3 months whereas the Chawton test periods are on average 110 months long. It might be that a high proportion of the months within the Chawton test periods which have been identified in fact contain sound registration.

We must now attempt to isolate the exact months in which burial activity was abnormal. Ultimately the aim is to run a second iteration of the LOWESS process which does not consider those months which the first iteration has found to be suspect. The second LOWESS trend should therefore follow more closely the path of the hypothetical average burial trend which is unbiased by any abnormal burial counts and thus, the second round of evaluating test period totals should be more accurate since the trend used in calculating the test period lengths is less adulterated. The second LOWESS calculation should follow the true trend more closely when the maximum amount of data is available along the series. Excluding all months that comprise test periods with abnormal totals from the second LOWESS calculation means potentially excluding many months of reliable data and from consecutive runs of months. In the case of Chawton, a third of the data points would have to be excluded from the second round. Thus, it is important that we search inside the suspect test periods to try and identify the exact months which contain abnormal burial counts and which months can be left in the second round of the LOWESS calculations.

From Test Periods Back to Months.

The process of identifying months within test periods that actually contain abnormal burial counts immediately leads us back to the problem we originally faced when approaching under registration. Once we return to evaluating the data as monthly counts, we can no longer rely on the assumption that the data is normally distributed. As we have seen, the data drifts away from normality as we reduce the size of the test period to the point where the length of the test period is equal to a single month. At this stage, only the largest burial series remain normally distributed, most have become severely right skewed.

Wrigley and Schofield attempted to overcome this by reducing the size of the test period in stages. This would ensure only sections of data that as a whole appear unusual will be evaluated when the size of the test period is reduced. At each stage only the months previously identified as suspect were grouped into sub periods and evaluated. This process was repeated until the sub periods for all series had reduced in size to the length of one or two months long.

The same general approach was taken here but some adjustments were made to the rules applied. Following Wrigley and Schofield, the sub periods were defined to be a third of the length of the test period in question. The sub period at each stage is a third of the size of the previous one until it is either 1 or two months long. The maximum number of rounds it takes to reduce sub periods to this size is four because the upper limit on the size of a test period is 120 months. The sub periods cannot be expected to contain 20 events so the average number of burials within the sub period was divided by the LOWESS trend of average burials to produce a ratio which, if we were using full test periods, would be normally distributed with a mean of 1.

Different rules were applied to upper and lower tail events. The threshold for the upper tail varies with the size of the sub period and the size of the underlying series. As the sub periods decrease in size, the ratio becomes more volatile. At the same time the ratio is always more volatile for smaller series. By the time all sub periods are either one or two months long, the standard deviation for the ratio is 2 for Chawton and only 1.3 for St Mary, Newington. This means it is impossible to select a fixed threshold above which the sub period is identified as extreme. Instead, the threshold varies. With each iteration the threshold increases, beginning at 2.5 for the first sub periods and progressing to 10 for the fourth sub periods. However, since it takes only one or two rounds for sub periods in the large series to decrease to a size of one or two months and it takes up to four rounds for the smallest parishes, the test periods for the smaller parishes are subjected to a higher threshold. The upper threshold thus adjusts for differences in the size of each series and ensures only the most extreme events are identified.

The threshold for the ratio at the lower tail also varies with the size of the sub period and the level of average burials in each series. The mechanism is the same for the lower tail as the upper: the more rounds needed to return the test period to individual months, the more stringent the threshold beyond which the period in question is identified as anomalous. This is especially important for the lower threshold because as the sub periods represent a smaller and smaller fraction of the original test period, the distribution is becoming more skewed towards low and zero values. The threshold for the first sub period is set equal to the threshold for the test period - 2.575 standard deviations below the mean or 0.5% confidence interval. By the fourth iteration, the threshold is equal to the 0.25% confidence interval or 2.81 standard deviations below the mean. The standard deviation was taken from the distribution of the ratio of the test period average to the LOWESS average in the 193 high quality series used earlier.

The results of this exercise are set out in table A.1.2. This shows that for all series the proportion of months suspected of containing extreme burial counts is lower than in table 1. Overall, the decline was from 29% to 20% with all series experiencing some reduction in the proportion of months identified as anomalous. This was particularly so for Chawton where 40% of the months contained within anomalous test periods were then rejected by the subsequent process and were judged to contain reliable burial counts.

Table A.1.2. Proportion of Months Within Final Test Sub Periods Identified as Suspect

Series Name	*% of Months in Suspect 4th Sub Periods*
Chawton	22%
Great Hampden	4%
St Margaret, Lowestoft	9%
St Mary, Newington	44%
Total	20%

The Second Iteration.

The whole process could then be repeated, the only difference being that the LOWESS average burial trends are calculated with the months identified as containing extreme events having been removed. The gaps this created in the trends were filled by interpolating the data. A lower band width (40% instead of 90%) was used in the second iteration so that the trend more closely reflected the local average of monthly burial counts. This was possible because the effects of extreme events had been removed. The test period lengths were then recalculated, generally becoming shorter as the bias caused to the LOWESS trends by under registration was much greater that the bias caused by burial peaks. All subsequent stages of the process set out above were then repeated. The results of the second iteration are set out in table A.1.3 this time I have taken the further step of separating out the months identified as burial peaks and those identified as burial troughs (periods of under registration).

