

The method of transmission of epidemic influenza: further evidence from archival mortality data

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(Received 22 March 1985; accepted 8 October 1985)

SUMMARY

Evidence for influenza-associated excess mortality in the three centuries before the 20th has been sought from parish burial registers in Cumbria, Devon, Dyfed, East Anglia, Gloucestershire and Northumbria, compared with inter-epidemic years. Most of the registers showed excess of burials concordant with eight historic influenza epidemics.

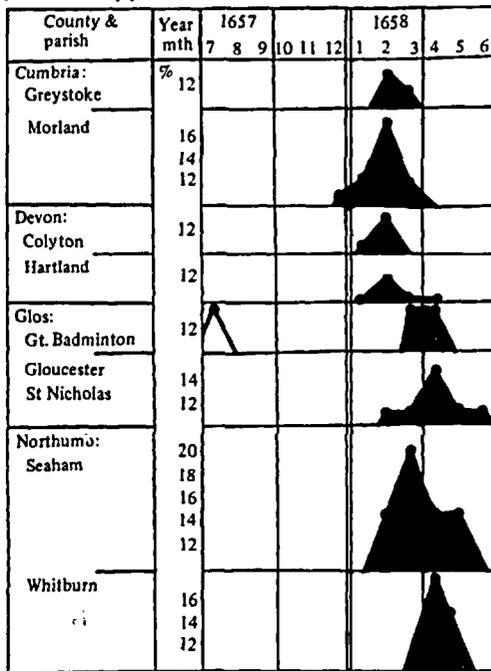
Comparison of the dates of these epidemics, deduced from the burials data in different areas, showed a rate of spread difficult to reconcile with direct person-to-person spread of influenza from the sick. An alternative explanation based on development of latency of the virus in the sick person and subsequent seasonal reactivation is discussed.

INTRODUCTION

Severe influenza epidemics in the 20th century have been found to cause an excess general mortality (Alling, Blackwelder & Stuart-Harris, 1981; Thatcher, 1981). Rather unexpectedly it was found that in previous centuries, before the days of death registration, a similar abrupt brief excess of burials was registered in parishes in Gloucestershire at times when severe influenza epidemics were present in Great Britain (Hope-Simpson, 1983). Such excess burials if widespread might be used to fix an approximate date of the onset of an influenza epidemic in different areas, and so provide a means of determining the rapidity with which influenza had spread from place to place in previous centuries.

On the current concept that influenza virus is spread directly from the sick person to his non-immune companions, the disease must have travelled through the inhabitants of Great Britain more slowly and fitfully in previous centuries, because of the paucity and slowness of communications in the smaller and more scattered population. For other reasons the simple concept of the direct spread of influenza is difficult to sustain and recently an alternative hypothesis has proposed that the virus so rapidly becomes latent in the tissues of the influenza patient that he cannot then transmit it. Later a seasonally mediated stimulus reactivates the virus residues so that the ex-patient becomes briefly a symptomless but highly infectious carrier and his non-immune companions may then develop influenza (Hope-Simpson, 1979). The stimulus, being seasonal, must ultimately be dependent on seasonal variations in solar radiation (Hope-Simpson, 1981). The new hypothesis therefore predicts that epidemic influenza will be found to have spread

(A) Burials Key year 1658.



(B) Burials Key year 1675.

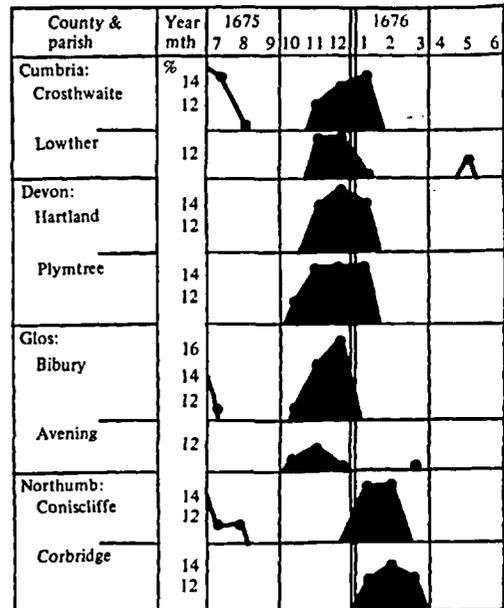


Fig. 1. Examples of excess burials in the 17th century in two 12-month periods each containing a presumptive influenza epidemic. Only those monthly percentages exceeding 10% of the 12-month total of burials are shown. For small parishes 3-month totals moving monthly are treated similarly. (a) 1658. 'Influenza' reported in April 1658. Peaks of excess burials occur from February in Cumbria and Devon to April in Gloucestershire and Northumbria. (b) 1675. 'Influenza' reported in October–November. Excess burials from October to January–March in Northumbria.

over the surface of the earth at a similar speed throughout human history, because on this view 'spread' depends on the inexorable annual variation of the seasonally mediated stimulus allowing epidemics to develop around the carriers. The rapidity of human communications is largely irrelevant to such a process.

The finding that parish registers in Gloucestershire reflected historic influenza epidemics by excess burials (Hope-Simpson, 1983) provided some support for the new hypothesis. The present paper extends the observations to other areas of Great Britain to confirm that the findings in the Gloucestershire area were representative of the country as a whole, and to determine whether the epidemic behaviour of influenza had altered perceptibly in the course of four centuries.

METHODS

The methods used were those already described (Hope-Simpson, 1983). For this investigation ten study-periods were chosen, mostly of 11 consecutive years, containing one or more 'key years'. These were 12-month periods, usually from July to June, in which an epidemic had occurred which had been considered by contemporary observers or medical historians to have been influenzal. The dates

