2 History and scope of the OPCS Longitudinal Study

The first part of this chapter describes the main factors which led to the inception of the OPCS Longitudinal Study (LS), while the second part provides a broad overview of some of the ways in which the study may be used for analysis. This draws on the early OPCS publication *Cohort Studies: New Developments*[1] and, where appropriate, illustrative examples from previous research. Although these examples cover some of the most significant LS work it is important to stress that they represent only a selection of the research that has used the Longitudinal Study. A comprehensive list of LS publications, reproduced in Appendix XV, provides an indication of the full range of LS work.

2.1 THE HISTORY OF THE LS

Two factors were particularly important in the decision to set up the LS in 1974.[1] These were concern over the limitations of the occupational data collected at death registration which were used to calculate occupational mortality rates, and a need for more information on fertility patterns, particularly changes in birth spacing.

In the late 1960s and early 1970s a great amount of interest was generated around the issue of occupational health. The Employment Medical Advisory Service (EMSA) and the Health and Safety Executive (HSE) were established in 1973 and 1974 respectively, and there was considerable interest in the health of occupational groups such as coal miners.

During this period the inability of existing mortality data to provide adequate information for studies of occupational mortality had been targeted as a particular problem. In order to provide evidence for a causal relationship between occupation and mortality, information on occupation is needed for a period well before the onset of illness and death. At the time, it was accepted that there were problems both with the range of questions asked and the quality of data recorded at death registration. In order to avoid the duplication of information provided on other occasions, such as the census, and because such information may not be known to the informant, it is not feasible to include questions on educational qualifications, housing tenure and circumstances at death (or birth) registration. Also, there was great concern about the accuracy with which information on occupation was recorded at death registration. Inaccuracies may be the result of a deliberate misinterpretation or simple ignorance of the deceased's occupation. For example, the tendency of informants to 'promote' the deceased person at death registration, by giving a more highly skilled or responsible job, has been widely documented.[2]

At the same time it was acknowledged that there were a number of shortcomings associated with the method used to calculate the mortality rates published by OPCS in the regular decennial supplements.[3] Using this method the number of deaths (the numerator) occurring in a given calendar year is divided by an estimate of the total population on 30 June (the denominator). Deaths are therefore characterised by the information on the death certificate, while estimates of the mid-year population are derived from the most recent census, updated to reflect subsequent births, deaths and migrations. Although this is satisfactory for annual mortality statistics, problems arise when the method is used to calculate occupational mortality rates. As there are differences in the collection of occupation at death and at census (e.g. the census records occupation with respect to the previous week), rates calculated using this method are prone to numerator/denominator bias.

Another limitation of the method used to calculate mortality rates concerns chronic diseases which may develop over a period of many years.[1] In the late 1960s, published mortality statistics were mostly based on the individual's characteristics at death rather than those at an earlier date. Job mobility, even when it is not health-related, means that occupational mortality statistics calculated in this way fail to take into account those individuals who have been exposed to an occupational hazard in one job and who then move to an alternative occupation before the effects become apparent. It was evident from this that traditional mortality data did not stand up to detailed examination and that the quality of mortality statistics, including those covering chronic diseases would be greatly improved if the data were to be analysed in terms of the individual's characteristics (occupation, employment status, area of residence, etc.) some years before death.

It was also accepted that there was a need for more detailed information on fertility patterns, in particular changes in the spacing of births, and the part that social and economic characteristics play in family formation.[1] Although the General Household Survey (GHS) has included questions on the number and spacing of children since it began in 1971, the total sample sizes were too small to allow the required level of analysis. Moreover, the cross-sectional nature of the surveys meant that complete fertility histories could only be constructed using the information derived from retrospective questions.

At the time it was decided that it was not feasible to extend the range of questions asked at birth registration - either to provide information on the interval between successive births or on those factors such as education which may influence fertility trends. Changes such as these would have required legislation and though field tests to assess the

impact of an additional question on the exact date of birth of the preceding child had been received favourably, there were marked differences in the accuracy of response. These showed that when a father registered the birth the replies were considerably less accurate than those registered by the mother.

As a way of addressing these problems, OPCS decided to make better use of existing data sources by establishing a longitudinal study based on linked census and vital registration data (births, deaths, cancer registrations) for a 1 per cent sample of the population of England and Wales, selected on the basis of four dates of birth equally spaced throughout the year. Significantly for the LS, the 1971 Census was the first British decennial census to include a question on date of birth (rather than age) and in 1969 the particulars collected at birth and death registration had also been modified to include date of birth instead of age. This facilitated their use in research studies, particularly those based on the linkage of different vital events. Finally, the advances in computing techniques which occurred in the sixties made a data linkage study like the LS possible.

Initially, it was envisaged that the LS would be used for a wide range of mortality and fertility analyses based on the demographic, social, economic and environmental factors recorded at census. This would allow an assessment of the relative contribution of factors such as social class and employment status on adult mortality rates, and overcrowding and birth spacing on infant mortality. The primary aim of linking cancer registration data with data from the 1971 Census was to improve the analysis of occupational cancer. However, it was also suggested that the data would provide information on the relationship between the incidence of cancer of the cervix uteri and previous reproductive history, and on the coverage and effectiveness of the cytological examination scheme.

There was also the potential for interrelating data from different types of events, for example in studies of infant mortality or cancer survival, so that with time the LS could be used to explore inter-generational differences in fertility and mortality. Finally, the longitudinal nature of the study and the fact that it was based on individual-level micro-data greatly enhanced the opportunity for using multivariate statistical techniques.

2.2 THE SCOPE OF THE LS

The LS has been used for a wide range of analyses, not all of which were envisaged when it began. The remainder of this chapter provides an overview of the ways in which LS data may be used. This covers each of the three distinct types of longitudinal analysis which may be carried out using the LS, plus a brief discussion of how the study may be used for cross-sectional and international comparative analyses.

2.2.1 The scope of the LS for longitudinal analysis

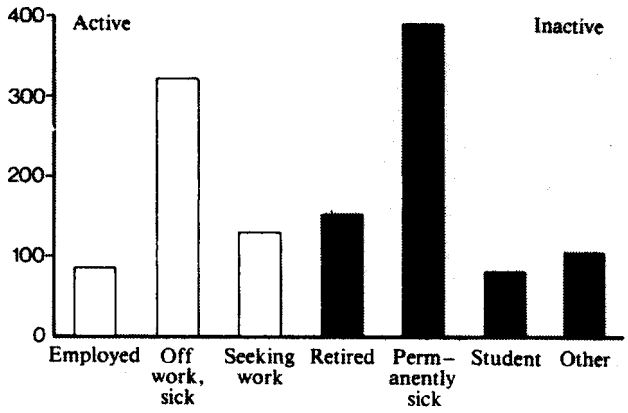
The ability of the LS to link census data with that from vital event registration opens up a number of opportunities for analyses using more than one time point. Each of the three ways in which the longitudinal strengths of the study may be exploited are outlined below, using examples from published research.

2.2.1.1 Prospective analysis of census and event data

In addition to its original use for the study of occupational mortality, the linkage of census and vital event registration data offers a wide range of opportunities for analyses of socio-demographic differences in mortality, the incidence of cancer, fertility and migration behaviour.

One of the most significant findings of the early work by Fox and Goldblatt[4] concerned the relationship between employment status and mortality. Fox and Goldblatt showed that whereas men and women who were in work the week before census had low mortality, those who were unemployed, particularly those who gave sickness as their reason for being out of work, had significantly higher mortality (see Figure 2.1, which compares male mortality by 1971 economic position). This highlighted the importance of analysing mortality data by economic position as well as occupation.

Figure 2.1 Mortality of males aged 15-64 by economic position



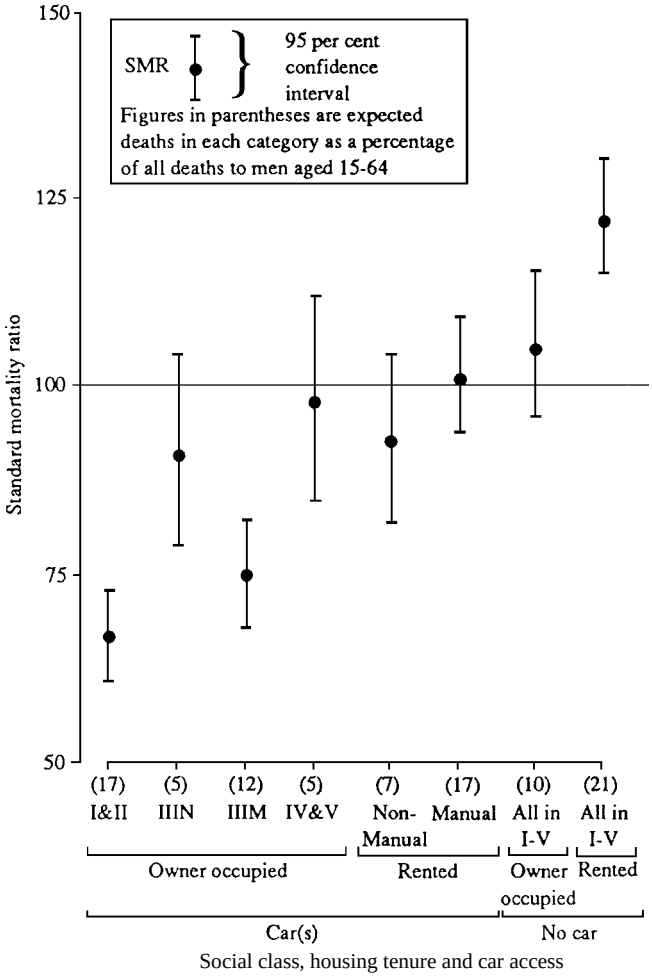
Source: Fox A.J. and Goldblatt P.O. 1971-1975 *Longitudinal Study: Socio-demographic mortality differentials, LS series no. 1.* London: HMSO, 1982

Although earlier prospective studies such as Fox and Collier[5] had indicated the general well-being of those in employment, the LS was the first population-based sample to provide evidence on the magnitude of the 'healthy worker effect', the size of the groups affected and the rate at which this effect wears off with time. It is also significant that the study identified the economic positions that were associated with ill-health selection (the temporarily sick and the permanently sick). While this provided some valuable information on social class mortality differentials, the follow-up period (1971-75) was not long enough to provide conclusive evidence on the rate at which the effect wears

off. (Further details of work into the 'healthy worker effect' are reported below.)