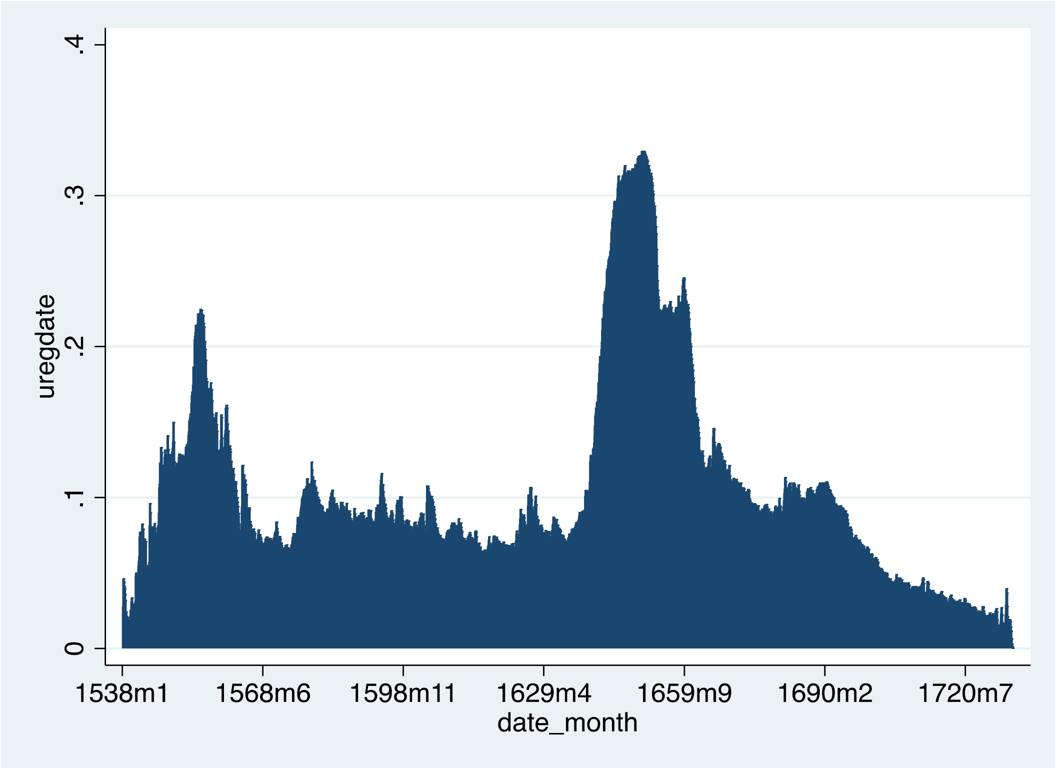
Table A.1.3. Proportion of Months Within Final Test Sub Periods Identified as Containing Either Peak or Trough (Second LOWESS Iteration)

Series Name	*% of Months Burial Peaks*	*% of Months Burial Troughs*
Chawton	0.0%	21.8%
Great Hampden	0.0%	4.4%
St Margaret, Lowestoft	0.3%	7.5%
St Mary, Newington	0.9%	41.6%
Total	0.3%	18.5%

The most striking thing about table A.1.3 is just how similar the overall proportions are to table A.1.2. Only in the case of the larger parishes did the second iteration affect the identification of anomalous months and even then, the effect was small. This suggests the abnormal counts in the data used to calculate the first LOWESS trend did not bias the positioning of the trend sufficiently enough to have a material impact on the identification of those abnormal periods in most cases.

We can also see from table A.1.3 that the vast majority of months that were flagged contained counts deemed to be under registered. Burial peaks represent only a tiny fraction of the total in all cases. It is also interesting to note that the proportion of burial peaks increases with the size of the parish, as we might expect. Whilst the burial peaks will be returned to the data, the periods of under registration can now be removed (replaced with a blank value).

Figure A.1.8. Proportion of All Active FHS Registers with Under Registered Burial Counts by Month, 1538 - 1730



Appendix 2

Distinguishing Plague Outbreaks from Other Mortality Crises

In investigating the history of a disease, one immediately faces the problem of accurate diagnosis at a distance of three to five hundred years. Monthly burial totals reveal peaks in the levels of mortality, but how can I tell whether these were caused by plague or some other factor in the absence of accurate written testimony or recovered DNA samples?

Addressing this problem is important because there are many other reasons why burials in a given month and parish may run higher than normal, even during periods of national outbreaks like the ones I am studying. If I am to investigate the incidence, severity, and patterns of plague dispersion, I must be sure that I have minimised the number of false positives I pick up for inclusion in my analysis. I say minimise because whatever approach I choose, I will never be certain that any individual outbreak was chiefly the result of plague. My aim is more realistic: to create samples of events for which I am satisfied the vast majority are mortality crises where the main causative agent was bubonic plague.

Defining Plague

Historians traditionally used contemporary diagnoses to identify epidemics for which plague was responsible. Recently, the refinement of DNA analysis techniques, which analyse dental pulp from plague skeletons, has revealed the causative agent responsible for these outbreaks was *Yersinia pestis* – the pathogen known to modern science as the cause of plague. When comparing these cases, a number of regularities in the burial data emerge with respect to the mortality rate, the seasonal incidence of mortality, and their duration. Below, I will set out a quantitative plague identification system which relies on these three dimensions of mortality crises to detect plague epidemics in the national parish register dataset.

Before I do, I should note *Yersinia pestis* can cause three different forms of plague which might lead to different mortality patterns. The most common and well known is bubonic plague. There are also pneumonic and septicaemic forms of the disease. Neither of these forms are likely to have occurred in the absence of bubonic plague. Both are associated with case fatality rates of nearly 100% and much shorter incubation periods. Like bubonic plague, transmission of the septicaemic variety requires ectoparasite vectors. The main types of vector responsible for plague transmission in the early modern period is a very controversial topic but it is likely both rat fleas and human fleas or lice were responsible. Pneumonic plague is caused by a secondary infection of bubonic plague in the lungs which can lead to the presence of *Yersinia pestis* in airdrops which are breathed out of the victim. Pneumonic plague can therefore spread without the need for a vector.

The Dimensions of Plague Epidemics

There are many reasons for burial totals in a given month to be higher than usual. These range from local accidents – a shipwreck, for instance – to the contamination of a local water supply to the arrival of one of the major causes of death outlined in table 1. For series where few burials occurred each year, chance variations could also be responsible. My plague detection system is designed to ignore all but the most serious of these perturbations. It does this by setting a threshold which will only be met if the burial totals for a given month can be designated as unusual with 99% confidence. Burials are assumed to follow a Poisson distribution.[595] A trailing average for the three months centred on the month in question is calculated for the four previous years. Using this figure as a rate parameter, it is possible to ascertain the value that equates to the 95th upper percentile of that distribution. The actual burial total for the month in question is then compared with this threshold. An alternative approach is to compare burials in a given month directly to a mean. Using a threshold derived from a Poisson distribution is preferrable because it accounts for the way the distribution of burials changes in association with the volume of burials recorded. Comparisons between parishes with different size populations should therefore be more reliable.

