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# Physical Function and Perceived Health: Cohort Differences and Interrelationships in Older People

Nicola Spiers,[1] Carol Jagger,[2] and Michael Clarke[2]

[1]Department of Medical Statistics, De Montfort University, Leicester, United Kingdom.
[2]Department of Epidemiology and Public Health, University of Leicester, United Kingdom.

***Differences between seven-year birth cohorts in physical functioning (as measured by independence in activities of daily living) are compared with corresponding inter-cohort differences in perceived health, in people aged 75 years and over. Age-period-cohort models were fitted to two linked cross-sectional surveys undertaken in 1981 (N = 1,203) and 1988 (N = 1,579). The proportion of older people who were dependent in ADLs was lower in succeeding cohorts but, by contrast, the proportion with less than good self-perceived health was higher. These inter-cohort differences in perceived health were particularly marked for the comparison between 1981 and 1988 of men aged 75–81 years in the dependent subpopulation. Furthermore, self-perceived health remained as strong a predictor of mortality in 1988 as in 1981. Self-perceived health may be indexing a higher prevalence of mild chronic conditions in newer cohorts of older people, with implications for primary health care providers.***

A SIGNIFICANT growth of the population at older ages in England and Wales has occurred during the 20th century, particularly in the numbers of very old. In the 21-year period between 1971 and 1992, the numbers aged between 65 and 74 years have increased by 7 percent, the 75- to 84-year-olds by 44 percent, and the numbers aged 85 years and over by 93 percent (Office of Population, Census and Surveys, 1994). Part of these increases is due to the increased life expectancy of the newer cohorts of older people. In 1976 the expectation of life at 65 years (that is, the remaining number of years a person aged 65 could expect to live) was 7.4 years for men and 9.8 years for women. In only a 12-year period, these life expectancies had increased by over 10 percent to 8.2 years for men and 10.8 years for women (Bebbington, 1991).

An important question born of this increase in life expectancy is the degree to which longer life means better health and whether the newer cohorts of older people are in better or worse health than previous cohorts. Health expectancies using both self-perceived health measures and disability, as measured by independence in activities of daily living (ADLs), have been calculated for a number of countries over the last decade. Although comparisons are difficult due to the variety of measuring instruments, the fundamental conclusion is an apparent increase in the years spent with milder disability (Robine, 1994). However, the calculation methods assume that newer cohorts, as they age, will experience the same prevalence of disability as older cohorts.

Evidence of improved health of newer cohorts has been equivocal. In a Finnish study (Winblad, 1993), no difference was found in the prevalence of disability, as measured by the Katz index of ADL, between two cohorts aged 75 years and over, some 10 years apart. With the same age group in a rural community in Finland, a clear deterioration in ADL functioning was shown in those living at home (Antilla, 1991). Similarly, in Canada, two cohorts 12 years apart demonstrated an increased limitation in ADL functioning accompanied by an increased life expectancy (Roos, Havens, and Black, 1993). However, the changes observed could have been due to the changing age structure of the population at older ages, and more defined cohort analysis is required.

Poor self-perceived health has been found to be an important predictor of mortality, even after adjustment for more objective measures of health (Idler and Kasl, 1991; Idler, Kasl, and Lemke, 1990; Jagger and Clarke, 1988; Mossey and Shapiro, 1982) and has been found to be strongly associated with both the presence of disability (Fylkesnes and Forde, 1992; Liang, 1986; Lindgren, Svärdsudd, and Tibblin, 1994) and with its incidence (Idler and Kasl, 1995; Jagger, Spiers, and Clarke, 1993). Self-ratings of health are influenced by clinically measured health ratings and a history of chronic and disabling physical and emotional problems and psychological distress, but may also represent a more global measure of ill health (Johnson and Wolinsky, 1993; Rakowski et al., 1993). Long-term trends in Healthy Life Percentage (the proportion of life spent in good self-reported health) in the Netherlands suggests a slight increase in this percentage between 1981 and 1990 (Perenboom, Boshuizen, and van de Water, 1992), although the effect of cohort differences has not been examined.

