PAPERS AND SHORT REPORTS

Death rates from stroke in England and Wales predicted from past maternal mortality

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Abstract

Geographical differences in maternal mortality in England and Wales during 1911-4 correlate closely with death rates from stroke in the generation born around that time. The geographical distribution of stroke is more closely related to past maternal mortality than to any leading cause of death, past or present, except ischaemic heart disease, for which correlation coefficients with stroke are similar.

This relation is new evidence that poor health and physique of mothers are important determinants of the risk of stroke among their offspring.

Introduction

There are large and unexplained differences in death rates from stroke in different parts of England and Wales.[1] We have noted previously a geographical relation: between mortality from stroke and neonatal mortality 60 years ago.[2] As neonatal mortality was previously linked to poor maternal health and physique[3,4] we made a detailed geographical comparison of maternal mortality in the early years of this century and the death rates from stroke in the generation born during the same period.

Methods

Maternal mortality in England and Wales during the early years of the century has been analysed in two government publications covering the years 1911-4 and 1919-22, respectively.[5,6] Maternal mortality was defined as death directly attributable to pregnancy or childbirth. During 1911-4 there were 14 045 maternal deaths. These were divided into two groups—namely, those due to puerperal fever (4951) and those due to "other complications of pregnancy and parturition" (9094). During 1919-22 there were 13 465 deaths, with 5137 and 8328, respectively, occurring in these two groups. From 1921 all deaths of women in different areas were divided into 32 groups according to cause of death.[1] We derived crude death rates for 1921-5 using data from the population at the 1921 census.

The numbers of neonatal deaths (deaths in the first month of life) in different areas were published from 1911 onward.[1] To match the data on maternal mortality, rates per 1000 births were calculated for 1911-4, when there were 137 960 neonatal deaths.

The Office of Population Censuses and Surveys made available extracts from all death certificates in England and Wales during 1968-78,[2] the period covered by the eighth revision of the *International Classification of Diseases*. Our analysis is based on mortality at ages 55-74, as these are deaths occurring in the generation born around 1911-4. Sex specific rates were based on data from the 1971 census and were expressed as standardised mortality ratios. Stroke was defined as ICD 431-438, which is cerebrovascular disease other than subarachnoid haemorrhage. The stroke rates were based on 142 975 deaths in men and 134 503 deaths in women. The average annual rates were 2876/million men and 2233/million women.

We analysed mortality in the 154 local authority areas used by the Registrar General since 1911—that is, 80 county boroughs (larger towns), 15 London boroughs, and 59 administrative countries (aggregates of metropolitan boroughs, urban districts, and rural areas). The data for maternal mortality do not allow separate analysis of local authority groupings within administrative counties.

We used correlation coefficients and scatter plots to examine the relation among adult, maternal, and neonatal death rates. The values of the coefficients reflect not only the strength of a relation but also the numbers of deaths. The coefficient describing a relation will tend to have a larger absolute value with increasing numbers of deaths. To allow for differences in the size of the population among areas the correlation coefficients with maternal and neonatal death rates were weighted according to the numbers of deaths from stroke at ages 55-74 expected in each area, as calculated from national rates.

Results

Maternal mortality in England and Wales during 1911-4 was 4·0/1000 births. The rates ranged from 1·9/1000 in Rutland to 8·7/1000 in Merioneth. During 1919-22 the rate was 4·1/1000 births, ranging from 1·5/1000 in Rutland to 7·9/1000 in Brecon. The geographical distribution was similar during the two periods and was described as follows: "Maternal mortality tends to be highest in rural, sparsely populated counties, and in industrial districts, notably those associated with the textile industries in Lancashire and Yorkshire, and with coal mining; and tends to be lowest in the South of England, in districts in and around London, and in certain large towns, such as Birmingham, Manchester and Liverpool."[6] During 1911-4 the rates of

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maternal death from causes other than puerperal fever were 2·6/1000 in the county boroughs, 1·6/1000 in the London boroughs, and 2·6/1000 in the administrative countries. For deaths from puerperal fever the corresponding figures were 1·5/1000, 1·5/1000, and 1·4/1000.