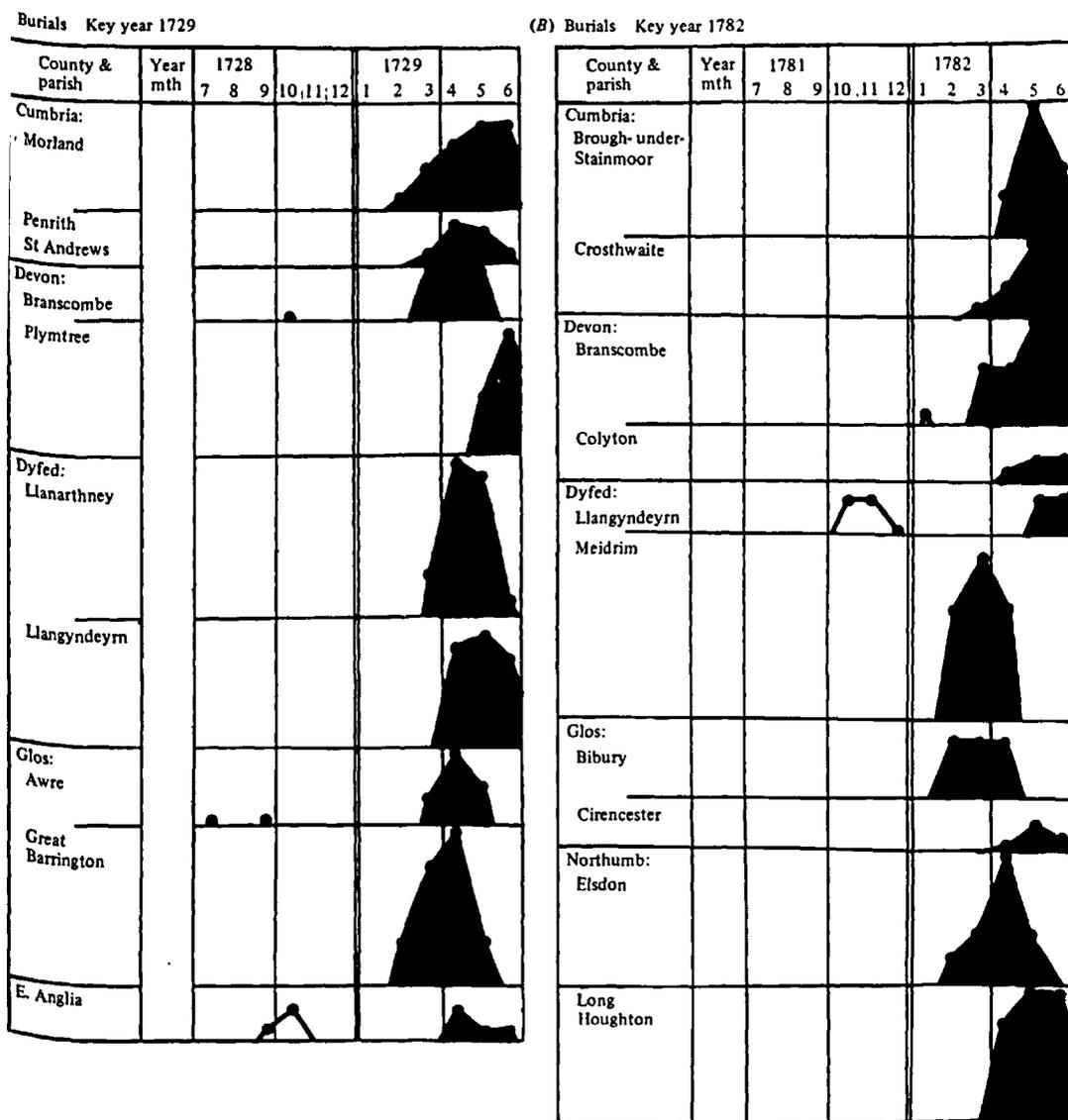
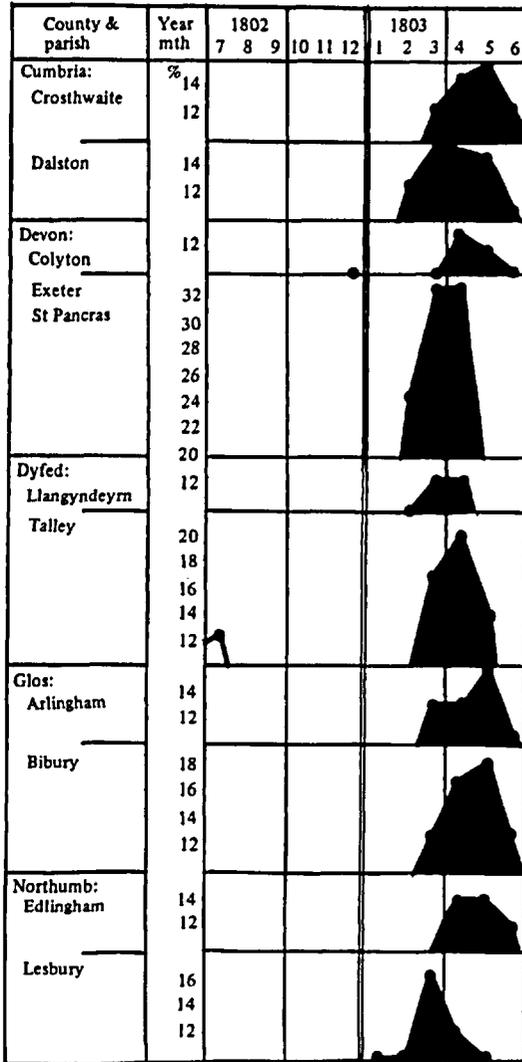


Fig. 2. Examples of excess burials in the 18th century (details as in Fig. 1). (a) 1729. Excess burials in late spring in all the counties. (b) 1782. Many references to influenza from March to May. All the excess burials shown are concordant.

of all burials during the study periods were extracted from the registers of 61 parishes in six areas: Cumbria, Devon, Dyfed, East Anglia, Northumbria, Gloucestershire. The registers varied in completeness and a few were seriously defective.

County archivists kindly supplied lists of parish registers available, with the dates covered by each register. Those chosen for study contained the longest continuous record of burials. Even so, insufficient reliable material was obtained for comparative analysis of the study periods around the two key years of 16th century epidemics and these have been omitted.

(A) Burials Key year 1803



(B) Burials Key year 1833

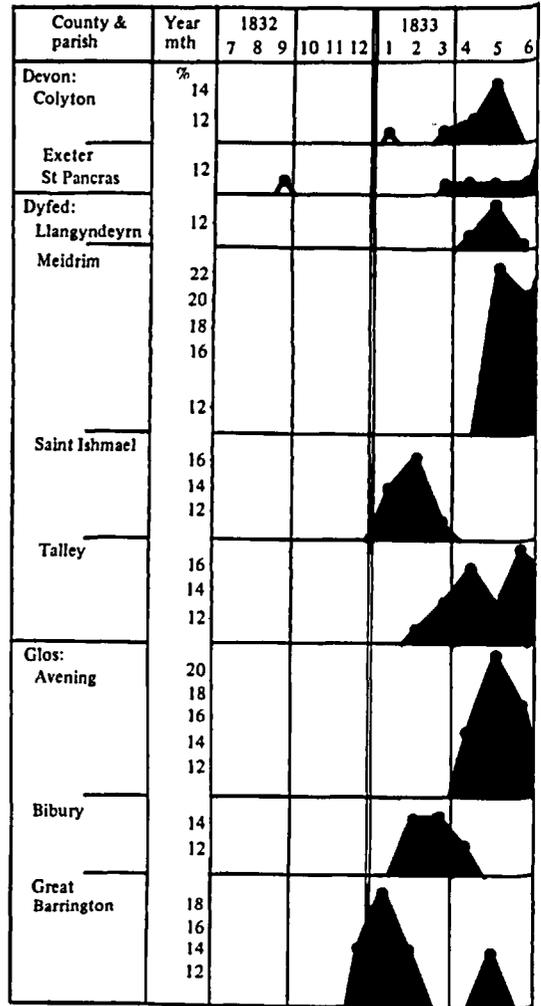
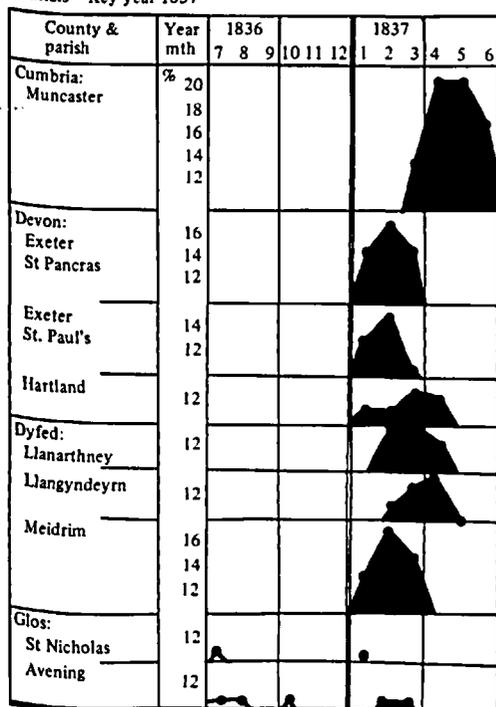


Fig. 3. Examples of excess burials in the early 10th century (details as in Fig. 1). (a) 1803. Influenza reported in January from London, Taunton, Shrewsbury, and in March from Crediton. Excess burials are highly concordant. (b) 1833. Influenza reported as in March–April. Peaks of excess were less closely consistent than in other epidemic years.