A decline in the prevalence of disability in the population aged 75 years and over in Melton Mowbray, Leicestershire, UK, between 1981 and 1988 has been reported elsewhere (Jagger, Clarke, and Clarke, 1991). The aim of this study is to further investigate these changes in physical functioning and whether they can be attributed to age, period, or cohort differences. In addition, inter-cohort differences in functioning and self-perceived health are contrasted, and the interrelationships between self-perceived health and functioning are explored.

## METHODS

Full descriptions of the methods of both surveys have already been published (Clarke et al., 1984; Jagger, Clarke, and Clarke, 1991); therefore, only relevant details are included here. The town and environs of Melton Mowbray, Leicestershire, UK, are unique in that they are served by a single general practice with 13 full-time and three part-time doctors and a practice list size of around 33,000. On December 31, 1980, the first survey population was drawn, comprising all those aged 75 years and over who were registered with the practice. Over the following three months these subjects were interviewed by trained field workers. Seven years later the survey was repeated with the population aged 75 years and over on December 31, 1987.

Both interviews included basic demographic data such as age, sex, marital status, social class, and household composition. Physical functioning was assessed by the Physical Activity scale (Jagger, Clarke, and Davies, 1986). A variety of scaling methods were used on the seven activities of daily living (ADLs) of transfer from bed, transfer from chair, getting to and from the toilet, bathing, mobility around the home, feeding, dressing, and two items on urinary and fecal incontinence. Two scales emerged, one measuring physical functioning on five of the ADLs (the Physical Activity scale) and the second measuring incontinence. The focus in this article is on the Physical Activity scale, which consists of the ADLs of transfer from bed, transfer from chair, getting to and from the toilet, mobility around the home, and dressing. Respondents were classified as independent if they were able to perform all five ADLs without assistance, or dependent if they were receiving help from a person or appliance with at least one ADL.

Perceived health was assessed by response to the question, "For your age, would you say in general your health is good, fair, or poor?" People living in institutions were not asked this question and hence, for the purposes of the analysis, perceived health was dichotomized into "good" and "less than good," the latter category including people in institutions, as well as those with poor or fair self-perceived health. For a small number of subjects information was obtained from a relative or caregiver, and, for the purpose of these analyses, perceived health was treated as "less than good" in these cases.

For both survey populations, fact, date, and cause of death were obtained from the National Health Service Central Registry.

### *Statistical Methods*

Respondents were divided into seven-year birth cohorts, corresponding to the interval between surveys, apart from the oldest cohort which included all those born in or before 1884. Five cohorts were identified with birth years $\leq$ 1884, 1885–1891, 1892–1898, 1899–1905, and 1906–1912.

In fitting models for age, period, and cohort effects, it is recognized that all three effects cannot be estimated simultaneously (Fienberg and Mason, 1985). It is necessary to adopt some constraints on the analysis in order to resolve this identification problem. The approach adopted here was to investigate cohort-age and period-age specifications for the data separately. The models are viewed as frameworks which account for the aggregated data observed, and no attempt is made to choose between the models with good fit, or to make statements about causality. Goodness of fit was measured by the likelihood-ratio test statistic (Aitken et al., 1989).

Proportions dependent in ADLs and with less than good self-perceived health were tabulated by cohort and period of survey (1981 and 1988). Proportions in 1981 were conditional on inclusion in the survey. In 1988 proportions were conditional both on survival and on inclusion in the 1988 survey. In order to quantify the effects observed, the GLIM system (Baker and Nelder, 1978) was used to fit logit models for the proportion dependent (or with less than good perceived health) using an age-period-cohort accounting framework as described above. Models were fitted for the male and female populations separately.

To investigate the relationship between perceived health and physical functioning measures, logit models were fitted for the proportion with less than good perceived health, with state of physical functioning (independent or dependent) included as a covariate, in addition to the age and cohort effects. Again, models were fitted for men and women separately, and prevalence was conditional on survival and inclusion in the survey.