Table I shows the causes, other than puerperal fever, of maternal death that were published for the two years 1913 and 1922.[5,6] The three leading causes were toxaemia (puerperal albuminuria and convulsions), puerperal haemorrhage, and other accidents of childbirth. Together these accounted for 67% of all "other" maternal deaths.

The standardised mortality ratios for stroke during 1968-78 among men aged 55-74 ranged from 60 in Westminster to 158 in Dewsbury and among women from 25 in the City of London to 146 in Wakefield. Their geographical distribution has been described elsewhere.[7] Among men the standardised mortality ratio was 110 in the county boroughs, 75 in the London boroughs, and 98 in the administrative counties; the corresponding figures for women were 105, 74, and 100.

We examined the correlation coefficients between maternal mortality during 1911-4 and standardised mortality ratios from the 25 leading causes of death at ages 55-74 during 1968-78. Leading causes of death were those for which more than 10 000 deaths occurred in each sex, or in the sex usually affected, during 1968-78. For total maternal mortality the highest correlation was with stroke (0·55) and, in descending order, ischaemic heart disease (0·47), stomach cancer (0·37), subarachnoid haemorrhage (0·30), chronic rheumatic heart disease (0·25), and cervical cancer (0·25). The coefficient for chronic bronchitis and emphysema was 0·02. Table II and subsequent analyses include lung cancer (−0·43) because of its association with cigarette smoking, a risk factor for vascular disease.

The correlation between maternal mortality and stroke depends on causes other than puerperal fever (figure). The coefficient is 0·65 (table II), and the statistical dependence is such that an increase of one maternal death from "other" causes/1000 births corresponds to an increase of 12 in the standardised mortality ratio for stroke.

Table III shows the correlations between causes of death in each sex and maternal mortality from other causes within county and London boroughs, administrative counties, and all areas combined. The coefficients for stroke were consistently high. Those for ischaemic heart disease were comparable, but for stomach cancer they were lower. All coefficients for lung cancer were negative. When mortality from stroke was correlated with maternal mortality from other causes during the later period, 1919-22, the coefficients were lower. The consistent relation between maternal mortality and both stroke and ischaemic heart disease, however, remained, while the relation with stomach cancer was greatly reduced. The coefficients for lung cancer were negative.

The correlations between the leading causes of death and neonatal mortality during 1911-4 differed from those between leading causes of death and maternal mortality from other causes during the same period. Though coefficients for stroke (0·60) and ischaemic heart disease (0·65) were similarly high, those for some other causes increased. In descending order they were: cancer of the rectum (0·57), stomach cancer (0·55), chronic bronchitis and emphysema (0·50), and cervical cancer (0·46). The coefficient for lung cancer was −0·01. Within each sex and geographical group the correlation between stroke and neonatal mortality (table IV) was less than that between stroke and maternal mortality from other causes (table III).

When standardised mortality ratios for stroke were correlated with those for other leading causes of death at ages 55-74 the rank order of the coefficients was ischaemic heart disease (0·72), stomach cancer (0·53), cervical cancer (0·49), cancer of the rectum (0·48), diabetes (0·42), and chronic bronchitis and emphysema (0·40). Within each sex and geographical group only coefficients for ischaemic heart disease were as high and