Examples of the findings are illustrated as monthly percentages of the total 12-month burials during the key year. In Figs. 1–5 only percentages exceeding ten are illustrated to make clear the periods of excess burials. This arbitrary proportion was chosen as being above the 8.3% average monthly burial rate of any 12-month period.

The term ‘concordance’ is used to denote excess monthly burials attributable to the recorded influenza epidemic by analogy with 20th century experience.

(A) Burials Key year 1837



(B) Burials Key year 1847

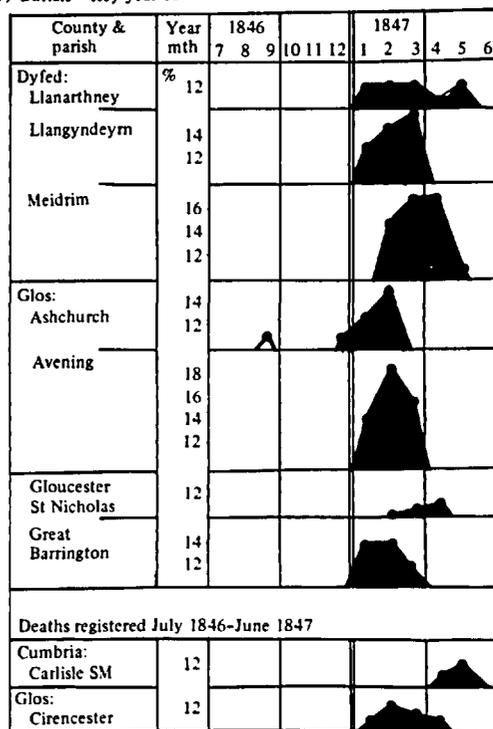


Fig. 4. Examples of excess burials in mid-19th century (details as in Fig. 1). (a) 1837. Influenza reported in January and February. The Cumbrian parish excess burials were later than those in other counties. (b) 1847. Excess burials are concordant with the winter influenza epidemic recorded in Hirsch (1883). Excess deaths registered in Carlisle St Mary's, Cumbria, were later than those registered in Cirencester, Gloucestershire.

Examples are readily seen in Figs. 1-4 and in Table 1 A. Table 1 B and Fig. 5 give examples in which such concordance as occurred is likely to have been fortuitous.

All the Tables from which the Figures are derived are given in the Appendix to this paper. More detailed material is available from the author.

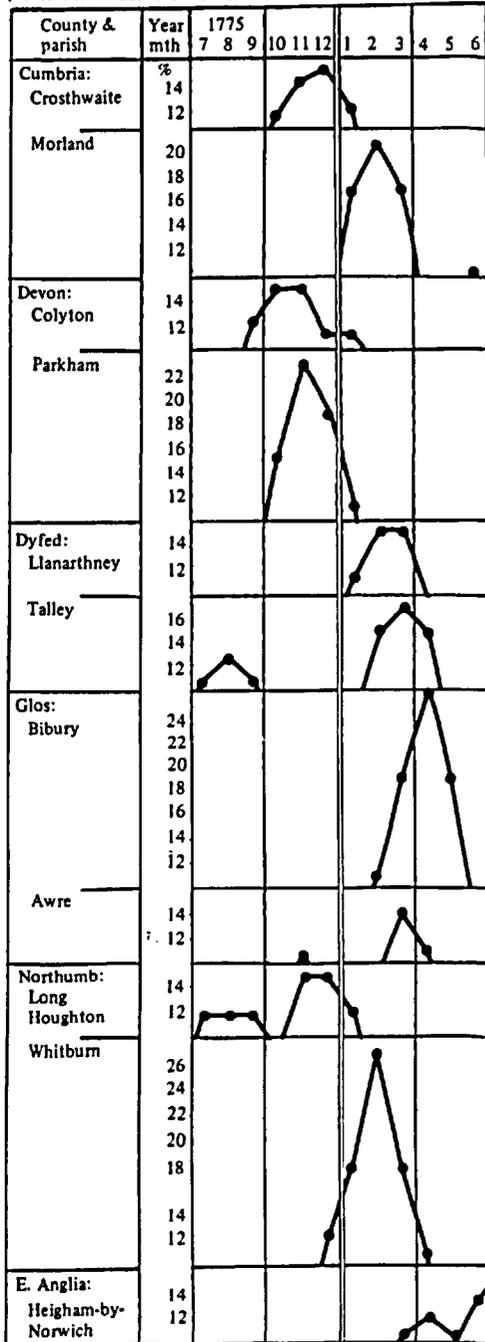
RESULTS

The searches of the registers provided a large amount of data. For reasons of space all of it cannot be included and care has been taken to avoid bias in favour of the hypothesis being proposed.

In Table 1 the findings in all the parish registers examined in five severe influenza epidemic seasons in three centuries (part A) are compared with those in two epidemic seasons, one of non-lethal influenza and the other probably not an influenza epidemic (part B).

Each of Figs. 1-5 gives examples of burials in representative parishes in different counties during two key seasons. Figs. 1-4 (Appendix Tables 1-4) show eight seasons in which the majority of parishes showed excess burials with concordance

(A) Influenza Oct.-Nov. 1775



(B) Alleged influenza in June

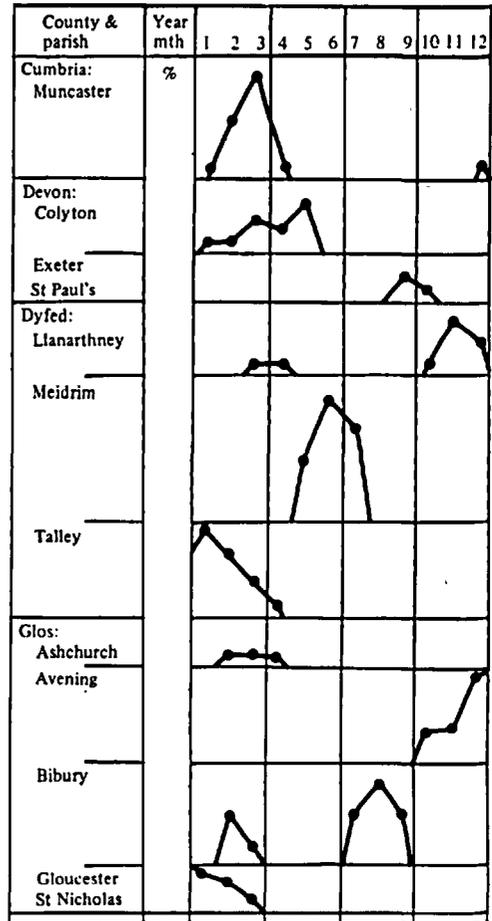


Fig. 5. Example of 'influenza' years in which concordance was low. (a) 1775. Widespread mild influenza in October and November. (b) 1831. Alleged influenza in June.

Table 1. Results of examining parish records for evidence of excess mortality

(A) Twelve-month periods in which severe influenza is recorded and burial registers tended to show excess of burials around the time of epidemic prevalence (concordance).

Parishes in	1657-8*	1728-9*	1802-3*	1836-7*	1846-7*	Total*	% concordance
Cumbria	11/13	11/14	6/6	—	—	28/33	84.8
Devonshire	5/6	6/7	8/9	5/7	—	24/29	82.8
Dyfed	—	5/5	5/5	5/5	4/5	19/20	95.0
Gloucestershire	3/6	9/11	10/11	3/5	4/5	29/38	76.2
Northumbria	3/4	10/17	14/16	—	—	27/37	73.8
Totals	22/29	41/54	43/47	13/17	8/10	127/157	
Percentage concordance	75.9	75.9	91.5	76.5	80.0	80.9	

(B) Similar periods in which an influenza epidemic was reported not to have been lethal or in which there is doubt as to the influenzal nature of the epidemic.