Outbreaks of smallpox and the sweating sickness probably exerted an effect on total monthly burials that was too small to meet the threshold described above. So, in all but the most extreme cases these events will be ignored. In any case, the sweating sickness was most active before the period under investigation and smallpox was only gaining its notoriously high virulence towards the second half of the 17th century. However, a glance at table A.2.1 (at the end of appendix) shows this is not the case for the other causes outlined there. Plague was one of the most severe diseases in the early modern world but outbreaks of typhus and influenza, could certainly produce mortality events that were more extreme than some plague outbreaks.

Plagues cannot be distinguished by their severity alone. Though the pool of potential causes can be narrowed further by considering the number of consecutive months over which a crisis lasted. Influenza and dysentery, in particular, are known to produce sharp increases in mortality that have only a short duration. The crises for which these diseases were responsible lasted no longer than a month in most cases. Outbreaks of bubonic plague almost always lasted longer. It was typical for plague activity to continue for three or four months at a level that would meet the crisis threshold outlined above. The full length of the epidemic, including the growing and declining activity associated with its beginning and end, could range from six months to two years. So, my detection system ignores all crises that lasted less than two months. The months either side of crisis months are subsequently evaluated using a threshold which is set at the 75% confidence interval to capture the full shape of the mortality event.

[595] Cummins et al, *Living Standards*, 16; Hinde, *Review*, 82–92. Since this assumption does not hold perfectly, it was also necessary to apply an absolute minimum threshold of 3 burials to prevent false positives caused by small and volatile series.

These steps should limit the number of crises caused by diseases such as influenza, but they will not affect other potential explanations such as typhus and harvest failures. Typhus could persist for a number of years; the mortality associated with harvest failures could continue for as long as long as crop yields were depressed by the weather. What differentiates these causes from plague is their seasonal timing. Epidemic typhus is most active in cooler weather. This is because it is transmitted by the human louse which lives in the greater quantity of clothing worn in the winter and is transmitted most easily when people gather close together - to stay warm, for instance. Mortality associated with harvest failures displays less consistent seasonal patterns. This is partly because the relationship between dearth and mortality is mediated by a number of factors which may differ over time and space. It is also because the effects of harvest failures can change with attempts to alleviate the dearth through grain importation for instance. This makes systematically excluding harvest failures difficult. However, the introduction of the poor laws meant the relationship between poor harvests and large-scale mortality was effectively broken between 1600 and 1650, therefore reducing the potential for identifying them in the later part of the parish register dataset.

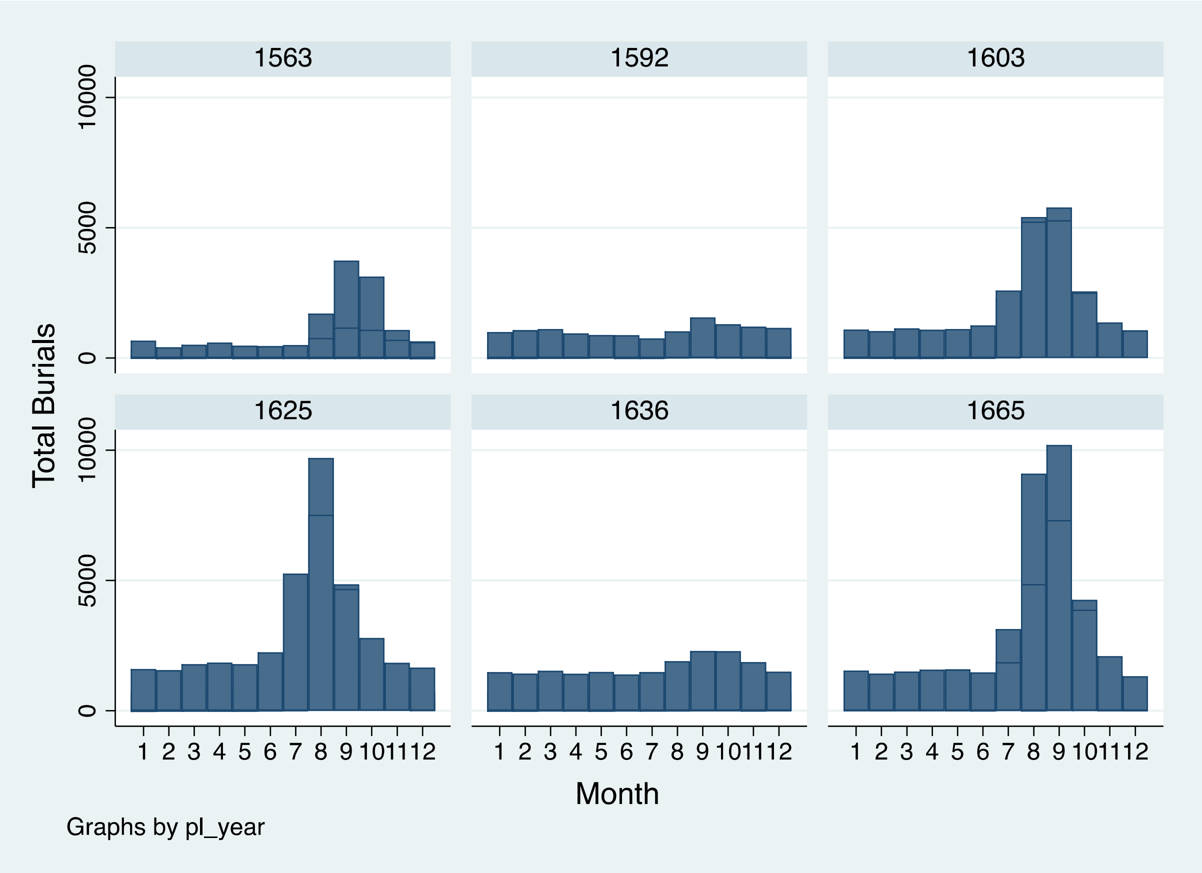
Plague outbreaks have a very typical seasonal mortality pattern. Both Shrewsbury and Slack provide numerous examples of the seasonality of mortality crises that were identified by contemporaries as plagues. Mortality almost always begins to increase in the spring or summer and reaches a peak between July and October. Shrewsbury argued that if more than half the burials occurring during a crisis took place between June and October, bubonic plague was likely the culprit and if more than two thirds of burials could be attributed to the period between July and September, the crises was 'almost certainly' caused by plague.[596] Shrewsbury's argument is supported by figure A.2.1 which shows the total number of burials recorded each month during the peak years of six major plague outbreaks. This includes all data I have available currently and includes London, though the same pattern exists if London is excluded. September is the month of peak plague activity in all cases apart from 1625 when the August total was higher. Each epidemic reflects the same seasonal pattern at the national level. Taking all six plagues together, I find 59% of burials occurred between July and October. Looking at 1625 alone (since it peaks a month earlier), I find 63% of burials occurred between July and October. Whilst individual plague epidemics did not always follow this pattern, the vast majority did.[597] My plague detection system therefore ignores outbreaks where 50% or more of total burials do not occur between July and October.