To investigate any overall differences in cohorts through survivorship and to establish the enduring relationship between self-perceived health and mortality, the five-year survival and the association between five-year survival and self-perceived health were compared for the two periods using Cox's proportional hazards regression model (Cox, 1972). The five-year survivals for the two periods were compared separately for males and females with age group included as a covariate. To model the association between self-perceived health and mortality, a stratified analysis was performed with place of residence (community/institution) defining the strata. Other confounding factors included in the modeling process were age, sex, dependence in ADLs, incontinence, presence of cognitive impairment, social class, and a three-level variable indicating marital status and household composition (married/not married, not living alone/not married, and living alone). Missing values were included in the final category as with self-perceived health. A stepwise approach was used, with separate analyses for the two surveys. The proportional hazards assumption was tested by fitting each of the covariates in turn as time dependent.

## RESULTS

Researchers identified 1,329 people aged 75 years and over on the age-sex register at the first survey in 1981. Of these, 4 percent died before interview, one percent were untraceable, and 5 percent refused to be interviewed. Eighty-five percent (1,124) were interviewed in their own homes in the community while 6 percent (79) were interviewed in institutions. By 1988, the initial population identified had risen to 1,890, with 7 percent dead prior to interview, 4 percent untraceable, and 5 percent refusing. Seventy-nine percent (1,500) were interviewed in the community and 4 percent (79) in institutions. The numbers interviewed by birth cohorts are summarized in Table 1.

By five years from interview, 41.9 percent (504/1203) of the 1981 study population had died compared to 39.2 percent (619/1579) of the 1988 study population. The probability of survival at various time points from interview is shown in Table 2 and indicates a decreased survival with increasing age. Comparison of the same age groups across the study period indicated some increase in survival for the more recent cohorts, although this did not reach statistical significance.

The proportion of elderly people dependent in ADLs is summarized by sex, cohort, and survey in Table 3. Men were consistently less likely than women to be dependent in ADLs across all cohorts in both surveys. Improved levels of functional capacity for later cohorts, compared to earlier cohorts, are evident from diagonal comparisons in the table. For example, 16 percent of women in cohort IV were dependent when interviewed in 1988, as compared to 33 percent in the same age group (75–81 years) in 1981. The best fitting models for these data are shown in Table 4 and included either cohort effects (Men: $G^2 = .96$, df = 2, $p = .62$; Women: $G^2 = 4.48$, df = 3, $p = .79$) or alternatively additive age and period effects (Men: $G^2 = 3.49$, df = 3, $p = .21$; Women: $G^2 = 6.94$, df = 4, $p = .14$). In an age-cohort framework (model 1) the odds of dependence were less for successively later cohorts, but there was no age effect present. In other words, within the cohort, the proportion of elderly people who were dependent in ADL remained the same as the cohort aged. Alternatively, with additive period and age effects (model 2), lower odds of dependence between surveys was countered by significantly greater odds of dependence with increasing age.

The proportions with less than good self-perceived health by cohort are also given in Table 3. In each cohort, women were more likely than men to perceive their health as less than good, in a pattern consistent with that for the ADL measure. However, the age-adjusted comparisons from diagonal elements indicated that more recent cohorts had greater proportions of elderly people who rated their health as less than good, in contrast with the improvement noted in functional status. For example, when interviewed in 1981, 44 percent of women aged between 75 and 81 years considered their health to be less than good, compared to 52 percent of women of the same age in 1988.

In order to investigate this apparent contradiction at a cohort level between lower levels of dependent functioning and higher levels of less than good perceived health, the interrelationship between these two factors was explored. The proportions of women in each cohort with less than good self-perceived health by functional status are illustrated in Figure 1. As would be expected, elderly women dependent in one or more ADLs were considerably more likely than their independent peers to perceive their health as less than good. In Figure 1, dotted lines link the proportion with less than optimal self-perceived health in 1981 with the corresponding proportion for the survivors from the same cohort interviewed in 1988. However, due to the changes in functional status, as well as migration and high levels of mortality experienced by this population, these proportions have denominators which differ considerably in size and membership. We concentrate instead upon comparisons between succeeding cohorts, made by considering the health of cohorts observed at the same age group midpoint. For example, comparisons between cohorts III and IV, both observed at age 75–79 years, are highlighted by arrows on Figure 1.