Parishes in	1795-6*	1831*	Total*	% concordance
Cumbria	5/12	—	5/12	41.7
Devonshire	4/8	3/7	7/15	46.7
Dyfed	0/5	2/5	2/10	20.0
Gloucestershire	1/9	1/5	2/14	14.3
Northumbria	5/16	—	5/16	31.2
Totals	15/50	6/17	21/67	—
Percentage concordance	30.0	35.3	31.3	—

* Number of registers showing appropriate excess burials/total number of registers examined.

comparable to that found in 20th century epidemic influenza seasons. Other parishes could have been substituted without altering the concordance. Fig. 5 (Appendix Table 5) for comparison shows two seasons of non-concordance of excess burials.

In the analysis of the epidemics below, the results for each key year are preceded where possible by brief quotations that date the epidemic in some area(s) of Great Britain. The page number in Thompson (1852), the anthology from which most extracts are taken, is given after the name of the author cited and, where known, his location.

17th century

1658 (see Fig. 1 (a) and Appendix Table 1 A). 'About the end of April, suddenly a distemper arose, as if sent by some blast of the stars...' (Willis, London, p. 11).

Three quarters of the parishes examined in five counties showed excess burials at a date concordant with that epidemic.

1675 (see Fig. 1 (b) and Appendix Table 1 B). '... the end of October... was succeeded by sudden cold and moisture. Then it was that coughs prevailed in greater numbers than at any other time in my remembrance...' (Sydenham, London, p. 17).

More than half of the parishes examined had excess burials concordant with the influenza epidemic. One third of them showed other dates of excess mortality, chiefly in the spring.

18th century

1729 (see Fig. 2(a) and Appendix Table 2A). '... in this city, in the year 1729, it was conjectured that two thousand persons at least were seized with it in one night' (Glass, Exeter, p. 102).

Three-quarters of the parish registers examined showed excess burials concordant with a spring influenza epidemic. Nearly a quarter of them showed an excess of burials the previous autumn, some experiencing both peaks of excess burials.

1782 (see Fig. 2(b) and Appendix Table 1B). '... March 1782 when the *febris epidemica catarrhalis* first appeared, and by the middle of April it was spread all over London and its environs' (Grant, London, p. 118 footnote).

Of the registers examined more than two-thirds showed concordant excess of burials.

19th century

1803 (see Fig. 3(a) and Appendix Table 3A. 'The influenza of 1803... seems to have been first observed in London early in January, and to have occupied nearly three months in its diffusion over the kingdom...' (Thompson, p. 202).

More than 90% of burial registers examined showed excess concordant with this epidemic.

1833 (see Fig. 3(b) and Appendix Table 3B. '... It was not until the 6th of April that the influenza developed its pathognomonic character, and within the city started up widely on a sudden...' (Hingeston, London, p. 287).

Some 66% of the parish registers examined recorded excess burials concordant with this epidemic.

1837 (see Fig. 4(a) and Appendix Table 4A). '... the epidemic catarrh which prevailed so extensively in the months of January, February and March...' (Streeten, London, p. 293).

Three-quarters of the registers examined recorded excess burials concordant with this epidemic.

1847 (see Fig. 4(b) and Appendix Table 4B). Hirsch (1883) reported that influenza was prevalent in England in the winter of 1846-7.

Eight of ten parish burial registers examined in Dyfed and Gloucestershire showed excess of burials concordant with an influenza epidemic that occurred in the early months of 1847. A similar excess of mortality was also shown at the same time in the death registers of Carlisle St Mary in Cumbria and Cirencester in Gloucestershire.

Non-lethal epidemics

1775 (see Fig. 5(a) and Appendix Table 5A). '... Many... people were attacked... preceding 20th October... This disease proved fatal to exceeding few...' (Glass, Exeter, p. 100).

'I do not know that one person died of it' (Pulteney, Blandford, p. 112).

'... fewer died during the prevalence of this disorder than during the same space of time since the opening of the poorhouse' (Rainey, Dublin, p. 115).

The dates of excess burials in the parish registers examined are widely scattered through the 12 months. Some 30% might be considered as concordant with the October–November epidemic.

1831 (see Fig. 5(b) and Appendix Table 5B). 'The present influenza... has prevailed epidemically for the last two weeks in the metropolis. Of seventy patients who presented themselves at the public Dispensary, on Thursday, the 23rd inst. (June), more than one half were suffering from the influenza...' (Burne, London, p. 278).

As in the 1775 epidemic the excess burials in the parish registers examined are widely distributed throughout the 12-month period, only about one-third of them being approximately concordant with the June epidemic of alleged influenza. The statement that more than 30 such patients 'presented themselves' at the Chancery Lane Dispensary suggests that if the epidemic was in fact caused by influenza virus it was of an unusually mild variety and at an unusual season. No other record of it was found.

DISCUSSION

The present investigation uses parish burial registers to study the behaviour of epidemic influenza in previous centuries in comparison with its present behaviour. An earlier study had indicated that the excess general mortality that characterizes severe influenza epidemics in the twentieth century might also be recognized by excess burials entered in parish registers at times when influenza has been recorded in Great Britain in contemporary annals. Here was a method whereby the presence of influenza epidemics might be dated in different parts of Great Britain when certification of causes of death had not yet become obligatory.

Many writers have emphasized the dramatic explosiveness and simultaneous onset of influenza epidemics, but influenza is generally an unpredictable pestilence varying much in the timing of its arrival in different places and in its duration in any area. Some severe epidemics have lasted for only 6 weeks whereas others have dragged along in desultory fashion for 3 months or more. The first two epidemics caused by the subtype H₃N₂ of influenza A virus in this country in the 1968/9 and 1969/70 seasons illustrate the difference; the first was long and desultory, the latter short and sharp. These variations in the natural expression of the disease have to be remembered when attempting to determine what changes have taken place in the epidemic behaviour of influenza from one century to another. Examples of the seasonal variations in peak morbidity from influenza epidemics in the 20th century both locally and nationwide, may be found in Massey (1951) and Hope-Simpson (1951, 1979).

Other difficulties arise from statistical differences in the material available for study. Parish registers usually record the burials occurring in small communities living in a relatively tiny area compared with the larger populations covered by death registers. In a small parish other causes of mortality sometimes kill a comparatively high proportion of the frail or elderly people and hence remove the very persons who would otherwise have fallen victim to the later influenza epidemic. Consequently some parishes may appear wrongly to have escaped an

influenza epidemic. Evidence was found that this sequence of events had taken place on several occasions, the old and debilitated being at risk of death from a variety of causes as well as influenza. Death registrations, drawn from a much larger population and a greater area, conceal such local variations. Most parishes that have suffered a severe influenza epidemic showed a higher proportional excess mortality than death registers, because the death registers include both the local populations that have escaped the epidemic and those that have experienced it.

The convenient method adopted in this paper of depicting the excess of burials by noting only the monthly proportions exceeding 10% of the 12 months' mortality is vulnerable to excess mortality due to other causes during the key period. Earlier or later fatalities sometimes depressed an influenzal excess below the critical 10%.

Despite these disadvantages Table 1A and Figs. 1–4 provide evidence that severe influenza epidemics in three previous centuries caused excess mortality in most of the parishes of which the burial registers were examined. From the dates of these excess burials in different areas of Great Britain, the rate at which influenza spreads seems to have altered little through four centuries.