Together, the severity, duration and seasonality criteria – as well as the focus on years in which plague was most active – should minimise the number of crises wrongly identified as plagues in my subsequent analysis. Nevertheless, I will also investigate a sample of crises identified as plagues in order to verify the majority are indeed plague outbreaks.

[596] See for instance: Shrewsbury, *History*, pp.175-178
[597] Eckert, *Structure*, 36-7

It is very likely other diseases were present during some local outbreaks and contributed to the burial totals. This could have produced mortality patterns which no longer resemble those typical of plague. However, the case-fatality rate of plague and its efficiency of transmission were both high enough to ensure the effects of plague were not often obscured by other diseases. Whilst I acknowledge other diseases would have been present in some cases, for the sake of brevity I will refer to outbreaks that meet the quantitative criteria for a 'plague' as a plague outbreak only.

Figure A.2.1. Seasonality of Burials in 6 Peak Plague Years Using Unadjusted Full Dataset



Validation: Plague Burials in the London Bills, 1644 – 1679

The plague detection system uses severity, duration, and seasonality characteristics of mortality crises to identify plague outbreaks in the aggregated parish register data. Yet the dataset itself provides no means for testing the accuracy of this approach. How successful is this approach at capturing genuine outbreaks of plague (sensitivity)? In what proportion of cases does the detection system identify plague when the true cause lay elsewhere (false positives)? These questions are central to my research approach. The validity of subsequent analyses of plague outbreaks rests on the accuracy of the system designed to identify them.

The London Bills of Mortality provide an excellent source for validating my detection system.[598] The data is available at the parish level for all London parishes from 1644 to the disappearance of the plague 1679 and contains information on cause of death. The bills were first established in order to detect plague outbreaks early so plague is the most consistent cause of death category they contain.[599] I aggregated the weekly bills data into monthly form. Then, I linked all London FHS data to the parishes for which the bills provided information. The result is a dataset containing time series running from 1644 to 1679 for 90 London parishes. Average burials per month for the parishes in this dataset ranges from 4 (St Leonard's Eastcheap) to 137 (St Giles Cripplegate) with a median of 10 (the median for the national dataset is 7).

The bills are by far the most comprehensive source of cause of death data available for early modern England. Even so, they certainly do not provide a perfect record of plague mortality. I will briefly note their shortcomings. The total number of plague burials recorded during major outbreaks is probably an underestimate of the true levels of mortality. This is because parish clerks in some parishes became overwhelmed by the huge numbers of burials they had to process.[600] However, this is not a critical problem for my approach because I am concerned with whether or not the plague was present, not the total number of people who died of the disease in a given month.

More concerning is the level of diagnostic accuracy reflected in the data. Many scholars have questioned the medical abilities of the searchers responsible for informing parish clerks of the cause of death.[601] Though, the high correlation in plague mortality between London parishes suggests a general agreement between the searchers responsible. More problematic is the practice of purposefully misdiagnosing burials in order to circumvent the regulations associated with plague, most importantly household quarantine. Later I will show this was indeed occurring in London. Still, enough burials were correctly diagnosed as plague deaths for this approach to allow for an evaluation of my plague identification system.

How successfully do severity, duration and seasonality predict the presence of plague in the monthly burial totals for 90 London parishes between 1644 and 1679? To begin I will define plague as active in the bills if at least one plague death is recorded for a given month. The results are outlined in table A.2.2. There are 998 months for which plague was active in the bills data across all parishes. Of those, the identification system found 435 or 44%. Initially, this seems disappointingly low. However, of the 563 plague months that were not identified, 300 contained only 1 plague burial. The system was designed to identify epidemic plague,

---

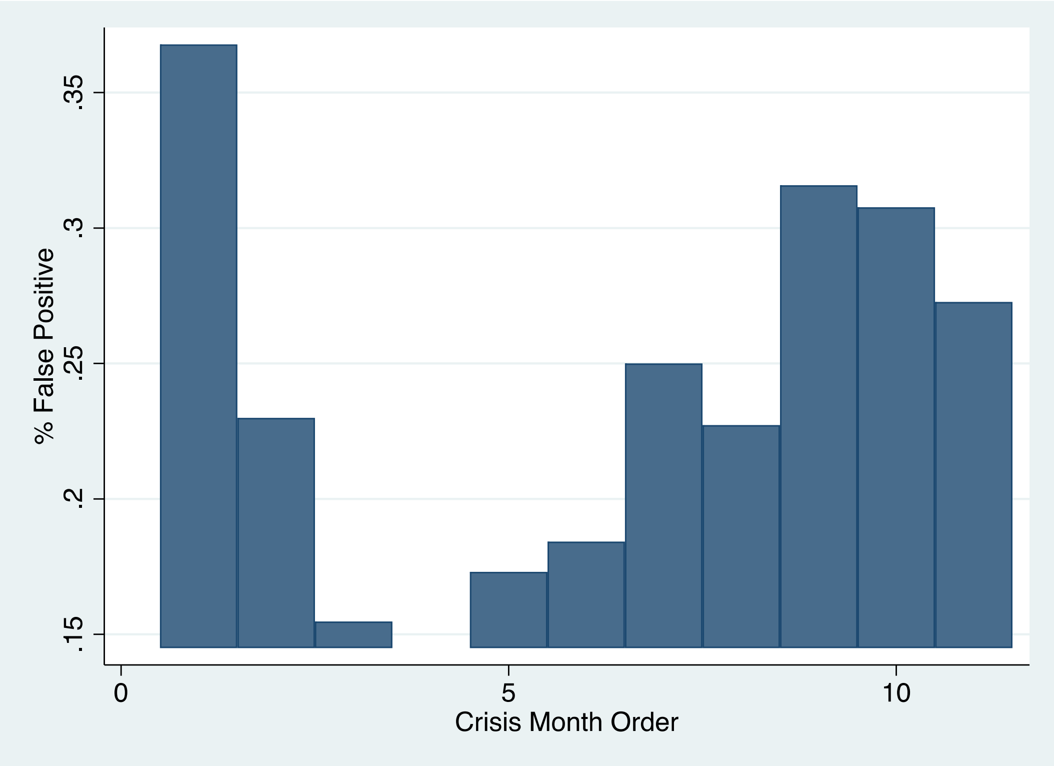
[598] I have used the weekly, parish level bills data that Campop recently deposited with the UK data service. A link is available here: https://beta.ukdataservice.ac.uk/datacatalogue/studies/study?id=854104
[599] Slack, *Impact*, 202
[600] Cummins et al, Living Standards, 8; 18
[601] Champion, *London's Dreaded*, 23-4