Table 1. Numbers Identified and Interviewed in 1981 and 1988 Surveys by Sex, Birth Cohort, Age When Survey Population Drawn, and Place of Residence at Interview

| Cohort | Birth Year | Age in Years | Number Interviewed in: Community | Institution |
|---|---|---|---|---|
| Men | | | | |
| 0 | ≤1884 | 96+ (1981) | 0 | 0 |
| | | 103+ (1988) | 0 | 0 |
| I | 1885–1891 | 89–95 (1981) | 12 | 2 |
| | | 96+ (1988) | 0 | 0 |
| II | 1892–1898 | 82–88 (1981) | 69 | 4 |
| | | 89–95 (1988) | 11 | 0 |
| III | 1899–1905 | 75–81 (1981) | 287 | 6 |
| | | 82–88 (1988) | 134 | 5 |
| IV | 1906–1912 | 68–74 (1981) | 0 | 0 |
| | | 75–81 (1988) | 378 | 8 |
| Women | | | | |
| 0 | ≤1884 | 96+ (1981) | 2 | 5 |
| | | 103+ (1988) | 0 | 0 |
| I | 1885–1891 | 89–95 (1981) | 49 | 25 |
| | | 96+ (1988) | 10 | 3 |
| II | 1892–1898 | 82–88 (1981) | 186 | 25 |
| | | 89–95 (1988) | 50 | 16 |
| III | 1899–1905 | 75–81 (1981) | 519 | 12 |
| | | 82–88 (1988) | 294 | 29 |
| IV | 1906–1912 | 68–74 (1981) | 0 | 0 |
| | | 75–81 (1988) | 623 | 18 |

Table 2. Probability of Survival at Yearly Intervals From Interview by Sex, Cohort (Defined by Birth Year) and Year of Survey

| Time From Interview (yrs) | Female | | | | | | Male | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 75–81 years | | 82–88 years | | 89–95 years | | 75–81 years | | 82–88 years | | 89–95 years | |
| | 1981 | 1988 | 1981 | 1988 | 1981 | 1988 | 1981 | 1988 | 1981 | 1988 | 1981 | 1988 |
| 0 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1 | 0.93 | 0.95 | 0.88 | 0.88 | 0.68 | 0.79 | 0.91 | 0.94 | 0.83 | 0.82 | 0.65 | 0.93 |
| 2 | 0.87 | 0.90 | 0.79 | 0.76 | 0.59 | 0.55 | 0.83 | 0.87 | 0.61 | 0.65 | 0.48 | 0.62 |
| 3 | 0.80 | 0.83 | 0.66 | 0.68 | 0.42 | 0.45 | 0.78 | 0.76 | 0.49 | 0.54 | 0.14 | 0.49 |
| 4 | 0.74 | 0.77 | 0.52 | 0.58 | 0.32 | 0.39 | 0.70 | 0.70 | 0.32 | 0.39 | 0.14 | 0.36 |
| 5 | 0.67 | 0.73 | 0.49 | 0.49 | 0.21 | 0.34 | 0.63 | 0.64 | 0.26 | 0.34 | 0.14 | 0.36 |

Table 3. Proportion (%) Dependent in ADL and Proportion (%) in Less Than Good Self-Perceived Health by Sex, Cohort (Defined by Birth Year), and Year of Survey

| Cohort (age at 12/31/1980) | | Female | | Male | |
|---|---|---|---|---|---|
| | | 1981 | 1988 | 1981 | 1988 |
| IV | Dependent in ADL (%) | — | 16 | — | 13 |
| (68–74 yrs) | Less than good perceived health (%) | — | 52 | — | 45 |
| III | Dependent in ADL (%) | 33 | 36 | 29 | 33 |
| (75–81 yrs) | Less than good perceived health (%) | 44 | 55 | 39 | 45 |
| II | Dependent in ADL (%) | 63 | 65 | 44 | 36 |
| (82–88 yrs) | Less than good perceived health (%) | 48 | 59 | 41 | 36 |
| I | Dependent in ADL (%) | 80 | 54 | 64 | — |
| (89–95 yrs) | Less than good perceived health (%) | 55 | 69 | 29 | — |