Fig. 5 and Table 5 confirm that the proportion of concordant parishes was much lower in the years in which influenza was mild. However the morbidity during the 1775 epidemic provides independent support for the findings in this paper that influenza 'travelled' as rapidly in previous centuries. Answers to a questionnaire circulated by Fothergill show that the epidemic was first noticed contemporaneously in London (Baker, p. 91), Dublin (Fleury, p. 113), Dorset (Cuming, Dorchester, p. 95; Pulteney, Blandford, p. 111), Yorkshire (White, York, p. 105) and 'in one part of Wales' (Haygarth, Chester, p. 108). All page numbers refer to Thompson (1852).

In the 20th century the general mortality regularly increases in the colder months, especially in the 4 months from December to March inclusive (Thatcher, 1981). Surprisingly few of the average number of burials among the Gloucestershire parishes analysed demonstrated a winter increase during the four previous centuries (Hope-Simpson, 1983). Its absence is illustrated in Fig. 6 in which the average weekly figures over 10 years contrast with the sharp excess characteristic of lethal epidemic influenza which coincided closely in the two widely separated small parishes, one in Cumbria the other in Gloucestershire. Explanations for this absence of a winter increase in the 10-year average of weekly burials in early times must be speculative. Deaths from non-respiratory maladies from April to November may have matched those caused by respiratory diseases in the colder months. Dysentery, typhus, typhoid, smallpox, plague and other ailments now rare or rarely lethal may have taken a big toll of life in the warmer months in any consecutive 10-year period.

Mortality statistics from the 20th and latter half of the 19th century are not easily compared with burials in the very small populations covered by individual parish registers. The monthly or 4-monthly deaths registered from the large populations covered by a 20th-century registration area necessarily include many other causes of mortality even during an influenza epidemic. Often in the past influenza may have caused all the burials in a small parish in the few weeks of its presence and in the subsequent week or two.

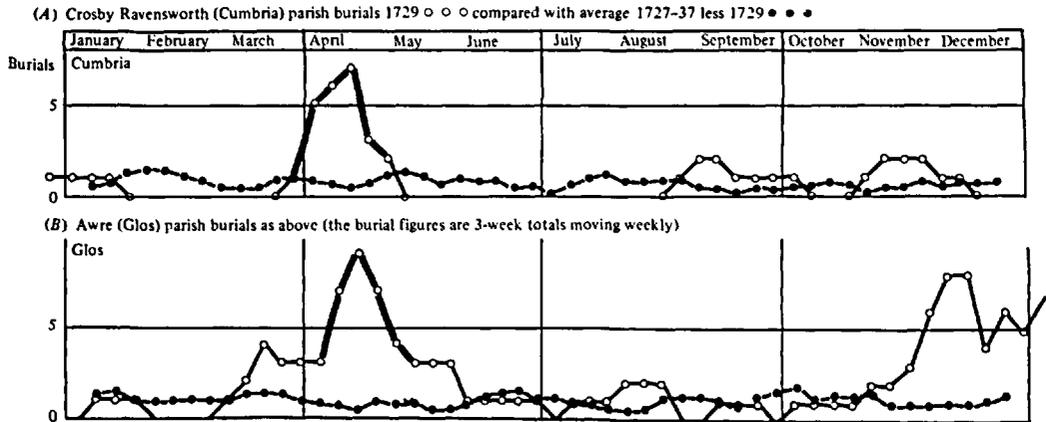


Fig. 6. Example of excess burials characteristic of epidemic influenza in two widely separated parishes in the key influenza year of 1729. Note also the lack of winter increase in mortality in the 10-year averages of burials. (a) Crosby Ravensworth, Cumbria. (b) Awre, Gloucestershire. ○—○—○, Three-weekly burials in 1729 moving weekly; ●—●—●, average 3-weekly burials for 10 years (1727-37 less 1729) moving weekly.

The findings reported in this paper are considered to be incompatible with the current concept of direct person to person spread of influenza, but they are consistent with the prediction made from the alternative hypothesis that the virus remains latent in those who have suffered influenza and is seasonally reactivated so that influenza is caught from these symptomless carriers. In the areas studied, the variation in timing of epidemics does not seem to have altered perceptibly throughout the four centuries and probably does not differ much from that found in 20th century epidemics.

I am most grateful for help from, amongst others, the following: The Wellcome Trust for expenses; the Registrar General for permission to have access to registers; Mr F. J. Petrie and Mrs Hansson of Cirencester Register Office; Mr D. G. Sandford and his staff at the Carlisle Register Office; the County Archivists for Gloucestershire, Cumbria, Dyfed, Northumberland and Norfolk, and the Area Librarian at Exeter, and Miss H. Spurrier of the Swindon Medical Library.

My secretary, Mrs Bettie Neal, and my wife, Mrs Eleanor Hope-Simpson, have given much help.

Appendix Table 1. *Figures forming the basis for Figure 1*

(A) Burials, July 1657–June 1658 (12-month period).

Month...	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	Total July- June
Cumbria																	
Greystoke																	
(a)*	4	0	1	4	2	2	4	0	3	5	4	2	2	3	3	3	32
(b)	—	5	5	7	8	8	6	7	8	12	11	8	7	8	9	—	95
Morland																	
(a)	2	0	3	2	2	0	3	2	4	4	4	2	2	1	0	2	29
(b)	—	5	5	7	4	5	5	9	10	12	10	8	5	3	3	—	83
Devon																	
Hartland																	
(a)	0	3	1	1	0	3	1	1	3	2	2	2	2	1	0	2	19
(b)	—	4	5	2	4	4	5	5	6	7	6	6	5	3	3	—	58
Colyton																	
(a)	5	2	3	2	3	2	4	1	5	6	4	1	4	1	5	3	36
(b)	—	10	7	8	7	9	7	10	12	15	11	9	6	10	9	—	112
Gloucestershire																	
Great Badminton																	
(a)	1	1	0	2	0	0	1	1	0	0	1	2	0	0	0	0	7
(b)	—	2	3	2	2	1	2	2	1	1	3	3	2	0	0	—	22
Gloucester																	
St Nicholas																	
(a)	3	2	2	1	0	1	1	1	3	1	3	3	3	1	3	0	20
(b)	—	7	5	3	2	2	3	5	5	7	7	9	7	7	4	—	62
Northumbria																	
Seaham																	
(a)	0	0	0	0	0	0	1	0	0	2	1	1	1	1	0	0	7
(b)	—	0	0	0	0	1	1	1	2	3	4	3	3	2	1	—	20
Whitburn																	
(a)	1	1	0	0	2	1	0	0	2	0	1	2	3	0	0	1	11
(b)	—	2	1	2	3	3	1	2	2	3	3	6	5	3	1	—	34

* (a), Monthly total; (b) three-monthly total, monthly.

Appendix Table 1 (cont.)

(B) Burials, July 1675–June 1676 (12-month period).