not low level and isolated events so it is reasonable to ignore these plague burials, assigning them instead to the non-plague category.

The results have been presented again in table A.2.3 but this time only instances where more than one plague death occurred are treated as plague months. This change reveals the identification system is more reliable than it originally appeared. Sixty percent of all months witnessing more than one plague burial are identified by the system. That said, 36% percent of the months identified appear to be false positives – i.e. months where no plague was recorded. This leads us back to the problem of misdiagnosis in the bills data. In table A.2.4, I have divided the false positive months from table A.2.3 into two categories, those that represent one month of a larger crisis for which the main cause of death is plague and those that are part of crises where no plague at all was present according to the bills. This table shows 56% of false positives belong to the former category. They have been picked up by the identification system as part of a wider plague crisis despite the bills showing no evidence of plague for that month specifically.

It is very likely the extremely high crisis mortality in these 'false positive' months was in fact caused by plague and that misdiagnosis explains why the bills themselves show no evidence of plague activity. Figure A.2.2 represents one way this claim can be substantiated. The chart plots the proportion of false positive months found for each monthly position in the crisis sequence. A proportion is used to control for the changing (diminishing) number of months in the sample as the crisis order position increases. The chart shows two things. First, the first month of a plague outbreak was by far the most likely month to show no plague burials despite total mortality in the parish registers rising to crisis levels. For months 2 onwards, the average proportion of false positives was 21% for the first month it was 38%. Plague burials were disguised at the start of an epidemic probably in order to circumvent plague regulations for individuals and perhaps to prevent restrictions for the parish as a whole.

Figure A.2.2. % False Positive Months vs Crisis Month Order for All True Plague Crises, 1644 - 1679



The second point I would like to raise on the basis of figure A.2.2 is that false positives were lowest for the months that typically fell in the middle-to-end of epidemics. The median crisis length is 5 months (mean 6). For month 4, no false positives at all were found and for months 3 to 6, inclusive, the average proportion of false positives was only 16%, below average (21%). After position six, the figure starts to rise again perhaps for the same reason as it is high at the start but also perhaps because apathy towards official record taking became more common. It is also interesting to note total burials were 7% lower in the parish registers than the London bills when taking all plague months into account. Though for ‘false positive’ months the totals in the parish registers are 37% higher than the bills. Burials were omitted from the bills entirely, not just reclassified as deaths attributable to other causes. This deeper investigation suggests many of the false positive months that form part of broader plague crises were, in reality, also caused by plague.

Assuming these false positive months do represent hidden plague months, the evaluation of the plague identification system I presented in table A.2.3 needs further adjustment. Table A.2.5 reassigns the false positive months which formed part of larger plague crises to the true, positive cell (bottom, right). As a result, the rate of genuine false positives falls from 36% to 16% and the sensitivity rate (% of true events, found to be true) rises from 60.7 to 78%. The plague identification system actually performs very well. It identifies the overwhelming majority of serious plague events and it does this without acquiring intolerable levels of false positives.

Identifying plague in settlements outside the capital

For London parishes, then, the plague identification system is very good at identifying plague months. How well does the system work in non-metropolitan parishes? To test the plague identification system in these parishes we need an independent source of information for the incidence of plague outbreaks. Bills of mortality almost never survive for parishes outside the capital in early modern England.[602] Instead, one can only rely on scattered contemporary references to the presence of plague which can be found in sources such as diaries, state papers and in the margins of parish registers.

Collecting together incidence information from these sources provides a sample of plague events against which I can evaluate the positive predictive power of the plague identification system. However, since all such information only reveals when a plague outbreak occurred and not when they failed to occur, it is not possible to test the negative predictive power of the identification system. I cannot distinguish between the true absences of plague from a particular location at a particular time and the absence of comment about plague in the historical record. When evaluating the plague detection system using only positive data, one must remember a trade-off between false positives and false negatives still exists. So, I should be cautious about adapting the system to maximise its sensitivity when the extent to which the false positive rate is increasing is unclear.

The qualitative data used here is taken from J F Shrewsbury as well as from comments and notes associated with parish register data provided to this project by a number of family history societies. The resulting sample includes 78 settlements which are identified as having witnessed a plague outbreak between 1663 and 1667 and for which monthly parish register data is also present in the FHS dataset. Table A.2.6 contains a breakdown of this sample. The under-registration algorithm flagged 11 settlements in the sample for having defective registration during the period where an epidemic is known to have occurred. These places include Braintree and Colchester which are known to have suffered extreme outbreaks.[603] It is likely defective registration in most of these cases was the result of the epidemic itself.