Linked census and mortality data have also been used as alternative measures of social classification - the main findings of which are published in Goldblatt.[6] Goldblatt *et al.* showed that though the Registrar General's social class is a reliable method of classification for investigating male mortality differentials, the use of housing tenure and car access offers some improvement (see Figure 2.2).

Figure 2.2 Mortality, 1976-81, of men aged 16-64 by social class, housing tenure and access to cars



Source: Goldblatt P.O. *1971-1981 Longitudinal Study: Mortality and social organisation LS Series no.6*, HMSO (London 1990).

Over the last decade there has been considerable discussion of the inadequacy of the Registrar General's measure of social class for investigating differences in women's mortality. Some of the criticisms raised concern about the way in which the classification fails both to adequately distinguish between jobs done by women and to fully reflect women's skills and responsibilities. Increasingly, it has also been shown that social class underestimates the number of men at the lower extremes of the social and economic spectrum. As a result, the use of additional measures reflecting tenure and car ownership, has been explored. When combined with social class these 'asset measures' produce larger groups which are differentiated according to social and economic well-being.

At the 1971 Census approximately 3 per cent and 6 per cent of the LS sample were classified to Social Classes I and II. Figure 2.2 shows that of the men aged 15-64 years at the 1971 Census, those with the most advantageous characteristics (owner-occupiers with car access, Social Classes I and II) accounted for 17 per cent of expected deaths in the period 1976-81 with a standardised mortality ratio (SMR) of 67. Those without access to a car and living in rented accommodation accounted for 21 per cent of expected deaths (SMR = 123). This compares with results based solely on social class which showed that 5 and 7 per cent of expected deaths in the period were attributed to those in Social Class I and V. (The SMRs were similar, at 67 and 125.) The fact that the larger groups produced using a combination of 'asset measures' have the same SMRs as the much smaller ones based exclusively on social class (as defined by occupation) shows that health inequalities are a phenomenon which continues to affect a sizeable proportion of the population.

Continuing reservations about the poor quality of occupational information for women prompted Moser, Pugh and Goldblatt[7] to use LS census and mortality data to investigate several alternative measures of socio-economic status for analysing differences in women's mortality. As well as key household indicators such as housing tenure and car access, they examined the effects of life cycle stage, in this case by focusing on married women and using the age of the youngest child. In recognition of the fact that the lives, employment patterns and domestic responsibilities of married and single women are different, a crude distinction was made between single women, married women classified to an occupation and 'unoccupied' married women. (The last of these categories includes both housewives and those who were 'permanently sick'.)

Results suggest that for single women, car access and own social class were both important discriminators, while for 'unoccupied' married women car access and husband's social class were most significant. Although there were differences for married women with an occupation, these were less marked. Furthermore, for married women the effects of life cycle stage and economic activity are associated with further differentiation in mortality. Mortality levels were found to be lower for those with dependent children than for housewives without children or with older children.

Another of the study's contributions to the understanding of occupational mortality concerns deaths at older ages, which had been neglected by previous decennial supplements. Goldblatt[6] used both individual and household-based measures to summarise socio-economic differences in male deaths during the period 1976-81. While all the measures identified differences in mortality in each of the age groups, housing tenure appeared to be most suitable for highlighting the variation in deaths at older ages (over 75). Both the proportion assigned to a social class and those with access to a car decreased with age. Goldblatt also demonstrated that the use of housing tenure is particularly valuable for summarising mortality differences among elderly women. For not only was

occupation seldom recorded for these women, but the majority were widowed and therefore could not be allocated to a social class on the basis of their husband's occupation.

Linked census and mortality data covering this period (1976-81) also confirmed a number of features of the 'healthy worker effect'. As Table 2.1 demonstrates, though the mortality rates for those employed at the 1971 Census were generally below those of other men and women in the LS, this relative advantage decreased with length of follow-up. Although they followed a similar pattern to that of employed men, mortality ratios were lowest among women and at older ages. As a result, differences between the mortality of those in employment in 1971 with those for all men and women in the LS were lowest in middle age, during the later follow-up period.

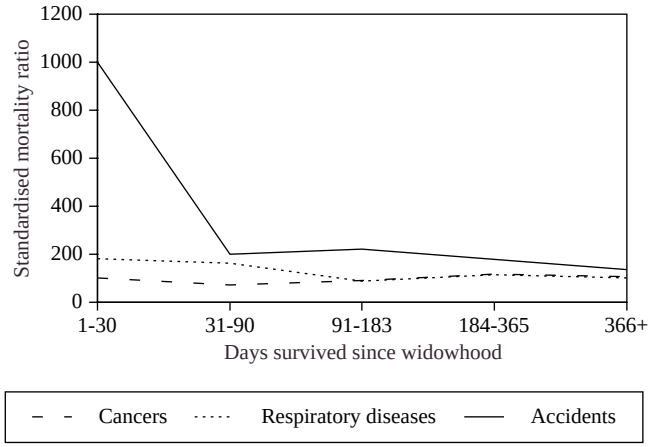
The inclusion of LS mortality data relating to the LS member's spouse offers scope for additional mortality analyses. For example, Jones and Goldblatt[8] used this for a study of post-bereavement mortality in the period 1971-81. Figures 2.3 and 2.4, based on LS mortality data for three major causes of death, demonstrate the pattern of deaths which occurred following bereavement. These show that for widows the majority of deaths occurred in the first six months after bereavement, while for widowers deaths occurred over a longer period of at least a year. In both groups, the raised mortality observed in the early months

Table 2.1 Death rates in 1971-81 for men and women employed in 1971 by calendar period and age at death

Age at death	Men				Women			
	Death rates*		Age-specific ratios†		Death rates*		Age-specific ratios†	
	1971-75	1976-81	1971-75	1976-81	1971-75	1976-81	1971-75	1976-81
20-24	622	643	87	60	502	245	104	58
25-29	704	692	86	86	512	330	85	87
30-34	767	902	87	89	568	733	65	106
35-39	1,127	1,394	82	89	773	766	73	98
40-44	2,259	2,368	89	91	1,986	1,339	101	105
45-49	4,500	4,336	88	97	2,326	2,711	74	91
50-54	7,359	7,995	87	93	4,374	4,326	79	87
55-59	13,040	13,188	85	95	6,349	6,366	79	84
60-64	19,618	22,493	83	94	9,535	10,824	71	88
65-69	32,169	35,093	77	90	10,592	15,000	52	81
70-74	43,100	53,235	67	85	21,677	24,468	62	78
75-79	63,494	84,062	68	85	24,395	42,022	42	75
80 and over	114,435	115,930	79	83	35,854	80,880	38	87

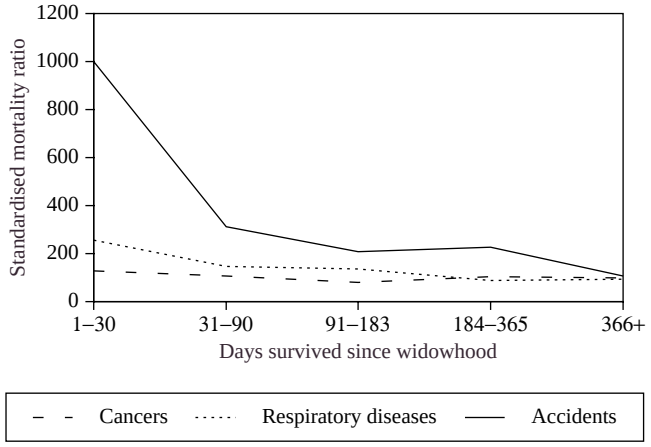
* Rate per million person-years at risk.
† Ratio of the age-specific rate for the employed to that for all men or women in the LS.
Source: Goldblatt P.O. *1971-1981 Longitudinal Study: mortality and Social Organisation,* OPCS Series LS no. 6, HMSO (London 1990).[6]

Figure 2.3 1971-1981 Mortality by interval since widowhood for selected causes of death



Source: Jones D.R. and Goldblatt P.O. Was Ciocco right? Cause of death in the widow(er)ed and their spouses in the OPCS Longitudinal Study, *Journal of Biosocial Science,* **19: 1,** 1987, pp 107-121.

Figure 2.4 1971-1981 Mortality by interval since widowerhood for selected causes of death



Source: Jones D.R. and Goldblatt P.O. Was Ciocco right? Cause of death in the widow(er)ed and their spouses in the OPCS Longitudinal Study, *Journal of Biosocial Science,* **19: 1,** 1987, pp 107-121.

declined steadily with the time since bereavement to the expected level. The figures demonstrate the high relative risk of death due to accidents and poisoning in the period after bereavement. However, it appears that even at younger ages, few of these were 'simultaneous accidental deaths', e.g. the death of both spouses in a car accident.

Linked census and cancer registration data have been used by Leon[9] to study social differences in the incidence of cancer. The ability to link post-census cancer registration data to individual census records has a number of advantages for the study of cancer incidence and clearly distinguishes the LS from the majority of investigations in this area. Studies based on cancer registrations provide a much larger number of events than those based on deaths, as inclusion is independent of survival. This is particularly relevant for those cancers with good to moderate prognosis, where substantial gains are made in terms of statistical power when registrations are used in preference to mortality data.