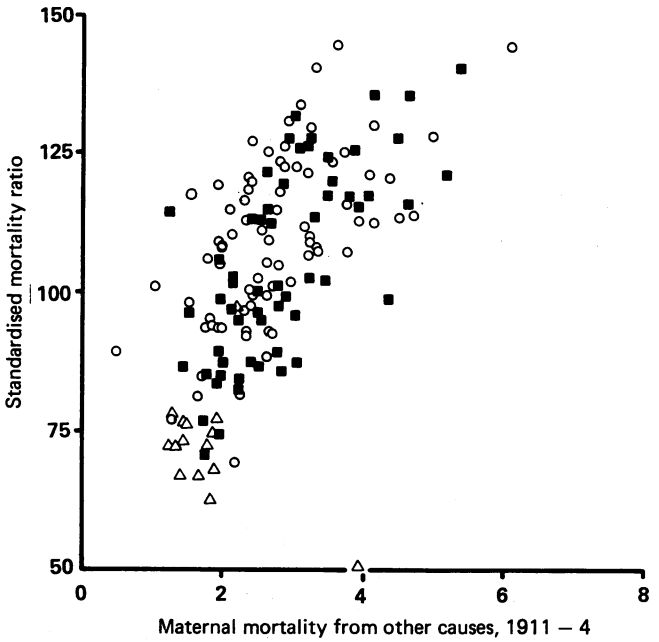
TABLE I—*Numbers (percentages) of maternal deaths by cause in 1913 and 1922, excluding deaths from puerperal fever*

Cause of death	1913	1922
Toxaemia	755 (32)	556 (29)
Puerperal haemorrhage	507 (21)	390 (21)
Other accidents of childbirth	374 (16)	304 (16)
Abortion	120 (5)	92 (5)
Other accidents of pregnancy	257 (11)	218 (12)
Puerperal embolism and sudden death	332 (14)	296 (16)
Puerperal insanity	28 (1)	30 (2)
Puerperal diseases of the breast	11	6
Total	2384 (100)	1892 (100)

*There were 1108 deaths from puerperal fever in 1913 and 1079 in 1922.

TABLE II—*Correlations between causes of death (standardised mortality ratios ages 55-74, 1968-78, both sexes) and maternal mortality (1911-4) in 154 areas of England and Wales*

Cause of death	ICD No (8th revision)	Puerperal fever	"Other" causes	All maternal mortality
Stroke	431-438	0·21	0·65	0·55
Ischaemic heart disease	410-414	0·17	0·56	0·47
Stomach cancer	151	0·21	0·40	0·37
Lung cancer	162	−0·24	−0·47	−0·43



Standardised mortality ratios for stroke (1968-78) at ages 55-74, both sexes, and maternal mortality/1000 births (1911-4) from causes other than puerperal fever in 154 areas of England and Wales.
○=County boroughs. △=London boroughs. ■=Administrative counties.

TABLE III—*Correlations between causes of death (standardised mortality ratios ages 55-74, 1968-78) and maternal mortality (1911-4 and 1919-22) from causes other than puerperal fever in two geographical groups*

	1911-4						1919-22					
	County and London boroughs		Administrative counties		All areas		County and London boroughs		Administrative counties		All areas	
Cause of death	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
Stroke	0·64	0·53	0·66	0·71	0·61	0·63	0·52	0·48	0·45	0·55	0·38	0·36
Ischaemic heart disease	0·76	0·72	0·72	0·47	0·60	0·46	0·62	0·59	0·49	0·45	0·40	0·35
Stomach cancer	0·43	0·47	0·60	0·62	0·38	0·36	0·23	0·33	0·41	0·51	0·04	0·11
Lung cancer	−0·22	−0·48	−0·49	−0·66	−0·39	−0·59	−0·37	−0·51	−0·52	−0·51	−0·39	−0·36

consistent as those for maternal mortality from other causes during 1911-4 (table V).

Maternal mortality from other causes during 1911-4 was correlated with mortality from other causes of death among women during 1921-5. The highest coefficients were for acute and chronic nephritis (0·57), non-respiratory tuberculosis (0·35), and cerebral haemorrhage (0·34). These were high in both geographical groups. For nephritis the coefficient was 0·45 in the county and London boroughs and 0·72 in the counties. For non-respiratory tuberculosis the corresponding figures were 0·29 and 0·60. For cerebral haemorrhage they were 0·31 and 0·31, respectively.