It is often suggested breaks in registration during epidemics were the result of a clerk dying or fleeing. Yet, this explanation is hard to square in cases like Colchester where 8 of the nine parish registers are defective at the same time and the remaining register shows no sign of an epidemic. In most large towns a good number of registers continue even through the height of an epidemic. Bills of mortality survive for Colchester in 1665-6 and they reveal it suffered

602 Exceptions to this include Norwich and Colchester.
603 Slack, *Impact*, 106-7

one of the worst outbreaks witnessed anywhere in early modern England.[604] I would like to suggest the concurrent ceasing of registration across the city was the consequence of the policy of recording death totals in the bills. The registration process was continued, perhaps in abbreviated form, for the purposes of tracking the epidemic but the full registration was deemed unnecessary during this period of crisis.

I have removed the heavily defective registers from my sample. This leaves 67 settlements which were identified in the qualitative accounts. The detection system identified 34 of these or 51%. This is lower than the sensitivity score for the London parishes. One reason for this is the less rigorous standards I used for assigning a positive incidence value to the settlements in the sample. A settlement is defined as affected if there is at least one mention of a plague case in that place somewhere in the qualitative accounts. There are 11 instances (16%) in this sample where references to plague are not matched by any sign of an extreme mortality event in the parish register data, despite the registers being intact.[605] If I remove those cases from the sample, the sensitivity increases to 60%.

<u>Table A.2.1. Characteristics of Main Causes of Early Modern Mortality Crises</u>

Cause	Known Mortality Rates / Crisis mortality Ratios	Known Years of Activity in England	Length of Crisis	Seasonality
Bubonic Plague	V. Rarely CMR < 3[3] Av. CMRs 5-8[3] Case fatality c50-66%[4, 12] Mortality rates 15-50%		Simple: <1 yr[4] (Almost never < 3mths) Multi-modal: > 1 yr[4]	Peaks: July-October
Pneumonic Plague	c.100% case fatality		< 3 months[1]	Winter[1]
Typhus	Case fatality 10-60%, dependent on nutritional status[9] Bristol, 1643. Av CMRs: 3, max: 5[5]	1640s[2]	>1 year[13] Bristol, 1634 <3 months	Winter/ Spring[1] Associated with colder weather[13] Bristol: Sep/Oct
Sweating Sickness Arbovirus?[2]	Mild[2]	1485, 1507-8, 1517, 1551[2]	Short, max 14 days[2]	

[604] Doolittle, I G. "The Effects of the Plague on a Provincial Town in the Sixteenth and Seventeenth Centuries." *Medical History* 19, no. 4 (1975), 334
[605] Slack finds this to be the case 19% of the time in Essex in 1664-7. See *Impact*, 106

		1556-9 – called sweat, but separate and more deadly. Prob. Influenza + harvest crisis[2]		If influenza, then winter
Dysentery	S. dysenteriae, case fatality: 5-15%[8]		Short, c.1 month[4]	Summer/ Autumn[1]
Smallpox	Case fatality: 14-25%[10] Increasing case-fatality rate from 1630s onwards[14] Mainly children[14]	Late 16th century onwards, but esp. post-1650[7, 14]	Around 3 months[14]	Any, July, August most common in London (1670-99)[11] Usually, summer[14]
Harvest Failure	CMR = c.2[6]	Worst: 1587, 1597, 1623[2] Mortality impact reduced significantly after c.mid 17th century[15]	Most of year following harvest[6]	Winter/ Spring[2,6] (less pronounced seasonality)

References: **1** = Schofield, *An Anatomy*, 121; **2** = Slack, *Impact*, 70-78, **3**= Slack, *Impact*, 88-90, 102-3, 116, 121, 135; **4**= Eckert, *Structure*, 35-6; **5** = Slack, *Impact*, 121; **6**= Appleby, *Disease or Famine,* 420-22; **7**= Davenport et al, *Geography*, 76; **8** = Dekker, J. P. & Frank, K. M. Salmonella, Shigella, and Yersinia. *Clin Lab Med* 35, 231 (2015). **9**= Bechah, Y., Capo, C., Mege, J.-L. & Raoult, D. Epidemic typhus. *Lancet Infect Dis* **8**, 418-421 (2008); **10** = DAVENPORT, R., SCHWARZ, L. & BOULTON, J. The decline of adult smallpox in eighteenth-century London. *Econ Hist Rev* 64, 1290 (2011); **11** = Landers, J. & Mouzas, A. Burial seasonality and causes of death in London 1670-1819. *Popul Stud* 42, 66 (1988); **12** = Slack, Impact, 176; **13** = Raoult, D. *et al.* Outbreak of epidemic typhus associated with trench fever in Burundi. *Lancet* 352, 355-356 (1998) and Ming-yuan, F., Walker, D. H., Shurong, Y. & Qing-huai, L. Epidemiology and Ecology of Rickettsial Diseases in the People's Republic of China. *Clin Infect Dis* **9**, 823–840 (1987). **14** = Duncan, S. R., Scott, S. & Duncan, C. J. The dynamics of smallpox epidemics in Britain, 1550–1800. Demography, 30 (1993), pp. 405–23. **15 =** Kelly, M. & Gráda, C. Ó. Living standards and mortality since the middle ages. *Econ Hist Rev* 67, 358–381 (2013).

Table A.2.2. Identified Plague Months vs Those Found in the London Bills of Mortality, 1644 - 1679

Plague Month Identified	Plague Months in Bills		
	No	Yes	Total
No	17,032	563	17,595
Yes	200	435	635
Total	17,232	998	

Sensitivity	44%
Specificity	99%
Positive Predictive	69%
Negative Predictive	97%

Table A.2.3. Identified Plague Months vs Those Found in the London Bills of Mortality (>1 Plague Burial), 1644 - 1679

Plague Month Identified	Plague Months in Bills		
	No	Yes	Total
No	17,332	263	17,595
Yes	228	407	635
Total	17,560	670	

Sensitivity	60.7%
Specificity	98.7%
Positive Predictive	64.1%
Negative Predictive	98.5%
False Positives	35.9%

Table A.2.4. False Positive Months vs Inclusion in Larger Plague Crisis

Part of Wider Plague Crisis	False Positive		
	No	Yes	Total
No	0	100	100
Yes	407	128	535
Total	407	228	

Table A.2.5. Identified Plague Months vs Those Found in the London Bills of Mortality (>1 Plague Burial and Adjusted False Positives), 1644 - 1679