Table 4. Estimated Odds Ratios (OR) of Dependence:Independence in ADLs Under Age Period and Cohort Models for Men and Women Separately, 95% Confidence Intervals (CI) in Parentheses

| Model | Covariates | Men OR (95% CI) | Women OR (95% CI) |
|---|---|---|---|
| (1) Cohort | Cohort IV | 1.00 | 1.00 |
| | Cohort III | 2.79 (1.89, 4.12) | 2.71 (2.05, 3.57) |
| | Cohort II | 4.30 (2.13, 8.68) | 8.40 (5.35, 13.18) |
| | Cohort I | 9.15 (2.25, 37.14) | 14.31 (6.65, 30.78) |
| | Age | 1.02 (0.96, 1.08) | 1.01 (0.97, 1.05) |
| (2) Age + Period | 1981 | 1.00 | 1.00 |
| | 1988 | 0.43 (0.32, 0.52) | 0.37 (0.29, 0.46) |
| | Age | 1.13 (1.09, 1.18) | 1.16 (1.13, 1.19) |

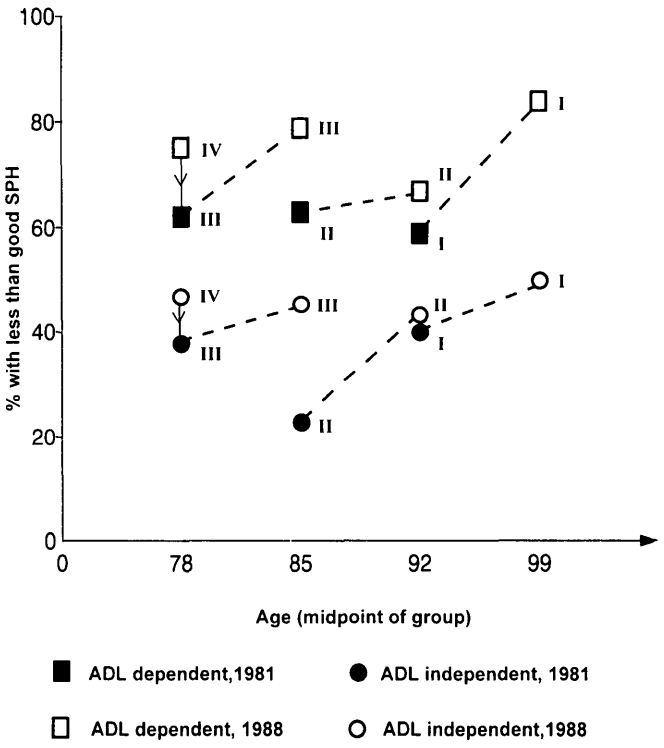


Figure 1. Proportion (%) of women with less than good self-perceived health by age (midpoint of age group), cohort, and ADL status.

For women, the most recent cohorts at each age had the highest proportion of members in less than good self-perceived health. This pattern held within both dependent and independent subpopulations. Statistical models for the proportions of women with less than good self-perceived health are represented in Table 5 and again show consistent patterns within the ADL subgroups. In model 3, the odds of less than good self-perceived health were greater for successively later cohorts, and there was an effect of age which resulted in higher odds of less than good perceived health among older women within cohorts ($G^2 = 5.07$, df = 8, $p = .75$). However, under the age-period framework (model 5) there was no age effect, with the data accounted for simply by higher odds of less than optimal self-perceived health in the later survey ($G^2 = 6.32$, df = 10, $p = .79$).