Month...	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	Total July– June
Cumbria																	
Crosthwaite																	
(a)	4	8	11	2	2	3	5	10	5	6	0	0	4	2	1	4	50
(b)	—	23	21	15	7	10	18	20	21	11	6	4	6	7	7	—	146
Lowther																	
(a)	1	1	2	1	0	1	3	4	1	1	1	3	2	2	0	1	21
(b)	—	4	4	3	2	4	8	8	6	3	5	6	7	4	3	—	60
Devon																	
Hartland																	
(a)	4	2	2	1	2	3	1	6	4	0	0	1	2	2	1	1	24
(b)	—	8	5	5	6	6	10	11	10	4	1	3	5	5	4	—	71
Plymtree																	
(a)	2	1	1	0	2	0	2	3	0	2	0	1	0	0	0	0	11
(b)	—	4	2	3	2	4	5	5	5	2	3	1	1	0	0	—	33
Gloucestershire																	
Avening																	
(a)	2	0	0	4	3	4	7	4	2	4	4	5	3	1	5	3	41
(b)	—	2	4	7	11	14	15	13	10	10	13	12	9	9	9	—	127
Bibury																	
(a)	3	5	1	1	0	0	6	2	1	1	1	2	0	3	1	1	18
(b)	—	9	7	2	1	6	8	9	4	3	4	3	5	4	5	—	56
Northumbria																	
Conisliffe																	
(a)	5	0	6	1	0	1	0	1	5	3	1	1	3	0	0	1	22
(b)	—	11	7	7	2	1	2	6	9	9	5	5	4	3	1	—	60
Corbridge																	
(a)	3	4	0	2	2	2	4	1	2	8	2	1	1	3	1	0	28
(b)	—	7	6	4	6	8	7	7	11	12	11	4	5	5	4	—	86

Appendix Table 2. *Figures forming the basis for Figure 2*

Month...	(A) Burials, July 1728–June 1729 (12-month period).																Total July– June
	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	
Cumbria																	
Morland																	
(a)*	2	4	0	0	0	2	0	1	2	4	2	4	5	3	4	0	23
(b)	—	6	4	0	2	2	3	3	7	8	10	11	12	12	7	—	74
Penrith (St Andrews)																	
(a)	10	7	9	2	3	6	4	6	7	7	11	9	13	10	4	3	87
(b)	—	26	18	14	11	13	16	17	20	25	27	33	32	27	17	—	253
Devon																	
Branscombe																	
(a)	0	0	0	1	1	0	2	0	0	1	1	2	1	1	0	0	10
(b)	—	0	1	2	2	3	2	2	1	2	4	4	4	2	1	—	29
Plymtree																	
(a)	1	1	0	0	2	1	1	1	1	2	0	0	3	3	2	1	14
(b)	—	2	1	2	3	4	3	3	4	3	2	3	6	8	6	—	42
Dyfed																	
Llanarthney																	
(a)	0	1	2	3	0	1	2	0	1	0	2	9	7	1	1	4	28
(b)	—	3	6	5	4	3	3	3	1	3	11	18	17	9	6	—	83
Llangynderyn																	
(a)	2	0	0	2	1	0	5	2	2	2	4	5	12	5	3	2	40
(b)	—	2	2	3	3	6	7	9	6	8	11	21	22	20	10	—	118
Gloucestershire																	
Awre																	
(a)	4	4	3	5	2	5	3	0	1	0	4	10	4	1	1	2	38
(b)	—	11	12	10	12	10	8	4	1	5	14	18	15	6	4	—	115
Great Barrington																	
(a)	0	0	0	0	1	1	0	0	1	1	3	3	2	0	1	1	12
(b)	—	0	0	1	2	2	1	1	2	5	7	8	5	3	2	—	37
East Anglia																	
Heigham-by-Norwich																	
(a)	1	0	0	2	3	2	3	1	1	0	2	3	3	1	3	1	21
(b)	—	1	2	5	7	8	6	5	2	3	5	8	7	7	5	—	65
Northumbria																	
Lesbury																	
(a)	4	0	0	1	2	1	1	1	1	3	4	2	3	4	3	1	23
(b)	—	4	1	3	4	4	3	3	5	8	9	9	9	10	8	—	68
Whalton																	
(a)	2	0	0	0	0	0	3	0	0	0	0	0	4	1	0	1	8
(b)	—	2	0	0	0	3	3	3	0	0	0	4	5	5	2	—	23

* (a), Monthly total; (b), three-monthly total, monthly.

Appendix Table 2-(cont.)

(B) Burials, July 1781–June 1782 (12-month period).

Month...	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	Total July– June
Cumbria																	
Brough-under-Stainmoor																	
(a)	2	3	2	0	2	0	2	2	1	0	0	3	5	4	0	1	21
(b)	—	7	5	4	2	4	4	5	3	1	3	8	12	9	5	—	60
Crosthwaite																	
(a)	2	1	0	0	2	2	3	3	3	5	4	4	7	8	4	1	41
(b)	—	3	1	2	4	7	8	9	11	12	13	15	19	19	13	—	120
Devon																	
Branscombe																	
(a)	0	0	0	0	1	0	0	1	0	2	0	2	2	1	2	1	9
(b)	—	0	0	1	1	1	1	1	3	2	4	4	5	5	4	—	28
Colyton																	
(a)	0	3	2	3	3	5	0	8	2	2	4	6	5	5	6	1	45
(b)	—	5	8	8	11	8	13	10	12	8	12	15	16	16	12	—	137
Dyfed																	
Llanarthney																	
(a)	2	2	2	1	2	3	5	2	1	1	0	2	3	5	2	4	27
(b)	—	6	5	5	6	10	10	8	4	2	3	5	10	10	11	—	78
Meidrim																	
(a)	0	2	0	1	0	0	1	0	0	1	4	1	0	0	1	0	8
(b)	—	2	3	1	1	1	1	1	1	5	6	5	1	1	1	—	27
Gloucestershire																	
Bibury																	
(a)	0	2	0	0	0	2	1	0	0	3	2	0	3	0	0	0	11
(b)	—	2	2	0	2	3	3	1	3	5	5	5	3	3	0	—	35
Cirencester																	
(a)	10	9	3	6	3	7	5	6	8	9	6	10	10	10	7	3	83
(b)	—	22	18	12	16	15	18	19	23	23	25	26	30	27	20	—	252
Northumbria																	
Elsdon																	
(a)	4	2	0	0	0	1	1	1	2	1	3	3	4	0	1	0	16
(b)	—	6	2	0	1	2	3	4	4	6	7	10	7	5	1	—	51
Long Houghton																	
(a)	0	0	0	0	0	1	2	0	1	1	2	1	5	3	1	0	16
(b)	—	0	0	0	1	3	3	3	2	4	4	8	9	9	4	—	46

Appendix Table 3. *Figures forming the basis for Figure 3*

(A) Burials, July 1802–June 1803 (12-month period).

Month...	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	Total July– June
Cumbria																	
(a)*	5	2	0	2	3	1	1	3	3	3	3	8	6	4	4	2	37
(b)	—	7	4	5	6	5	5	7	9	9	14	17	18	14	10	—	113
Dalston																	
(a)	2	2	1	3	2	1	3	1	1	2	3	7	5	2	3	2	31
(b)	—	5	6	6	6	6	5	5	4	6	12	15	14	10	7	—	95
Devon																	
Colyton																	
(a)	0	3	4	2	1	0	3	7	1	1	5	5	4	4	3	2	37
(b)	—	7	9	7	3	4	10	11	9	7	11	14	13	11	9	—	109
Exeter																	
St Pancras																	
(a)	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	1	4
(b)	—	0	0	0	0	0	0	0	0	3	4	4	1	0	1	—	12
Dyfed																	
Llangyndeyrn																	
(a)	8	4	4	3	4	0	3	3	3	3	6	6	3	1	3	4	39
(b)	—	16	11	11	7	7	6	9	9	12	15	15	10	7	8	—	119
Talley																	
(a)	3	4	0	4	0	0	0	1	2	0	4	7	2	0	0	1	20
(b)	—	7	8	4	4	0	1	3	3	6	11	13	9	2	1	—	64
Gloucestershire																	
Arlingham																	
(a)	2	2	0	0	0	2	1	0	1	2	0	3	2	1	1	1	12
(b)	—	4	2	0	2	3	3	2	3	3	5	5	6	4	3	—	38
Bibury																	
(a)	1	0	2	3	0	0	0	0	1	2	2	3	4	3	0	1	20
(b)	—	3	5	5	3	0	0	1	3	5	7	9	10	7	4	—	55
Northumbria																	
Edlingham																	
(a)	0	0	1	0	0	3	2	0	1	2	1	2	4	1	1	0	17
(b)	—	1	1	1	3	5	5	3	3	4	5	7	7	6	2	—	50
Lesbury																	
(a)	2	3	0	1	0	2	1	1	1	3	1	4	1	0	1	0	15
(b)	—	5	4	1	3	3	4	3	5	5	8	6	5	2	1	—	49

* (a), Monthly total; (b), three-monthly total, monthly.