Plague Month Identified	Plague Months in Bills		
	No	Yes	Total
No	17,444	151	17,595
Yes	100	535	635
Total	17,544	686	

Sensitivity	78.0%
Specificity	99.4%
Positive Predictive	84.3%
Negative Predictive	99.1%
False Positives	15.7%

Table A.2.6. Breakdown of Results of Qualitative Accounts Based Validation Process, 1663-1667

Settlements in Sample	78
Identified as Affected	34
% Identified	44%
Severe Under Registration	11
% Identified (ignoring severe u.reg)	51%
No Crisis Detected	11
% No Crisis (ignoring severe u.reg)	16%
Category 6 Parishes	28
Category 6 Parishes identified	5
% Category 6 Identified	18%
% Category 6 Severe Under Registration	2
% Category 6 identified (ignoring severe u.reg)	19%
% Categories 1-5 identified	58%
% Categories 1-5 identified (ignoring severe u.reg)	71%

Appendix 3

Calculating the Bristol Population Size

To calculate the total population at risk in Bristol at the start of each plague epidemic, the average crude birth rate in the parish of Christchurch is applied to average baptisms recorded in all available parish registers. Then a multiplier that accounts for the proportion of the town's population which is missing from the sample is applied. The calculations are described in table A.3.3 below.

Two birth rates for Christchurch are averaged to limit the effect of short-term variations. The population of the parish in 1575 and 1602 were reconstituted by linking the communicants listed in the Easter tithe books to the parish registers of baptism and burial. The average number baptisms occurring in the five years ending in the Easter book year is divided by the reconstituted population. The same average fertility rate is used to calculate the population before each outbreak.

The crude fertility rate for Christchurch is then used to estimate the population size of the parishes for which average baptisms can be calculated from the parish registers. For 1575 and 1603-4, the sample parishes are the nine featured in this study plus St Ewen's. For 1565, the sample is smaller because the baptism registers for St Steven and St John the Baptist do not survive.

Two benchmarks are used to inflate the resulting estimates so that they represent the whole population of Bristol. The 1545 chantry returns show the number of housing people (adult householders) by parish. The 1696 marriage duty assessments provide an estimate of the population by parish. A multiplier can be calculated using both sources that allows for the baptism sample population to be inflated to account for the parishes for which registers are missing. In table A.3.3 the population estimates derived using both multipliers are shown as well as the average of the two. As the parish sample represents a diminishing proportion of the population over time, the true population was probably lower than the average in 1565 and higher by 1603.

These estimates for 1565 and 1575 are very close to previous estimates based on the 1523-7 subsidy assessments and the 1545 chantry returns, both of which suggest Bristol had a population of between 9,500 and 10,500 in this period.[606] However, the estimate of the population in 1603 is higher than Slack's estimate of around 12,000.[607] Slack's figure represents the city's population as recorded in a census of 1607 – directly after the epidemic – and makes no adjustment for the loss of life during the outbreak.[608] Adding the total death toll of 2,600 to the post-epidemic population size estimate leads to a pre-plague population

[606] Russell, J C. British Medieval Population. Albuquerque: University of New Mexico Press, 1948, 285; Hoskins, W. G. English Provincial Towns in the Early Sixteenth Century. *T Roy Hist Soc* 6, 1956, 5
[607] Slack, *Local Incidence,* 51
[608] Lattimer, *Bristol*, 34

size of 14,600.[609] This is too high because the city's population would have grown between the end of 1604 and 1607 due to in-migration. The estimate presented here implies population growth of around 1,100 people (8%) in two years.

Treatment of Common Surnames in Clustering Estimates

To address the problem of overmatching individuals with common surnames, a list of common surnames was created using all registers which contained the names of household heads. If two or more households within the same register shared a surname it was added to the list. This list reveals little that would surprise anyone with a knowledge of English surnames. The frequency of surnames like 'Williams' 'Welsh' and 'Hewes' could be interpreted as evidence of the many Welsh people who lived in early modern Bristol.

The next step was to remove all individuals with any surname on the list from the 27 plague burial samples. The list contains the 38 common surnames out of a total of approximately 560 unique names present across all 27 samples.[610] This means common surnames represent c.7% of the total surnames, though they are associated with 809 burials (22%) across all parishes and epidemics. The removal of these people will not bias the results if the true distribution of surname clusters among households with common surnames is the same as that for the rest of the population.

In the best cases, the register also contains additional information that allows us to relate an individual to their household. So, it is possible to create a second set of estimates of clustering which utilise all this information. These estimates can be used to check the accuracy of the surname-only approach. A comparison of the two reveals a relatively consistent set of estimates.

---

[609] For references for estimates of plague mortality for the whole town see footnote 33.
[610] It is difficult to ascertain the exact figure because many surnames have multiple variants but 560 is my best estimate. This is for all 27 samples combined.

<u>Table A.3.1 Social, Economic, and Political Characteristics of Bristol Parishes</u>

District	*Parish*	*Population (1696 Marriage Duty)*	*Hearths / Entry 1662*	*Political Elite (Later 17th century)*
Centre	**St. Werburgh**	**291**	**5.00**	**13**
Centre	**All Saints**	**278**	**4.60**	**7**
Centre	**Christchurch**	**710**	**4.60**	**8**
Riverside	**St Nicholas**	**1256**	**4.50**	**23**
Riverside	St Leonard	315	4.50	5
Periphery	St Augustine	1610	4.50	3
Riverside	**St Thomas**	**1544**	**4.30**	**14**
Centre	**St John**	**906**	**4.10**	**10**
Castle Precincts	Castle	1376	3.90	3
Centre	St Ewen	155	3.80	4
Centre	St Peter	995	3.70	8
Riverside	**St Stephen**	**1800**	**3.60**	**6**
Periphery	**St James**	**2885**	**3.60**	**3**
Periphery	St Michael	984	3.40	10
Periphery	**St Mary Redcliffe**	**1534**	**3.40**	**6**
Periphery	Temple	1593	3.40	5
Periphery	St. Philip & St. Jacob	1576	3.30	1
Centre	St Mary le Port	404	3.00	6
Population Total		20212	3.96	135
Sample Total		11204	4.19	90