In this work, Leon investigated the differences in cancer incidence attributed to area of residence, marital status, fertility history and five different measures of socio-economic position in the five-year period following the 1971 Census (1971-75). The socio-economic differences shown by the study are generally in accord with findings reported elsewhere. For example, the incidence rates for cancers of the cervix, stomach and lung were greatest among the 'disadvantaged' sections of the study population, while those for cancers of the breast and ovary tended to be greatest among the 'advantaged' sections.

Leon also looked at the relationship between fertility history and cancer incidence, using information derived from the 1971 Census fertility questions asked of ever-married women aged between 16 and 59. Despite the restriction this placed on analysis, the study provided further confirmation that women who are childless have a higher risk of cancers of the breast, 'other uterus' and ovary compared with those who have had children (within marriage). In addition, it showed that the older a woman is at the birth of her first child, the lower her risk of cervical cancer (see Table 2.2).

Another potential use for linked census and event data in the LS is for the analysis of socio-economic differences in fertility and birth outcome. Werner[10] used details of births registered between 1971 and 1980 to a group of female LS members, to provide information on aspects of the women's early childbearing histories including age at first birth. Figure 2.5 shows the variation in the proportion of women who became mothers before their twenty-fifth birthday according to their family background. Whereas less than one third of women from owner-occupied homes had become mothers by the age of 25, over half of those in local authority housing had had children. As the figure demonstrates, this difference was even greater when the

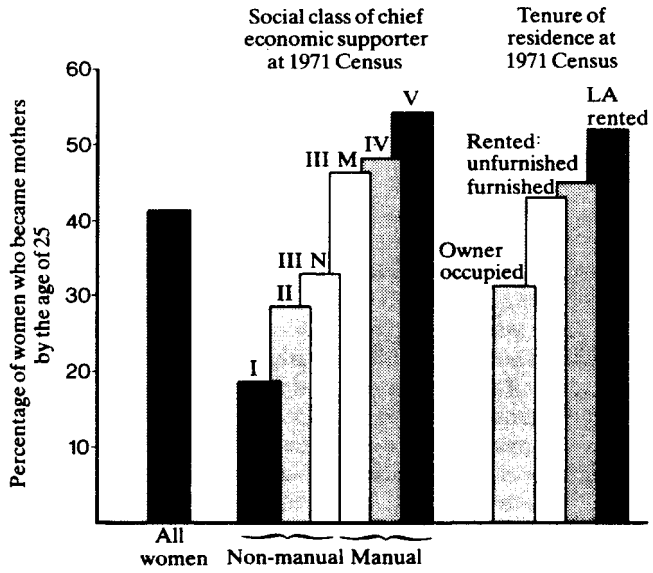
Table 2.2 Cervical cancer registrations among ever-married women aged 16-59 at the 1971 Census by age at registration, type of lesion and age at first birth, 1971-75

Note: the statistics in each cell are: standardised registration ratios (top row); observed and expected number of registrations (middle row); and 95% confidence intervals (bottom row).

Age at birth of first child (years)	Type of lesion						
	In-situ		Invasive*		All carcinoma of cervix		
	16-39	40-64	16-39	40-64	16-39	40-64	16-64
16-19	**175** 17 9.7 102-281	**181** 4 2.2 50-466	**318** 7 2.2 128-656	**154** 8 5.2 66-303	**202** 24 11.9 129-300	**162** 12 7.4 84-283	**187** 36 19.3 131-258
20-24	**114** 35 30.6 80-159	**106** 14 13.2 58-178	**68** 5 7.4 22-158	**115** 35 30.5 80-160	**105** 40 38.0 75-143	**112** 49 43.7 83-148	**109** 89 81.7 87-134
25-29	**45** 6 13.2 17-99	**101** 11 10.9 50-181	**54** 2 3.7 7-195	**83** 23 27.8 52-124	**47** 8 16.9 20-93	**88** 34 38.7 61-123	**76** 42 55.6 54-102
30 and over	**50** 1 2.0 1-279	**53** 3 5.7 11-154	**167** 1 0.6 4-929	**61** 10 16.4 29-112	**77** 2 2.6 9-278	**59** 13 22.1 31-100	**61** 15 24.7 34-100
All parous women†	**106** 59 55.5 81-137	**100** 32 32.0 68-141	**108** 15 13.9 60-178	**95** 76 79.9 75-119	**107** 74 69.4 84-134	**97** 108 111.9 79-117	**100** 182 181.3 86-116

* Carcinoma of cervix excluding in-situ. † Excluding women with age at birth of first child not stated.
Source: Leon D.A. *1971-1975 Longitudinal Study: social distribution of cancer*, OPCS Series LS no. 3, HMSO (London 1988).[9]

Figure 2.5 Percentages of women born in 1955-59 who were mothers before their 25 birthday



Source: Werner B. Fertility and family background: some illustrations from the Longitudunal Study. *Population Trends*, **35**, 1984.

women were classified according to the social class of the chief economic supporter (CES) at the 1971 Census. The proportion of women who became mothers by age 25 ranged from 19 per cent of those with CESs in Social Class I to 55 per cent of those with CESs in Social Class V.

Linked census and birth registration data have also been used by Fox[11] to study social class and occupational mobility. This work, which compared the occupational information recorded at the 1971 Census and at birth registration for a subgroup of LS men who became fathers between 1971 and 1977, provides an indication of the main directions of movement and variations between subgroups at this important stage of men's family life cycle.

The main findings indicate that, after allowing for recording and coding differences between census and birth registration, social mobility occurred from all social classes to Class II (the group which includes managers and senior administrators). The groups of men who experienced high rates of upward mobility include those living in the South East, those who had moved between local authorities in the year before census and those in owner-occupied accommodation. A combination of these characteristics was associated with particularly high rates. By comparison, upward social mobility was low for those men living in the North and for those in local authority accommodation.

Linked census and event data may also be used to examine the relationship between life cycle events such as marriage, childbirth, divorce, retirement and subsequent migration. For example, Grundy[12] used the LS to look at the effects of marriage on women's migration. In this instance the LS was chosen in preference to other datasets based on survey data which are generally too small to investigate some of the complex relationships between life cycle events and geographic mobility. Results from Grundy's work show that most women experienced a change of address at, or soon after, marriage. Migration rates varied according to the women's circumstances and those who were relatively disadvantaged experienced more difficulty in establishing an independent home at the time of their marriage.

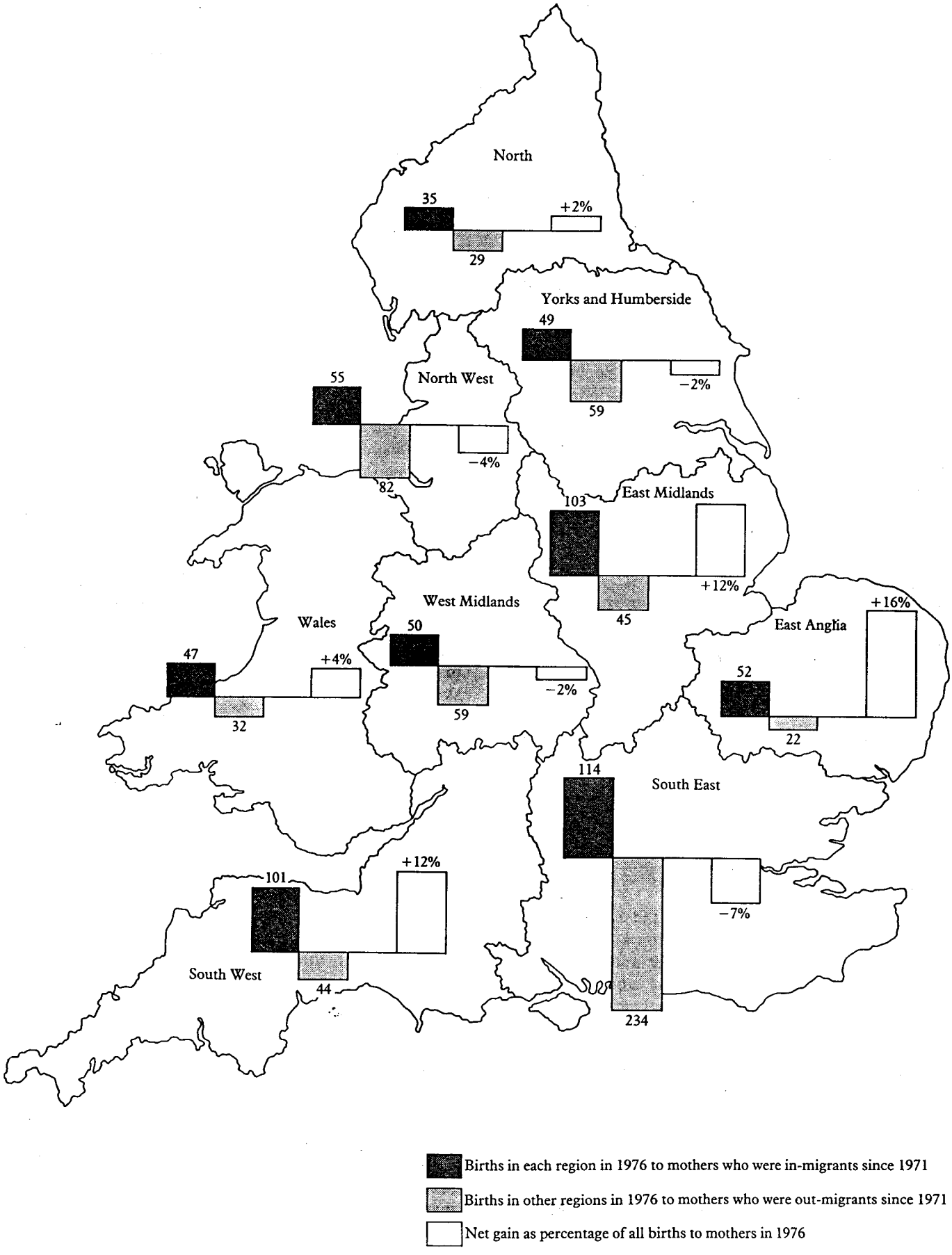
Grundy also observed regional variations in the proportion of women moving in the early years of marriage. Although the net population changes were not large, except in East Anglia and the East Midlands which were both net gainers of the newly married, Figure 2.6 illustrates that the migration of young women of childbearing age had an indirect effect on regional population growth. This figure shows the number of births in each region to women who were living in another region in 1971 ('in-migrants'), the number of births which occurred elsewhere to women who had left the region ('out-migrants') and the net gain in births expressed as a percentage of the region's total births in 1976. While East Anglia, the East Midlands and the South West made the greatest gains in the proportion of births due to inter-regional migration, the South East sustained the greatest losses.