TABLE IV—*Correlations between causes of death (standardised mortality ratios ages 55-74, 1968-78) and neonatal mortality (1911-4) in two geographical groups*

	Geographical group					
	County and London boroughs		Administrative counties		All areas	
Cause of death	Men	Women	Men	Women	Men	Women
Stroke	0·56	0·46	0·52	0·55	0·61	0·54
Ischaemic heart disease	0·57	0·57	0·53	0·67	0·63	0·65
Stomach cancer	0·50	0·54	0·48	0·50	0·47	0·54
Lung cancer	0·04	−0·51	−0·18	−0·54	0·09	−0·38

TABLE V—*Correlations between death from stroke and other causes (standardised mortality ratios ages 55-74, 1968-78) in two geographical groups*

	Geographical group					
	County and London boroughs		Administrative counties		All areas	
Cause of death	Men	Women	Men	Women	Men	Women
Ischaemic heart disease	0·72	0·73	0·77	0·59	0·73	0·64
Stomach cancer	0·48	0·50	0·68	0·64	0·53	0·47
Lung cancer	0·03	−0·56	−0·18	−0·70	0·01	−0·60
"Other" maternal mortality 1911-4	0·64	0·53	0·66	0·71	0·61	0·63

The standardised mortality ratios for stroke were correlated with the crude death rates in both sexes for all 32 causes of death during 1921-5. After maternal deaths from other causes (0·66) and a group of causes of infant death (0·54, shortlist No 28) the highest coefficients were for non-respiratory tuberculosis (0·46), rheumatic fever (0·42), influenza (0·40), and cerebral haemorrhage (0·37).

Discussion

We have shown that current death rates from stroke in different areas of England and Wales can be closely predicted from maternal mortality, from causes other than puerperal fever, 75 years ago (figure). This geographical relation is consistently close in both sexes, in towns, and in counties (table III). Its specificity is remarkable. Among other current causes of death only ischaemic heart disease correlates as closely with both current mortality from stroke and past maternal mortality (tables II, III, and V). The relation between stroke and maternal mortality is so strong that the correlations exceed those between either cause of death and past mortality from any cause.

The relation is closer for maternal mortality around the years of birth of the people who died from stroke than for later years (table III). It is restricted to maternal death from causes other than puerperal fever. The geographical distribution of deaths from puerperal fever differed from that of maternal deaths from other causes and was thought to be determined largely by midwifery practices.[6] Most "other" deaths, which made up 65% of all maternal deaths, were certified as being due to toxaemia, puerperal haemorrhage, or other accidents of childbirth (table I). Their geographical distribution was similiar to that of mortality from two chronic diseases: nephritis and non-respiratory tuberculosis.

Campbell *et al*'s analyses of the causes of maternal mortality in Britain clearly implicated the poor physique and health of mothers.[6,8] This was a result of poor nutrition and ill health among young girls and of rickets and the industrial employment of children. Stroke is more closely and specifically related to maternal mortality than to neonatal mortality (table IV) despite the small number of maternal deaths—10% of the total of neonatal deaths—which would tend to diminish correlations. This emphasises an association with maternal influences rather than the neonatal environment. The strong negative correlations with lung cancer (tables II, III, and V) show that the relation between stroke and maternal mortality is not determined by a confounding relation with cigarette smoking.

Hypertension is one of the possible links between maternal health and stroke. A parental history of hypertension increases the risk of hypertension in the offspring,[9,10] and hypertension is a risk factor for stroke.[11] There is increasing evidence that hypertension originates in childhood.[12] The persistence of rank order of blood pressure between patients examined at intervals—so called "tracking"—has been repeatedly observed in longitudinal studies of children as well as of adults,[13-16] though the tracking coefficients in children are lower than those in adults.[12] Three studies of infants have shown small correlations between maternal blood pressure and systolic or diastolic pressure in the neonatal period.[17-19] In one of the studies the correlations with both systolic and diastolic pressure were shown to persist at 12 months.[18]

A link between the intrauterine environment and hypertension is suggested by the negative relation between birth weight and blood pressure. In a national sample of 3240 children born in Britain and followed up to the age of 36 there was an inverse relation between birth weight and systolic pressure in both men and women.[20] Two studies have shown a similiar inverse relation in children aged 7 and 10 years.[21,22] As an alternative to a direct intrauterine influence on blood pressure Ounsted has suggested that the accelerated growth of healthy babies of low birth weight during the first six months may be accompanied by an accelerated increase in blood pressure.[23] The resulting above average values may persist.