For the male population, Figure 2 demonstrates a similar pattern of less than good self-perceived health in more recent cohorts. The inter-cohort difference was particularly marked among those members of the newer male cohorts aged 75–81 years who were dependent in ADL. In 1988, 42 of the 50 men (84%) in this age group and dependent in ADL said their health was less than good, compared to 49 out of 85 men (58%) in the similarly defined subpopulation in 1981. This exaggeration of the effect of poor physical health upon self-perceived health among younger men dependent in ADL was reflected in the modeling by some evidence of an interaction between disability and cohort effects (model 4), although the interaction was not statistically significant (change in $G^2 = 4.41$, df = 2, $p = .11$). If uniformity between ADL dependent and independent subgroups was assumed, the statistical models summarized in Table 5 confirmed a somewhat different picture to that for the female population. In model 3, higher odds of less than good self-perceived health across successively later cohorts were combined with little evidence of a negative effect of age ($G^2 = .79$, df = 1, $p = .38$). Alternatively, in the age-period model 5 there were higher odds of less than good self-perceived health in the later survey ($G^2 = 5.40$, df = 6, $p = .49$).

The preceding analyses assumed that elderly people resident in institutions had less than good perceived health.

Table 5. Estimated Odds Ratios of Less Than Good Self-Perceived Health[a]

| Model | Covariates | Men OR[b] (95% CI) | Women OR[b] (95% CI) |
|---|---|---|---|
| (3) ADL + Cohort + Age | Cohort IV | 1.00 | 1.00 |
| | Cohort III | 0.60 (0.44, 0.84) | 0.56 (0.44, 0.72) |
| | Cohort II | 0.41 (0.20, 0.83) | 0.30 (0.18, 0.47) |
| | Cohort I | —[c] | 0.22 (0.10, 0.47) |
| | Independent | 1.00 | 1.00 |
| | Dependent | 4.18 (2.97, 5.88) | 3.41 (2.73, 4.27) |
| | Age | 1.03 (0.96, 1.09) | 1.07 (1.02, 1.11) |
| (4) ADL + Cohort + Age with ADL-Cohort interaction | Independent | | |
| | Cohort IV | 1.00 | |
| | Cohort III | 0.69 (0.48, 0.99) | |
| | Cohort II | 0.41 (0.17, 0.95) | |
| | Dependent | | |
| | Cohort IV | 1.00 | |
| | Cohort III | 0.28 (0.12, 0.66) | |
| | Cohort II | 0.24 (0.08, 0.74) | |
| | Age | 1.03 (0.97, 1.09) | |
| (5) ADL + Age + Period | 1981 | 1.00 | 1.00 |
| | 1988 | 1.61 (1.20, 2.17) | 1.76 (1.44, 2.16) |
| | Independent | 1.00 | 1.00 |
| | Dependent | 4.18 (2.97, 5.88) | 3.39 (2.71, 4.25) |
| | Age | 0.96 (0.92, 1.01) | 0.99 (0.96, 1.01) |

[a]Adjusting for independence in ADLs under age-period and cohort models for men and women separately, 95% confidence intervals (CI) in parentheses.

[b]Odds ratio of "less than good": "good" self-perceived health, where "less than good" includes those living in institutions.

[c]Inestimable due to scarcity of data.