LS census and mortality data have been used by Britton *et al.*[13] to analyse geographic differences in mortality. Part of this work involved classifying individuals according to a 36-category classification based on the socio-economic characteristics of the area in which they were living in 1971. Results show that mortality was raised for both males and females in areas such as urban council estates and 'areas of older settlement', both of which were defined as 'low status'. In comparison, below average mortality was observed in virtually all of the areas classified as 'high status'. These mortality differences persisted when the data were grouped by broad region - the North and West, Central and the South and East. For example, within each grouped region the 'low status' areas had the highest levels of mortality and those classified as 'high status' had the lowest.

The fact that the LS also records information on other household members resident at the time of the census means that the study may be used to investigate inter-generational effects. There is scope to examine the influence of family of origin on fertility and birth outcome, the incidence of cancer and subsequent mortality. Information on fertility history recorded by the 1971 Census may be used, for example, in association with birth registration data to describe and model inter-generational patterns of teenage fertility. It is important to note that, with time, this aspect of the study's potential will be enhanced, as events are linked into the study and complete fertility histories are achieved for successive cohorts of female LS members.

Leon[14] has used socio-economic information from the 1971 Census together with information on infant deaths recorded to female LS members to explore inter-generational differences in neonatal and post-neonatal mortality (i.e. infant deaths recorded in the first 28 days and between 1 month and a year). Preliminary results are summarised in Table 2.3. This gives the post-neonatal risk ratios by the

Figure 2.6 Regional gain or loss of births in 1976 due to net inter-regional migration between 1971 and 1976



Source: Grundy E.M.D. *Women's migration: marriage, fertility and divorce*, LS Series no. 4, HMSO (London 1989).

Table 2.3 Postneonatal risk ratios by social class of grandfather at 1971 Census adjusted for selected factors sample members aged <16 at 1971 Census, 1971-88

Grandfather's social class at 1971 Census	Interval	Interval + maternal age	Interval + parity	Interval + maternal age + parity	Interval + maternal age + parity + father's social class
Non-manual	1.00	1.00	1.00	1.00	1.00
Manual	1.81 (1.06-3.09)	1.76 (1.03-3.02)	1.77 (1.03-3.04)	1.58 (0.92-2.70)	1.61 (0.93-2.78)
Other	2.08 (0.81-5.32)	2.01 (0.78-5.16)	2.00 (0.78-5.17)	1.71 (0.66-4.40)	1.73 (0.67-4.49)
Family household: no grandfather	2.64 (1.33-5.25)	2.50 (1.25-4.99)	2.52 (1.26-5.05)	2.14 (1.07-4.28)	2.14 (1.07-4.31)
Non-family private household	1.45 (0.33-6.32)	1.34 (0.31-5.89)	1.36 (0.31-5.98)	1.10 (0.25-4.83)	1.09 (0.25-4.83)
Non-private household	4.21 (1.40-12.69)	4.06 (1.34-12.25)	4.12 (1.36-12.44)	3.45 (1.14-10.46)	3.42 (1.13-10.38)

Source: Leon D (1993) personal communication.
Note: The relevant 95% confidence intervals are shown in brackets. The term 'interval' refers to the period in which the birth occurred.

LS member's father's social class in 1971 (referred to in the table as 'grandfather's social class'), adjusted for selected factors including the period or 'interval' in which the birth occurred. (The relevant 95 per cent confidence intervals are shown in brackets.)

The results show that for post-neonatal deaths there is an effect attributable to the LS member's father's social class. Women whose fathers recorded a manual occupation at the 1971 Census were more likely to experience post-neonatal death of an infant than those with non-manual fathers. However, this relationship was reduced slightly and became non-significant after controlling for maternal age and father's social class at birth registration.

2.2.1.2 Prospective analysis of data from successive censuses

The second way of capitalising on the longitudinal nature of the LS is to use it to analyse changes which have taken place between the 1971, 1981 and 1991 Censuses. Researchers representing a wide range of interests have used the LS in this way to examine the changes in housing tenure, car ownership, migration behaviour and occupational mobility which occurred between the 1971 and 1981 Censuses.

Hamnett and Randolph[15] used the LS to investigate the process of tenure-specific polarisation in Greater London between 1971 and 1981. The results of this work suggest that there was a distinct tendency towards polarisation in the two dominant tenures over this period. The composition of the local authority sector shifted significantly towards the economically inactive and unemployed. It became increasingly associated with the elderly and the economically marginalised (those who had been displaced from the workforce either into unemployment or unpaid domestic labour). By comparison, the owner-occupied sector became increasingly characterised by economically active households with children. Hamnett and Randolph showed that this tendency (towards polarisation) was further reinforced by those moving into and out of the two major tenures.

The change in housing conditions between 1971 and 1981 has also been the focus of research carried out by Williams and Dale.[16] Although the period 1971-81 was characterised by a reduction in the proportion of the population living in overcrowded housing or in properties lacking essential amenities, nonetheless Williams and Dale showed that the problem of inadequate housing conditions persisted for significant subgroups of the population. Those of Asian ethnic origin were very much more likely to experience overcrowding than any other ethnic group and elderly people were identified as the group most likely to lack an inside WC or bath. Large households containing more than one family, or with several children, were most likely to be overcrowded. While part of this work used linked census data, the results presented above are based on cross-sectional comparisons. Further results of this work, based on a multivariate analysis incorporating these factors are reported in Williams and Dale.[17]

Linked census data were used by Holmans, Nandy and Brown[18] to look at the effects of household dissolution and formation. Here the choice of the LS was significant as previous work had been based on cross-sectional analyses. Given the continuing increase in the incidence of divorce, their findings are particularly interesting. Data were used to provide estimates of the number of successor households and of some of the changes of tenure generated by divorce. While divorce among owner-occupiers led to a net increase in the number of owner-occupier households, about 30,000 former owner-occupiers became tenants, over half of them

renting from a local authority. The change from owner-occupation to local authority tenure was particularly pronounced for women, as illustrated by Table 2.4. Similar results for private tenants, showing that divorce produced a net increase of about 25,000 in the number of households classified in this way, provide further evidence of the demand for rented accommodation that is generated by marital breakdown.

Table 2.4 Sample members married in 1971 and divorced in 1981: household status and tenure, 1971 and 1981

England & Wales

	Men		Women	
	1971	1981	1971	1981
Head of household				
Owner-occupier	46	35	47	33
Local authority/new town tenant	32	22	30	37
Other tenant	20	15	19	10
In private household, not head of household	3	26	3	19
Not in a private household	0	2	0	-
Sample size (= 100%) (numbers)	2,685	2,685	3,286	3,286

Source: Holmans AE, Nandy S and Brown A. Household formation and dissolution and housing tenure: a longitudinal perspective, *Social Trends*, **17**, 1987, pp 20-28.

Holmans *et al*.[18] also explored how far the effects of divorce were reversed by remarriage. It was estimated that even when the effects of remarriage were taken into account, the number of new households created through divorce was approximately 55,000 per annum, at the divorce rates current at the time of the research.

LS occupation and migration data for the period 1971-81 have also been used by Fielding[19] to investigate the relationship between occupational and spatial mobility for the South East region and the rest of England and Wales. Results suggest that during this period London acted as a kind of 'escalator' for individuals wanting to get on in life. The choice of metaphor describes the fact that London was attracting many of Britain's best qualified young people, training and promoting them as professionals or managers and then despatching them into other parts of England and Wales to establish their own families.

Finally, as a result of its sample size, the LS may be used to examine the changing characteristics of particular subgroups of the population - for example teenagers of school leaving age or those resident in a particular region. The LS has been used by Condon and Warnes[20] to show the patterns of retirement migration exhibited by those leaving London. Figure 2.7 illustrates the 1981 destinations of those migrants who were aged 55 to 59 and lived in the London Metropolitan Region in 1971. Londoners are most likely to move to the county districts immediately around the capital and up to 75 km (46.6 miles) from the city, or to a wide range of rural and coastal destinations in southern England. Few cross the Severn-Wash divide, and of those who do, most are found in the conurbations that have had severe economic problems, e.g. South Wales, Tyneside and South Lancashire.