Studies of the relation between body weight and stroke point to the importance of growth during adolescence. Evidence whether obesity is a risk factor for stroke is conflicting,[11] but three studies have shown that obesity at around 20 years of age is associated with an increased risk.[24-26] In one of these studies short stature was also a risk factor.[24]

Baird has related the large geographical differences in perinatal mortality in Britain during this century to differences in the physique and health of women.[3] Poor living standards, which accompanied industrialisation or economic depression in certain areas, adversely affected the development of young girls and impaired their subsequent reproductive efficiency. We suggest that the close geographical relation between past maternal mortality and current mortality from stroke indicates that this impaired reproductive efficiency is also expressed as an increased risk of stroke in the surviving offspring.

This interpretation may explain the paradox that while the time trends of stroke and ischaemic heart disease in Britain are in opposite directions the geography of the two diseases is similar, both being more common in poorer areas and lower income groups.[27] The increased incidence in ischaemic heart disease during this century is attributed to affluence, in particular diet, during adult life. We have previously suggested that, in contrast, the geography of the disease reflects differences in susceptibility related to adverse maternal and early postnatal influences.[2] We suggest here that both the decrease in mortality from stroke during the past 40 years and its geographical distribution reflect a dominant effect of maternal physique and health.

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Type A behaviour and ischaemic heart disease in middle aged British men

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Abstract

The Bortner questionnaire, which measures aspects of type A (coronary prone) behaviour, was completed by 5936 men aged 40-59 selected at random from one general practice in each of 19 British towns. The presence of ischaemic heart disease was determined at initial examination and the men were followed up for an average of 6·2 years for morbidity and mortality from myocardial infarction and for sudden cardiac death.

Non-manual workers had significantly higher scores (more type A) than manual workers and the score decreased (less type A) with increasing age. After adjustment for social class and age men with higher scores had higher prevalences of ischaemic heart disease less marked for electrocardiographic evidence and more marked for response to a chest pain questionnaire (angina or possible myocardial infarction). A man's recall of a doctor's diagnosis of ischaemic heart disease, however, did not relate to his Bortner score. There was no significant relation between the Bortner score and the attack rate or incidence of major ischaemic heart disease events.

In this study type A behaviour, as measured by the Bortner questionnaire, did not predict major ischaemic heart disease events in British middle aged men.

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Introduction

Type A or coronary prone behaviour is characterised by intense competitiveness, a sense of being under time pressure, and easily provoked hostility. Type A behaviour has been shown to relate to the prevalence and incidence of ischaemic heart disease independently of the traditional risk factors of hypertension, hypercholesterolaemia, and cigarette smoking in several countries, but it has not been examined extensively in the United Kingdom.[1-3]

We describe the relation between type A behaviour and the prevalence and attack rate of ischaemic heart disease in roughly 6000 middle aged British men selected at random from one general practice in each of 19 British towns as part of the British regional heart study. Type A behaviour was assessed by using the Bortner questionnaire, a 14 item questionnaire which is used extensively in Great Britain and western Europe.[4] We find that it has adequate reliability and that it relates well to the Jenkins activity survey, the questionnaire more widely used in North America.[5]

Subjects and methods

The British regional heart study is a prospective study of men aged 40-59 randomly selected from the age-sex registers of one group general practice in each of 24 towns in England, Wales, and Scotland. The 24 towns were primarily selected from those with populations of 50 000-100 000 (1971 census). They were chosen to represent the full range of cardiovascular disease mortality and included towns in all the main regions. Each general practice was selected to have a social class distribution which was more or less representative of the men of that town. From each age-sex register some 420 men aged 40-59 were randomly selected and in a letter signed by their general practitioner invited to take part. On average 78% of those invited attended for examination and 7735 men were screened. The Bortner questionnaire was given to the 6177 men in the last 19 towns to complete while they waited to be examined. This paper is concerned with the 5936 men who satisfactorily completed the Bortner questionnaire.