Appendix Table 3. (cont.)

(B) Burials, July 1832–June 1833 (12-month period).

Month...	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	Total July– June
Devon																	
Colyton																	
(a)	2	3	3	2	0	2	1	5	2	4	2	5	5	5	0	1	36
(b)	—	8	8	5	4	3	8	8	11	8	11	12	15	10	6	—	103
Exeter																	
St Pancras																	
(a)	1	1	0	1	1	1	0	1	0	0	2	1	0	2	1	1	9
(b)	—	2	2	2	3	2	2	1	1	2	3	3	3	3	4	—	27
Dyfed																	
Llangyndeyrn																	
(a)	2	1	3	5	2	3	1	1	4	4	3	4	6	6	0	4	42
(b)	—	6	9	10	10	6	5	6	9	11	11	13	16	12	10	—	118
Meidrim																	
(a)	3	0	2	0	0	0	1	0	2	2	0	2	2	6	1	3	17
(b)	—	5	2	2	0	1	1	3	4	4	4	4	10	9	10	—	44
St Ishmael																	
(a)	3	1	0	3	0	1	0	0	3	3	1	1	2	0	0	0	14
(b)	—	4	4	3	4	1	1	3	6	7	5	4	3	2	0	—	43
Talley																	
(a)	3	0	1	0	0	1	1	2	2	1	4	3	3	2	6	1	20
(b)	—	4	1	1	1	2	4	5	5	7	8	10	8	11	9	—	63
Gloucestershire																	
Avening																	
(a)	0	1	1	1	1	1	1	1	0	0	1	2	4	4	0	1	17
(b)	—	2	3	3	3	3	3	2	1	1	3	7	10	8	5	—	47
Bibury																	
(a)	0	1	0	0	1	1	2	0	1	3	2	1	2	1	0	3	14
(b)	—	1	1	1	2	4	3	3	4	6	6	5	4	3	4	—	42
Great Barrington																	
(a)	0	1	0	0	0	0	0	1	2	1	0	1	1	1	0	1	7
(b)	—	1	1	0	0	0	1	3	4	3	2	2	3	2	2	—	21

Appendix Table 4. *Figures forming the basis for Figure 4*

(A) Burials, July 1836–June 1837 (12-month period).

Month...	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	Total July– June
Cumbria																	
Muncaster																	
(a)*	1	0	0	0	1	0	0	0	1	1	0	3	3	0	2	0	9
(b)	—	1	0	1	1	1	0	1	2	2	4	6	6	5	2	—	29
Devon																	
Exeter																	
St Pancras																	
(a)	0	1	1	1	1	1	1	0	2	4	1	1	0	1	0	1	14
(b)	—	2	3	3	3	3	2	3	6	7	6	2	2	1	2	—	41
Exeter																	
St Paul's																	
(a)	3	2	2	4	1	3	3	1	7	10	3	1	8	2	2	5	45
(b)	—	7	8	7	8	7	7	11	18	20	14	12	11	12	9	—	135
Hartland																	
(a)	1	1	3	1	1	2	4	4	3	6	4	5	5	1	0	2	39
(b)	—	5	5	5	4	7	10	11	13	13	15	14	11	6	3	—	114
Dyfed																	
Llanarthney																	
(a)	2	0	3	1	1	0	3	1	2	4	4	2	3	1	1	4	25
(b)	—	5	4	5	2	4	4	6	7	10	10	9	6	5	6	—	72
Llangyndeyrn																	
(a)	4	4	3	2	3	1	3	1	4	2	6	6	3	2	2	2	36
(b)	—	11	9	8	6	7	5	8	7	12	14	15	11	7	6	—	109
Meidrim																	
(a)	2	0	1	0	1	0	1	1	2	3	3	1	2	1	0	0	16
(b)	—	3	1	2	1	2	2	4	6	8	7	6	4	3	1	—	46
Gloucestershire																	
Gloucester																	
St Nicholas																	
(a)	3	12	8	11	8	8	6	11	5	14	7	4	9	5	3	5	96
(b)	—	23	31	27	27	22	25	22	30	26	25	20	18	17	13	—	290
Avening																	
(a)	2	3	1	2	3	0	3	0	0	4	2	0	2	1	1	0	18
(b)	—	6	6	6	5	6	3	3	4	6	6	4	3	4	2	—	56

* (a), Monthly total; (b), three-monthly total, monthly.

Appendix Table 4. (cont.)

(B) Burials, July 1846–June 1847 (12-month period).

Month...	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	Total July– June
Dyfed																	
Llanarthney																	
(a)	5	3	1	1	1	1	1	1	4	4	1	4	3	2	?	?	24
(b)	—	9	5	3	3	3	3	6	9	9	9	8	9	5	—	—	74
Llangyndeyrn																	
(a)	3	2	0	1	5	1	2	3	1	7	4	2	1	0	0	2	27
(b)	—	5	3	6	7	8	6	6	11	12	13	7	3	1	2	—	83
Meidrim																	
(a)	1	2	0	1	0	1	1	0	3	1	4	4	1	1	2	1	17
(b)	—	3	3	1	2	2	2	4	4	8	9	9	6	4	4	—	54
Gloucestershire																	
Ashchurch																	
(a)	2	0	1	5	1	2	2	1	5	3	3	1	0	0	1	0	24
(b)	—	3	6	7	8	5	5	8	9	11	7	4	1	1	1	—	72
Avening																	
(a)	6	2	0	3	1	1	3	0	2	8	3	0	1	1	0	4	23
(b)	—	8	5	4	5	5	4	5	10	13	11	4	2	2	5	—	70
Gloucester																	
St Nicholas																	
(a)	9	5	2	12	3	4	6	5	11	4	9	12	6	3	4	11	77
(b)	—	16	19	17	19	13	15	22	20	24	25	27	21	13	18	—	235
Great Barrington																	
(a)	1	1	1	1	0	2	0	2	1	3	2	0	2	0	0	1	14
(b)	—	3	3	2	3	2	4	3	6	6	5	4	2	2	1	—	42

Deaths for the same period registered in Cumbria and Gloucestershire

Month...	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	Total July– June
Cumbria																	
Carlisle, St Mary's																	
(a)	44	37	44	29	54	50	38	48	35	29	48	73	66	59	38	29	573
(b)	—	125	110	127	133	142	136	121	112	112	150	187	198	163	126	—	1691
Gloucestershire																	
Cirencester																	
(a)	19	14	13	16	16	14	14	21	32	29	31	28	22	20	9	13	256
(b)	—	46	43	45	46	44	49	67	82	92	88	81	70	51	42	—	758

Appendix Table 5. *Figures forming the basis for Figure 5*

(A) Burials, July 1775–June 1776 (12-month period).