2.2.1.3 The scope for using data for three time points

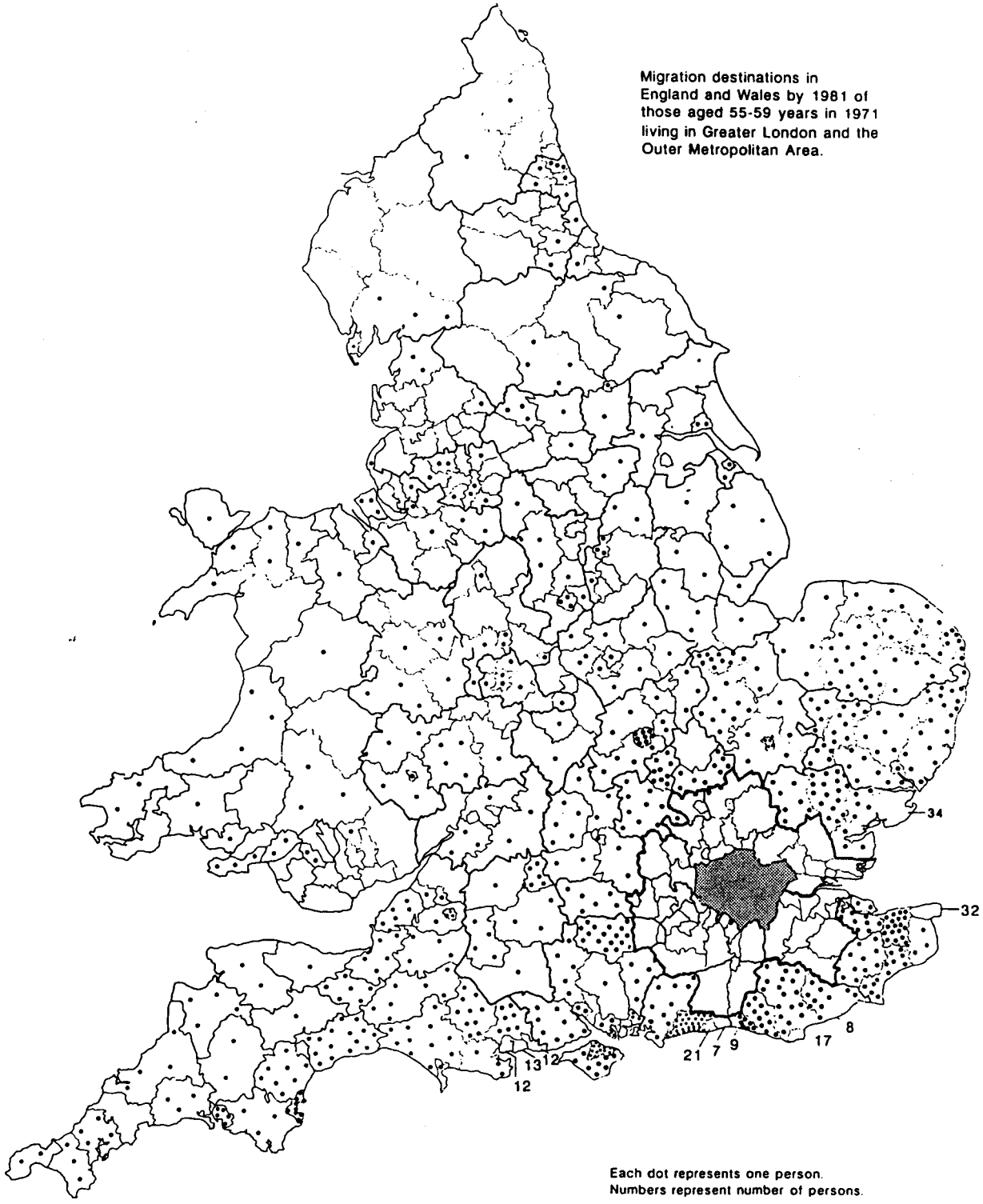
Now that the linkage of the 1991 Census data is complete, the LS provides an extremely valuable data source for charting those changes which took place between 1971 and 1991. It will be particularly interesting to compare the changes which occurred between 1981-91, a period of significant social change, with those observed during the previous decade (1971-81). For example, it will now be possible to extend analyses for the 1971-81 period, focusing on the proportion of local authority tenants who purchased their own home, and to establish the proportion who did so following the 1980 Housing Act, which offered local authority tenants the 'right to buy'(see Creeser[21]). Socio-demographic data may be used to compare the characteristics of those who bought in the 1970s with those who deferred buying until the 1980s.

The addition of data from the 1991 Census on ethnicity and limiting long-term illness[22] will significantly enhance the research potential of the study. The 1991 Census information on self-ascribed ethnicity may be used to chart some of the social changes which have taken place over the last 20 years. For those with linked data for the three time points it will be possible to ask: how do the housing conditions of Britain's ethnic minority population in the early nineties differ from conditions at the beginning of the seventies, and how do these changes compare with the experiences of those who described themselves as 'white'? There is also scope to investigate changes in education, employment and migration. As an extension to earlier LS-based research, it will be interesting to see whether the distinct ethnic patterns in social mobility Robinson[23] observed in the seventies persisted into the eighties.

Capitalising on the longitudinal nature of the LS, the data on limiting long-term illness may be used to explore the extent to which the incidence of long-term illness is associated with earlier census characteristics. For example, the area of usual residence recorded at the 1971 Census may be used to relate former area of residence and subsequent migration history to current health status.

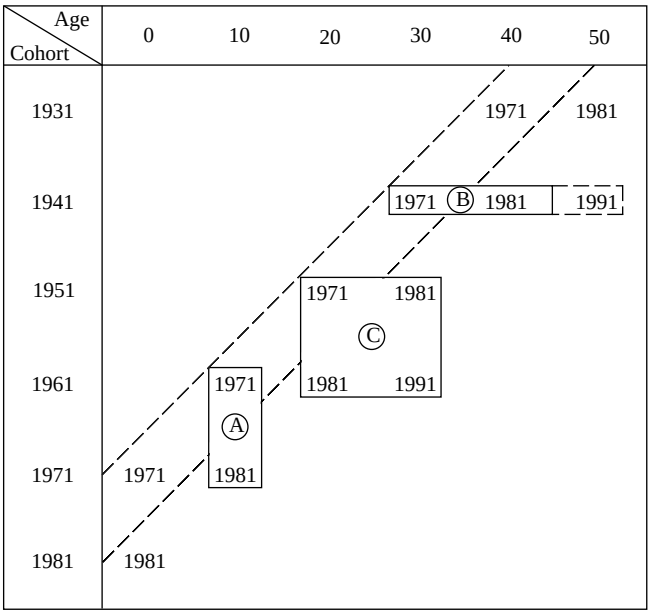
The availability of data for three time points means that the LS may now be used to model age, period and cohort effects, as illustrated in Figure 2.8. In this figure the rows define the cohort of interest, the columns their ages, while the years in the body of the diagram represent a given

Figure 2.7 Destinations of migrants aged 55-59 living in London in 1971
(see figure 2 of OPCS/SSRU *LS Newsletter no. 3)*



Source: Condon S. and Warnes A.M. Les stratégies résidentielles des Londoniens retraités. In: Lelièvre E and Lévy-Vroelard C (eds). *La ville en mouvement: Habitent et habitants*, Harmattan (Paris 1992), pp 101-16.

Figure 2.8 Age, period and cohort dimensions of change



Source: Plewis. I. The analysis potential of the LS, LS User Guide No. 3, London: LS Support Programme, SSRU, City University, 1990.

period. The diagonal represents the cross-sectional data taken at one census with the age and cohort dimensions confounded. The vertical box (A) represents a series of cross-sections or censuses and gives aggregate change over a cohort (or period) for a fixed age. For example, it is possible to compare those who were 10 years old in 1971 (the 1961 birth cohort) with those who were 10 in 1981 (the 1971 birth cohort). The horizontal box (B) represents change over age (or period) for a fixed cohort, in this instance those born in 1941. Finally, the square box (C) represents the potential of the LS for identifying different cohorts and studying individual-level change over the same biological age, often referred to as 'cohort analysis'. Thus it is possible to investigate whether longitudinal associations established for one cohort, for example those born in 1951, also exist for those born 10 or more years later. Without doubt, this is the great strength of the LS and a feature that will be further enhanced with the addition of data from the 2001 Census. More information on the potential of the study for analysing change may be found in Plewis.[24]

Though the linked census dimension of the LS promises to be a valuable tool for describing some of the social changes which have taken place in the latter part of the century, researchers should not lose sight of the limitations inherent in census-based data. Essentially, a census represents a snapshot in time, for a particular day in a 10-year period. This has obvious implications for the analysis of occupational and migration data. For example, over a period of time individuals move in and out of employment - a fact that will not be picked up by the census, and any subsequent investigation based on it, which restricts the focus of analysis to activities carried out in the previous week. Similarly, though the census records the usual address at enumeration and at one year prior to census day, the limitations of using these data as an estimate of the total number of moves made in the intercensal period are well documented (see Nicholson).[25] To list the most obvious limitation, the data omit all moves made by those who were born or died during the intercensal period, who moved to or from another country, as well as within the country, plus multiple moves, which are possibly the largest category of all. (However, for those registering an intercensal event such as a birth, it is possible to identify whether there has been a change of address between the census and event. This may be done by comparing county district recorded for both data points.)

Also, by necessity the range of topics and the degree of detail which the census can cover is restricted. The absence or limitations of census data relating to specific topics such as income and health may further restrict the types of analysis which are feasible. For example, in the 1991 Census the subject of health is confined to one simple question on limiting, long-term illness.

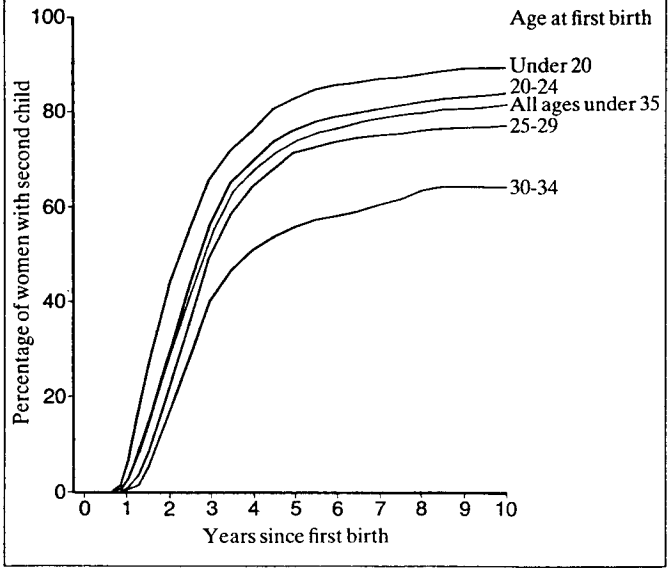
2.2.1.4 Prospective analysis of data from successive events

One further way to exploit the longitudinal component of the LS is to use the linkage of information from successive events (birth, stillbirth, infant death, cancer registration and death), possibly in conjunction with data from the census. An obvious candidate for this type of analysis is the fertility information derived from births registered to female LS members, which may be used to explore fertility patterns and changes in the characteristics of the sample over time.