Source: Bristol Hearth Tax, 1662-1673. (eds) Leech, R, Barry, J, Brown, A, Ferguson, C, Parkinson, E. British Record Society, vol. 135, Hearth Tax Series vol XI, 2018, 344-5

Note: ‘Political Elite’ = Aldermen and Common Councillors

Table A.3.2. Ratio of Adult to Child Burials in Four Parishes with Sufficient Data, 1565 to 1603-4

Parish	*Plague Year*	*Total Burials*	*Adults*	*Children*	*Adults/Children*
All Saints	1565	32	26	6	4.33
All Saints	1575	16	13	3	4.33
All Saints	1603-4	15	5	10	0.50
St Werburgh	1565	32	9	23	0.39
St Werburgh	1575	14	10	4	2.50
St Werburgh	1603-4	42	12	30	0.40
Christchurch	1565	97	66	31	2.13
Christchurch	1575	100	49	51	0.96
Christchurch	1603-4	73	30	43	0.70
St Mary Redcliffe	1565	202	60	142	0.42
St Mary Redcliffe	1575	203	57	146	0.39
St Mary Redcliffe	1603-4	288	138	150	0.92
Total	1565	363	161	202	0.80
Total	1575	333	129	204	0.63
Total	1603-4	418	185	233	0.79

Source: Bristol Archives, Parochial Registers: P.Xch/R/1/a, P.St MR/R/1/2, P.AS/R/1/a, P.St_W/R/1,

Table A.3.3. Calculation of Bristol Population Size, 1560 - 1602

	1560-4	*1570-4*	*1598-02*
Christchurch Crude Birth Rate	3.23/1000	3.23/1000	3.23/1000
Annual Baptisms (5-year av)	132	181	255
Estimated Sample Population	4,080	5,604	7,882
1545 Chantry Return Multiplier	2.00	1.64	1.64
1696 Marriage Duty Multiplier	2.38	1.79	1.79
Estimated Total Population Min	8,161	9,186	12,922
Estimated Total Population Max	9,715	10,007	14,076
Average Population Estimate	**8,938**	**9,597**	**13,499**

Source: Easter books: Bristol Archives, P.Xch/ChW/2/1-4; Bristol Archives, Parochial Registers: P.Xch/R/1/a, P.St_J/R/1/a, P.St MR/R/1/2, P.St_N/R/1/b, P.St_N/R/1/c, P.St_JB/R/1/a, P.AS/R/1/a, P.St_W/R/1, P.St_T/R/1/a, P.St_S/R/1/a; Chantry Returns: Russell, J C. British Medieval Population. Albuquerque: University of New Mexico Press, 1948, 285; Hoskins, W. G. English Provincial Towns in the Early Sixteenth Century. *T Roy Hist Soc* 6, 1956, 5; Marriage Duty: Bristol Hearth Tax, 1662-1673. (eds) Leech, R, Barry, J, Brown, A, Ferguson, C, Parkinson, E. British Record Society, vol. 135, Hearth Tax Series vol XI, 2018, 344-5

Table A.3.4 Total Burials in Each of the 27 Samples (Burials included in Surname Only Samples in Brackets), 1565-1604

Parish	*1565*	*1575*	*1603-4*
All Saints	32 (28)	16 (13)	15 (15)
St Werburgh	32 (22)	14 (11)	42 (35)
Christchurch	97 (76)	100 (83)	73 (60)
St John the Baptist	93 (85)	60 (46)	114 (96)
St Thomas	226 (194)	180 (138)	221 (158)
St Mary Redcliffe	202 (176)	203 (163)	288 (204)
St Stephen	170 (147)	173 (147)	236 (168)
St James	184 (138)	156 (124)	335 (237)
St Nicholas	129 (92)	145 (106)	169 (134)
Total	1165	1047	1493

Source: Bristol Archives, Parochial Registers: P.Xch/R/1/a, P.St_J/R/1/a, P.St MR/R/1/2, P.St_N/R/1/b, P.St_N/R/1/c, P.St_JB/R/1/a, P.AS/R/1/a, P.St_W/R/1, P.St_T/R/1/a, P.St_S/R/1/a

Table A.3.5. Surname Only Clustering Results for All Parish Samples, 1565 - 1604

Parish	*1565*	*1575*	*1603-4*	*Pre-1578*	*Absolute Difference*
Christchurch	18%	24%	72%	35%	37%
All Saints	39%	0%	60%	27%	33%
St John the Baptist	20%	28%	54%	25%	29%
St Werburgh	18%	0%	49%	12%	28%
St Thomas	28%	34%	50%	30%	20%
St Mary Redcliffe	27%	31%	35%	29%	6%
St Stephen	33%	31%	37%	32%	5%
St James	33%	31%	37%	26%	4%
St Nicholas	26%	28%	19%	27%	-8%

Source: Bristol Archives, Parochial Registers: P.Xch/R/1/a, P.St_J/R/1/a, P.St MR/R/1/2, P.St_N/R/1/b, P.St_N/R/1/c, P.St_JB/R/1/a, P.AS/R/1/a, P.St_W/R/1, P.St_T/R/1/a, P.St_S/R/1/a

Table A.3.6 Full Household Linkage Results for All Parish Samples, 1565 - 1604

Parish	*1565*	*1575*	*1603-4*	*Pre-1578*	*Absolute Difference*
Christchurch	33%	26%	58%	29%	29%
St Werburgh	22%	0%	40%	15%	25%
All Saints	59%	0%	60%	42%	18%
St Mary Redcliffe	21%	30%	35%	26%	9%
St Thomas	N/A	N/A	55%	N/A	N/A
St Stephen	N/A	N/A	41%	N/A	N/A
St James	N/A	N/A	29%	N/A	N/A
St Nicholas	N/A	N/A	27%	N/A	N/A
St John the Baptist	N/A	N/A	N/A	N/A	N/A

* N/A is used for cases where the registers do not allow for this type of analysis.

Source: Bristol Archives, Parochial Registers: P.Xch/R/1/a, P.St_J/R/1/a, P.St MR/R/1/2, P.St_N/R/1/b, P.St_N/R/1/c, P.St_JB/R/1/a, P.AS/R/1/a, P.St_W/R/1, P.St_T/R/1/a, P.St_S/R/1/a