Year... Month...	1775				1776								Total July- June				
	5	6	7	8	9	10	11	12	1	2	3	4		5	6	7	8
Cumbria																	
Crosthwaite																	
(a)*	2	1	1	2	3	2	5	6	3	2	0	3	1	4	0	2	-32
(b)	—	4	4	6	7	10	13	14	11	5	5	4	8	5	6	—	92
Morland																	
(a)	2	0	1	1	0	0	0	1	1	3	2	0	0	0	3	3	9
(b)	—	3	2	2	1	0	1	2	5	6	5	2	0	3	6	—	26
Devon																	
Colyton																	
(a)	3	2	1	1	4	8	4	4	4	4	1	0	0	4	4	1	35
(b)	—	6	4	6	13	16	16	12	12	9	5	1	4	8	9	—	106
Parkham																	
(a)	0	0	1	0	0	1	3	2	0	1	0	1	0	0	0	0	9
(b)	—	1	1	1	1	4	6	5	3	1	2	1	1	0	0	—	26
Dyfed																	
Llanarthney																	
(a)	2	1	3	0	0	1	1	1	2	3	3	2	0	2	2	0	18
(b)	—	6	4	3	1	2	3	4	6	8	8	5	4	4	4	—	52
Talley																	
(a)	1	1	1	3	2	0	0	0	1	1	5	2	0	1	0	1	16
(b)	—	3	5	6	5	2	0	1	2	7	8	7	3	1	2	—	47
Gloucestershire																	
Bibury																	
(a)	0	0	0	0	0	0	1	0	1	0	2	3	2	0	0	1	9
(b)	—	0	0	0	0	1	1	2	1	3	5	7	5	2	1	—	27
Awre																	
(a)	1	1	1	3	0	1	3	2	0	3	2	3	1	0	0	1	19
(b)	—	3	5	4	4	4	6	5	5	5	8	6	4	1	1	—	57
Northumbria																	
Long Houghton																	
(a)	0	4	2	3	1	2	3	1	1	4	2	3	0	0	1	3	22
(b)	—	6	9	6	6	6	6	5	6	7	9	5	3	1	4	—	69
Whitburn																	
(a)	1	0	1	1	0	0	1	1	5	4	6	0	0	0	0	0	19
(b)	—	2	2	2	1	1	2	7	10	15	10	6	0	0	0	—	56
East Anglia																	
Heigham-by-Norwich																	
(a)	1	0	2	0	2	0	1	3	1	1	3	3	2	2	5	4	20
(b)	—	3	2	4	2	3	4	5	5	5	7	8	7	9	11	—	61

* (a), Monthly total; (b), three-monthly total, monthly.

Appendix Table 5. (cont.)

(B) Burials for 1831 (12 month period).

Year...	1830		1831												1832		1831
Month...	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	Total
Cumbria																	
Muncaster																	
(a)	1	0	0	1	2	1	2	0	0	1	0	0	1	1	1	0	9
(b)	—	1	1	3	4	5	3	2	1	1	1	1	2	3	2	—	27
Devon																	
Colyton																	
(a)	3	4	3	5	4	5	4	6	0	2	1	1	3	1	4	6	35
(b)	—	10	12	12	14	13	15	10	8	3	4	5	5	8	11	—	109
Exeter																	
St Paul's																	
(a)	0	3	2	3	2	1	4	0	0	4	4	2	3	2	2	2	27
(b)	—	5	8	7	6	7	5	4	4	8	10	9	7	7	6	—	82
Dyfed																	
Llanarthney																	
(a)	0	1	1	3	2	2	3	1	0	0	1	2	4	3	1	0	22
(b)	—	2	5	6	7	7	6	4	1	1	3	7	9	8	4	—	64
Meidrim																	
(a)	1	0	0	1	1	0	1	5	2	0	1	1	1	0	1	1	13
(b)	—	1	1	2	2	2	6	8	7	3	2	3	2	2	2	—	40
Talley																	
(a)	0	4	2	2	3	1	1	1	1	1	0	0	2	1	0	1	15
(b)	—	6	8	7	6	5	3	3	3	2	1	2	3	3	2	—	46
Gloucestershire																	
Ashchurch																	
(a)	3	0	1	2	1	1	2	0	1	0	1	2	0	1	1	0	12
(b)	—	4	3	4	4	4	3	3	1	2	3	3	3	2	2	—	35
Avening																	
(a)	2	0	2	0	1	2	2	1	2	1	1	3	4	1	6	4	20
(b)	—	4	2	3	3	5	5	5	4	4	5	8	8	11	11	—	63
Gloucester																	
St Nicholas																	
(a)	13	15	9	9	13	5	2	4	8	8	7	2	6	4	9	4	77
(b)	—	37	33	31	27	20	11	14	20	23	17	15	12	19	17	—	242

Appendix Table 6. *Figures forming the basis for Figure 6.*

Burials, weekly and three-weekly, moving weekly.

Date	Crosby Ravensworth, Cumbria				Awre, Gloucestershire			
	1729		Av. 1727-1737 less 1729		1729		Av. 1727-1737 less 1729	
	Weekly	3-weekly	Weekly	3-weekly	Weekly	3-weekly	Weekly	3-weekly
Jan. 1	—	1	3	—	—	—	3	—
8	1	1	—	7	—	1	6	13
15	—	1	4	8	1	1	4	14
22	—	—	4	13	—	1	4	10
29	—	—	5	14	—	—	2	9
Feb. 5	—	—	5	14	—	—	3	9
12	—	—	4	11	—	—	4	10
19	—	—	2	9	—	—	3	10
26	—	—	3	5	—	1	3	9
Mar. 5	—	—	—	5	1	2	3	13
12	—	—	2	5	1	4	7	13
19	—	—	3	9	2	3	3	13
26	—	1	4	10	—	3	3	10
Apr. 2	1	5	3	9	1	3	4	8
9	4	6	2	7	2	7	1	7
16	1	7	2	6	4	9	2	5
23	2	3	2	8	3	7	2	9
30	—	2	4	11	—	4	5	8
May 7	—	—	5	13	1	3	1	8
14	—	—	4	10	2	3	2	6
21	—	—	1	7	—	3	3	6
28	—	—	2	9	1	1	1	7
June 4	—	—	6	8	—	1	3	12
11	—	—	—	9	—	1	8	14
18	—	—	3	4	1	1	3	15
25	—	—	1	5	—	1	4	11
July 2	—	—	1	2	—	—	4	11
9	—	—	—	7	—	1	3	9
16	—	—	6	10	1	1	2	8
23	—	—	4	11	—	1	3	5
30	—	—	1	8	—	2	—	5
Aug. 6	—	—	3	8	2	2	2	6
13	—	—	4	9	—	2	4	12
20	—	—	2	8	—	—	6	13
27	—	1	2	5	—	—	3	14
Sep. 3	1	2	1	4	—	1	5	11
10	1	2	1	2	1	1	3	9
17	—	2	—	4	—	1	1	13
24	1	1	3	3	—	—	9	16

Appendix Table 6. (cont.) Figures forming the basis for Figure 6.

Burials, weekly and three-weekly, moving weekly.

Date	Crosby Ravensworth, Cumbria				Awre, Gloucestershire			
	1729		Av. 1727-1737 less 1729		1729		Av. 1727-1737 less 1729	
	Weekly	3-weekly	Weekly	3-weekly	Weekly	3-weekly	Weekly	3-weekly
Oct. 1	—	1	—	5	—	1	6	19
8	—	—	2	6	1	1	4	12
15	—	—	4	8	—	1	2	14
22	—	—	2	6	—	1	8	14
29	—	1	—	2	1	2	4	15
Nov. 5	1	2	—	4	1	2	3	9
12	1	2	4	5	—	3	2	9
19	—	2	1	8	2	6	4	9
26	1	1	3	5	4	8	3	12
Dec. 3	—	1	1	7	2	8	3	9
10	—	—	3	7	2	4	3	11
17	—	—	3	9	—	6	5	14
24-31	—	—	3	—	4	5	6	—
Total	15	—	—	—	41	—	—	—

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