Linked event data have been used by Werner[26] to provide information on fertility (changes in birth spacing), one of the topics for which the LS was originally established. This work, which looked at the spacing of births to those women born between 1935 and 1959, highlighted the importance of the mother's age at first birth in determining the timing of second and subsequent births. This is illustrated for women born in 1945-9 in Figure 2.9. Two and half years after the birth of their first child, over half of those women who had become mothers in their teens had had another child. Over the same period slightly less than a third who had become mothers between the ages of 30 and 34 had gone on to have another child.

The potential also exists for using linked fertility data to calculate the median interval between births for second and subsequent births in any given year. This is particularly valuable because, though OPCS report annually on the median interval between marriage and first birth, it is not possible to establish the median intervals for second and subsequent births from registration data. This arises as the questions asked at birth registration do not include date of previous birth(s). Furthermore, though it is possible to obtain birth interval data relating to the second and subsequent births from the GHS, the sample size when compared with the LS, is small. This means that it is necessary to aggregate results for successive years, whereas the LS can be used to examine annual trends.

Figure 2.9 Progression from first to second births of women born in 1945-49 by age at first birth



Source: Werner B. Spacing of births to women born in 1935-59: evidence from the OPCS Longitudinal Study, *Population Trends*, 52, 1988, pp20-25.

Table 2.5 Standardised case-fatality ratios (SFR) for breast cancer by parity, age at first full-term pregnancy (FFTP) and age at death†

Parity and age at FFTP	Age at death			
	16-44		45-71	
	No	SFR	No	SFR
Parity				
Nulliparous	9	96	65	139
Parous	46	124	328	93
Age at FFTP				
Under 20	6	133	25	135
20-29	33	90	228	89
30 and over	7	226	78	100

† Married women aged less than 60 at 1971 Census. The upper age limit for the older age-group is 71 years as it includes women aged 59 at 1971 Census, getting a cancer in 1971 and surviving until 1983.

Source: Kogevinas M. *1971–1983 Longitudinal Study: socio-demographic differences in cancer survival*, LS Series no. 5, London: HMSO, 1990.

Linked LS fertility data may also be used for validation purposes. Work by Babb and Hattersley[27] on the quality of the LS fertility data has highlighted the limitations of using national birth registration data to provide information on fertility trends. An important difference between the two sources is that the LS facilitates a more complete picture of parity, as it includes births both inside and outside marriage. However, it is important to note that the study does not at present include complete fertility histories. This is because the LS does not have access to birth registration records for those women who gave birth prior to the 1971 Census and the younger age cohorts of women, who started childbearing after 1971, may not yet have completed their families.

Linked event data from cancer and death registration have been used with census data by Kogevinas[28] to describe and model patterns of survival after cancer registration between different social and demographic groups, as identified by the 1971 Census. Here the LS was chosen for its unique linkage facility which provided an opportunity for the first detailed study of survival patterns at a national level.

Results suggest that those in local authority housing at census nearly always had a lower rate of survival from cancer than those in owner-occupation. This is illustrated in Figure 2.10, which shows the standardised case-fatality ratios (SFRs*) for a number of major cancers registered to men in the LS between 1971 and 1983. Differences were most pronounced for cancer of the colon, skin, testis and bladder.

Kogevinas also used information from the 1971 Census fertility question to analyse the relationship between fertility history and cancer survival for breast cancer (see Table 2.5). This suggests that female survival rates are related to reproductive history. Women who had children exhibited significantly improved survival rates from breast cancer when compared with those who had not had children. However, the survival rates of those who had their first child in their teens were poorer than those who had delayed childbearing until later.

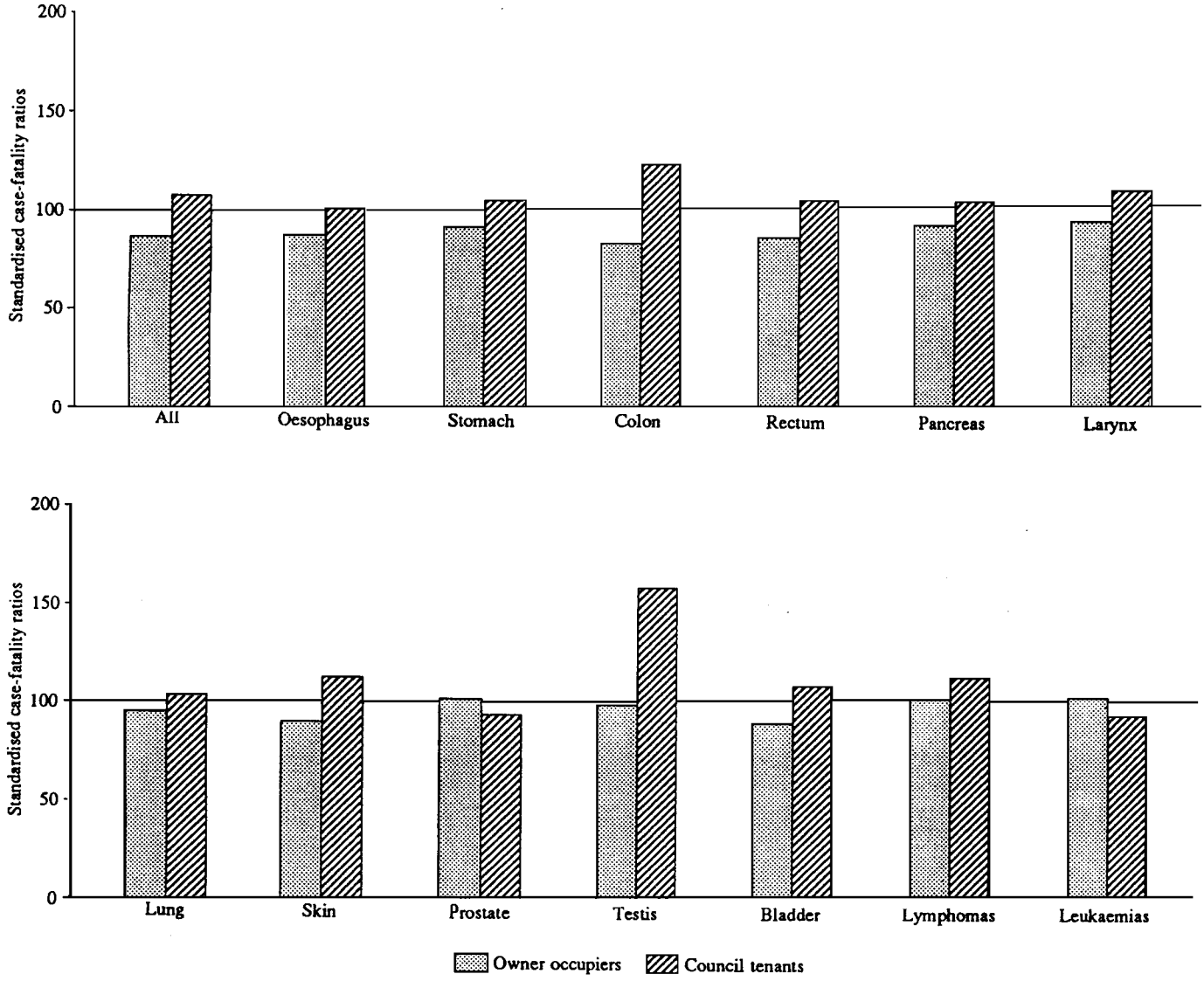
Kogevinas postulates that several biological pathways could explain the effect of reproductive history on breast cancer survival. For example, the presence of oestrogen receptors in the breast tissue have been related to age at first full-term pregnancy (FFTP) and parity. Early FFTP produces a long-term decrease in serum prolactin levels. High levels of serum prolactin have been shown to be associated with poor breast cancer prognosis (see Newman *et al.*).[29]

2.2.2 The scope of the LS for cross-sectional analysis

Though it was not originally designed to be used in this way, several features of the LS make it suitable for a range of cross-sectional analyses. These include the information which is added to the LS over and above that from the census and vital event registration which feeds into the study. In addition, cross-sectional data from the LS may be used for validation purposes and for constructing new classifications.

* Standardised case-fatality ratios (SFRs) were calculated by using the case-fatality rates of the whole LS population for the cancer in question. For example, for cancer of the lung in men, the standard case-fatality rates would be the age-specific rates of all men with this cancer in the LS. It is important to note that *high* SFRs correspond to *low* survival. In addition to this the SFRs were standardised for year of registration and period of follow-up, enabling comparisons to be made between SFRs for specific age-groups, years of registration or periods of follow-up.

Figure 2.10 Cancer survival in men by housing tenure, 1971-83



Source: Kogevinas E. *1971-1983 Longitudinal Study: Socio-demographic differences in cancer survival,* LS Series no. 5, London: HMSO, 1990

However, individual-level census data is also available for the 1991 Census in the form of the samples of anonymised records (SARs). These cover a 1 per cent sample of households and a 2 per cent sample of individuals drawn from the 10 per cent census sample. In most cases, the SARs will be the appropriate data source for cross-sectional analyses of the 1991 Census.

The census data in the LS include individual-level data classifying the area of residence (and enumeration). The study also incorporates aggregate geographical data, such as the small area statistics (SAS), which are added to individual records by means of a geographical identifier, usually the ward (see Creeser).[21] This feature of the LS distinguishes it from other census data sources (e.g. the SARs) which are unable to provide this level of detail.

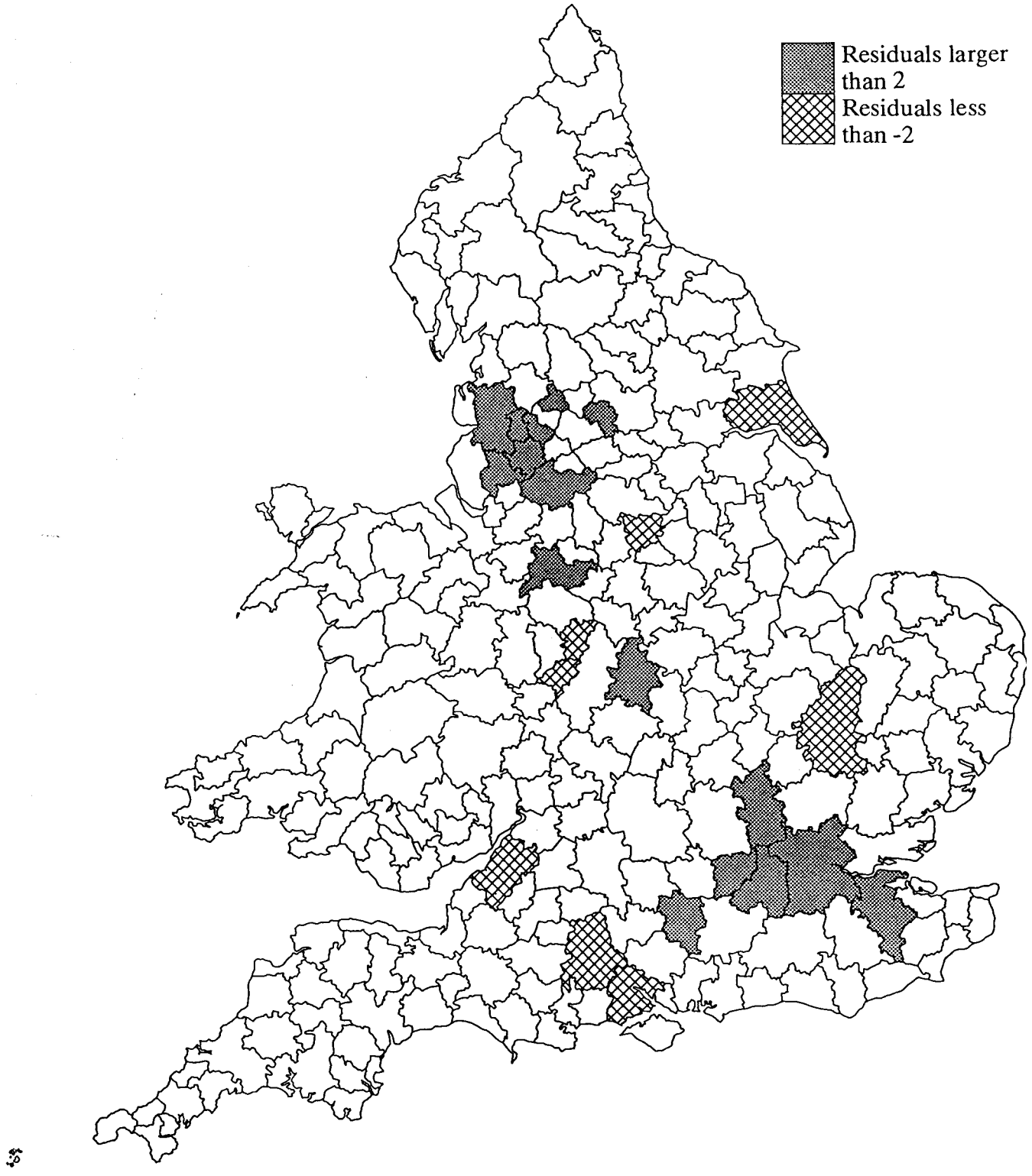
For 1971 an approximation of the LS member's ethnic group is also available, based on responses to the census questions inquiring about the LS member's and parents' country of birth. (A question on self-ascribed ethnicity was first included in the 1991 Census. Further details on this variable may be found in section 4.3.1.)

The LS has been used by Ward and Dale[30] to investigate geographical variation in women's employment status, after controlling for life cycle stage and ethnicity. This work capitalised on the information on ethnicity and travel-to-work area (TTWA*) included in the LS.

Levels of both full-time and part-time working varied according to TTWA and this variation may be explained, to a large extent, by the labour market and demographic

* Currently the TTWA is one of the most widely known and commonly used set of local-labour-market-areas (LLMAs) in Britain. TTWAs are defined so as to approximate self-contained labour market areas within which commuting to and from work occurs. The basic criterion used to define TTWAs in 1981 was that in areas with a working population of between 3,500 and 20,000 people, the number of people living and working in an area should be 75 per cent of both the total number of workers living in the area **and** the total number of people working in the area.

Figure 2.11 The proportions of women in each travel-to-work area (TTWA) working full-time: residuals from final model



Source: Adapted from Ward C. and Dale A. A geographical variation in female labour force participation: an application of multi-level modelling, *Regional Studies*, **26: 3**, 1991, pp 243-255

characteristics of the TTWA in which the woman was resident. This is illustrated by Figure 2.11 in which the residuals of a multi-level modelling exercise show that full-time work was overrepresented in two groups of TTWAs (identified in the figure by the dark areas of shading): a group in the South East described as high-tech growth centres and established service centres and a second group in the North West characterised as manufacturing (towns) and declining towns, both of which have a long tradition of female employment. A further grouping of TTWAs, characterised in a similar way, is also found in the West Midlands.

The research also showed that, after controlling for the presence of children and marital status, women from non-white ethnic groups were less likely to work part-time than their 'white' counterparts. Furthermore, as Table 2.6 highlights, there was a marked difference in the incidence of part-time work among women of Indian and Pakistani/ Bangladeshi ethnic origin, with women in the latter group much less likely to be in any type of paid work.

Table 2.6 Employment status by ethnic group for women aged 16-59 in 1981

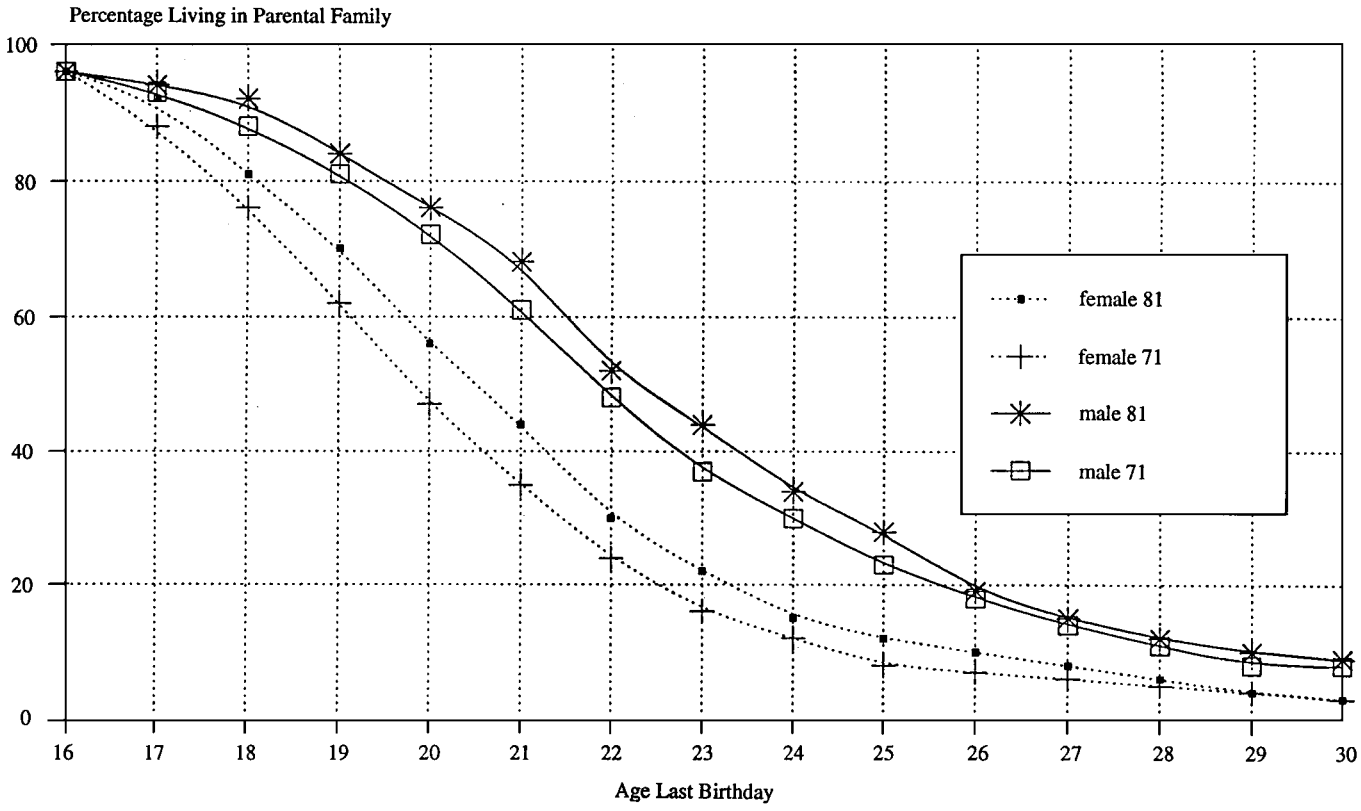
Ethnic group	Full time (%)	Part time (%)	Not working (%)	Number
'White'	35	22	43	132,568
West Indian	51	11	38	1,418
Indian	40	9	51	907
Pakistani/Bangladeshi	16	3	81	237
Other	44	12	44	754
(Number)	47,418	29,184	59,282	135,884
(% of total)	35	21	44	100

Source: Ward C and Dale A. Geographical variation in labour force participation: an application of multi-level modelling. *Regional Studies*, **26:3**, 1991, pp. 243–255.

LS cross-sectional data can also be used for the purpose of validation. For example, the study may be used to provide baseline information on the distribution of families at the 1971 and 1981 Censuses and on the age, sex and ethnic group composition of an area. LS census data on family and household type, the age of youngest child and the number of dependent children have been used in this way by Harrop and Plewis[31] to produce baseline figures indicating the distributions of families at the 1981 Census. These data were used in place of published census results as they provided a greater level of detail and definitions more comparable with those based on the GHS and used by the researchers.

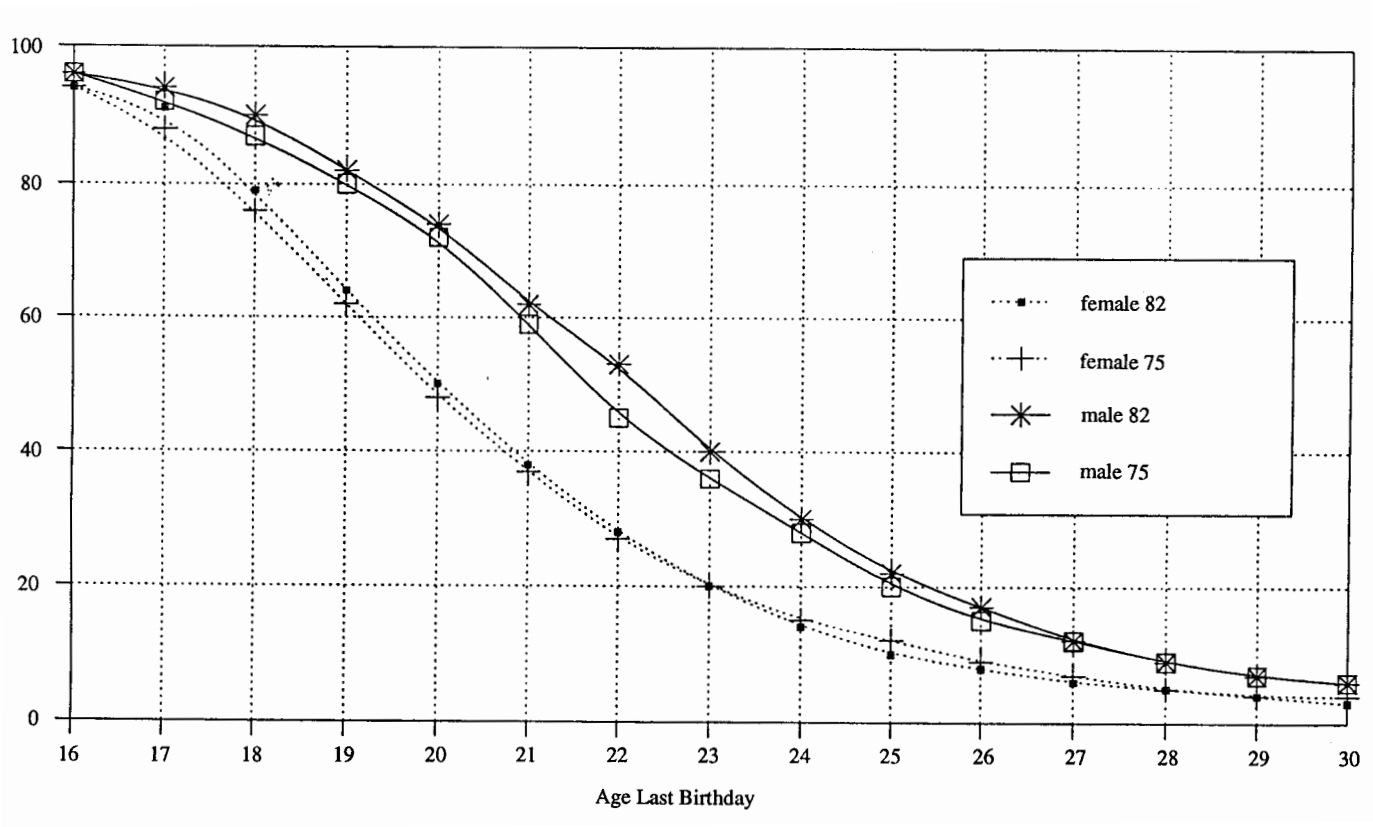
One further use of LS cross-sectional data concerns the ability to develop complex or alternative classifications not normally facilitated by published census data. The LS has been used in this way for a project comparing the residence patterns of children, young adults and the elderly in England and Wales at the start of the 1980s, with equivalent patterns for those resident in France (see Penhale;[32] Wall[33]). Figures 2.12 and 2.13 show the proportion of young adults living as unmarried children with their parents at each of the censuses. In both countries, and for both sexes, the proportion of those below age 25 resident in the parental home was greater at the later census. However, with the exception of English males in their late teens and early twenties, the differences are small.

Figure 2.12 Percentage of young adults in England and Wales living in the parental family



Source: Penhale B. *Living arrangements of young adults in France and England*. LS Working Paper no. 68, London: LS Support Programme, SSRU (City University 1990).[32]

Figure 2.13 Percentage of young adults in France living in the parental family



Source: Penhale B. *Living arrangements of young adults in France and England.* LS Working Paper no. 68, London: LS Support Programme, SSRU (City University 1990).[32]

2.2.3 The scope of the LS for international comparative work

As a result of the continuing concern over socio-economic differences in mortality, many other countries have established data linkage studies similar to the LS. For example, the French statistical office, INSEE, maintains a longitudinal study or Echantillon Démographique Permanente (EDP), which has much in common with the OPCS Longitudinal Study. The EDP, which was established in 1982, contains information from the French censuses of 1968, 1975, 1982 and 1990 for an approximate 1 per cent sample of the French population (about 700,000 individuals) plus information from vital event registration (birth, stillbirth, marriage, divorce and death).

Several other countries, particularly those in Scandinavia, have maintained studies since the early 1970s, based on the linkage of census and mortality data (Denmark, Finland, USA)[34] or between data for successive censuses (Norway). In Italy, linked census (1971, 1981 and 1991) and mortality data are available for the entire population of Turin.[35] Since the late 1970s, the Committee for International Cooperation in National Research in Demography (CICRED) has been responsible for promoting research into socio-economic differences in mortality in the industrialised countries, through the CICRED Network on Socio-economic Differential Mortality,[36] while the United Nations (UN) and the World Health Organization (WHO) have been responsible for equivalent work in the developing world. Other countries have carried out one-off census-link exercises producing data which may be used for comparative research. For example, in Israel the records of 20 per cent of households enumerated at the 1983 population census have been linked to birth registration data to facilitate more detailed analyses of fertility patterns.[37]

By comparison with the LS, the linkage of the Nordic studies is greatly simplified by the existence of a system of population registers and a unique identification number which is used to facilitate linkage. As a consequence, it is possible for studies of occupational mortality to cover the whole population. Many of the findings of these studies are available as English reports or summaries. For example, see Lynge[38] and Andersen[39] (Denmark); Valkonen *et al.*[40] and Valkonen *et al.*[41] (Finland); Costa[42] (Italy); Tønnesen,[43] Haldorsen and Glattre[44] and Kristofersen[45] (Norway) and Statistika Centralbyrån[46] (Sweden).

Most recently in 1991, the Netherlands established a longitudinal study of socio-economic health differences (LS-SEHD) based on a sample of 27,000 persons drawn from the population registers in the South East of the country (see Mackenbach *et al.*).[47] The study will incorporate data on self-reported health and socio-economic position and follow-up data on hospital admissions, cancer incidence and mortality.

The many similarities between these studies and the LS mean that there is considerable scope for international comparative work. For example, the LS has been used for an international study comparing the size of socio-economic mortality differences among men in the 1970s (see Kunst and Mackenbach).[48] This work is presently being extended using more recent data to ascertain to what extent international variation in health inequalities changed in the 1980s. Women's mortality patterns and comparisons by selected cause of death will also be investigated.

In addition, LS mortality data on ischaemic heart disease is being used to study occupational differences in mortality and hospitalisation in three EC countries. This study draws upon the following data sources: LS mortality data (1971-89), the Danish occupational mortality register (1970-85) and occupational hospitalisation register (1981-84) and occupational mortality data for Turin, Italy for the period 1981-89. Furthermore, Malcolm Williams and Lyn Bryant from the Department of Applied Social Science, University of Plymouth are exploring the possibility of using data from the LS and the EDP for a comparative study of migration and its effects on housing opportunity in Cornwall and Finisterre (Brittany).

Although there are many opportunities for work using the EDP and LS, it is important to note that the former excludes medical-based data, such as birth weight, duration of pregnancy and cause of death, which would be valuable for making comparisons with the LS. The reason for this omission is that in France such data are deemed 'medical secrets' and are therefore unavailable for linkage into the study. Further information on the full range of EDP variables available for analysis may be found in INSEE[49] and Desplanques.[50]

2.2.4 Concluding remarks

In recent years, as part of OPCS' continuing support for the LS, there have been a number of significant improvements in the scope and quality of the data and the arrangements for access. As the dataset ages and as additional information is incorporated, the research potential of the LS will be substantially enhanced.

The features highlighted above enable the LS to be used to provide individual-level census data for the 1971, 1981 or 1991 Censuses and linked longitudinal data for studying intercensal change and socio-economic differences in fertility and birth outcome, mortality, cancer incidence and survival. Two particular features of the LS, the availability of census data on other household members and the ability to attach contextual information to individual records using a geographic identifier, further enhance its scope.

With time the opportunities for analysis will depend upon the permutations of feasible linkages and the imagination of individual researchers to use the LS to investigate specific research problems.

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