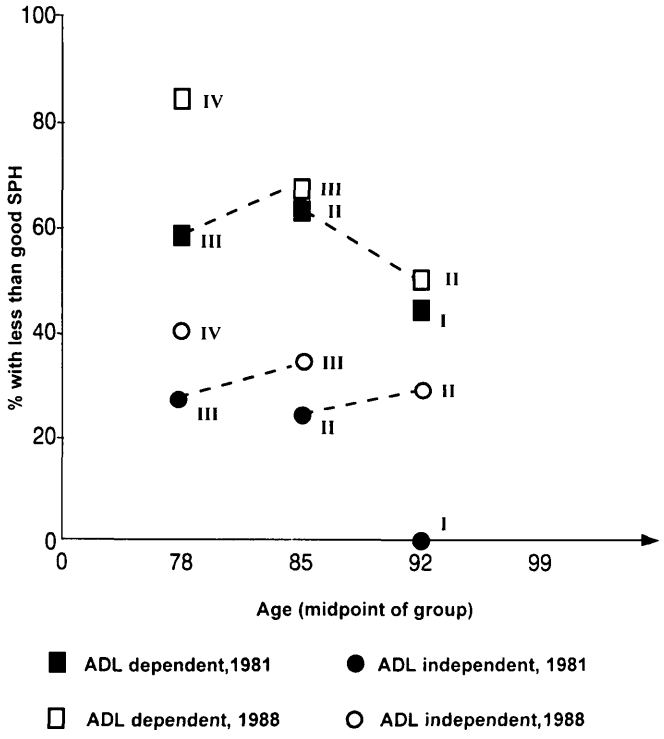


Figure 2. Proportion (%) of men with less than good self-perceived health by age (midpoint of age group), cohort, and ADL status.

When the analyses were repeated, omitting those resident in institutions, the association between self-perceived health and ADL dependence was attenuated, with reduction in odds ratio from 4.2 to 3.7 for men and from 3.4 to 2.7 for women. The pattern of cohort differences described above remained the same with the exception of some exaggeration of the odds ratio for cohort I (born 1885–1891), although the standard errors were large.

Analysis of the association between self-perceived health and mortality in the 1981 survey resulted in a model which included significant effects of age, sex, incontinence, ADL dependence, presence of cognitive impairment, and the factor indicating marital status and household composition as well as self-perceived health. Checking the proportional hazards assumption for each covariate resulted in a significant time dependency in self-perceived health with the hazard of death for those with less than good perceived health, relative to those with good perceived health, decreasing with time. Thus, at time zero (start of the survey) the relative risk of death for a person with less than good perceived health compared to one who perceived their health to be good, after adjustment for the other confounding factors, was 1.43 (95% confidence interval [CI] 1.18 to 1.74), while one year from the survey the relative risk was 1.25 (95% CI 1.06 to 1.43). Analysis of the 1988 data produced a very similar model although the marital status/household composition variable was not significantly associated with five-year survival and incontinence, as well as self-perceived health, significantly violated the proportional hazards assumption. At time zero (start of the survey), the relative risk of death for those with less than good self-perceived health in 1988 was 1.44 (95% CI 1.20 to 1.71), decreasing to 1.26 (95% CI 1.09 to 1.43) by one year later. In addition to the sustained association between self-perceived health and mortality over the time, the association between ADL and mortality did not decrease between 1981 and 1988. The relative risk of death for those dependent in ADL in 1981 was 1.56 (95% CI 1.28 to 1.91) whereas in 1988 the relative risk of death was 1.66 (95% CI 1.36 to 2.02). When exactly the same model was fitted to both the 1981 and 1988 data, including all covariates significantly associated with mortality in either study, there was little change in the relative risks.

*Effect of Migration*

Information on period of residence in the area and distance moved into the area was available from the 1988 survey questionnaire. In-migrators were defined as those who had been resident in the area 10 years or less (the categories in the questionnaire did not allow for the seven-year time period between the surveys) and had moved a distance of more than five miles. Ninety-three people (including the 79 people in institutions) had missing data, and 188 in-migrators and 1,298 non-migrators were identified. When all the analyses reported above were repeated with only non-migrators present in 1988, there were no substantial changes in the conclusions drawn.

## Discussion

The longitudinal study of the older people of Melton Mowbray offers a rare opportunity to observe changes in health status of this age group over time, at cohort as well as population level. However, with such population studies, enhanced, or indeed poorer, health may be a result of substantial shifts of groups into or out of the area. The numbers interviewed in the two surveys indicate that the population aged 75 years and over within the general practice increased by 31 percent between 1981 and 1988, compared to an increase of only 14 percent in England and Wales between the 1981 and 1991 decennial censuses. Hence, one could conjecture that the reduction in dependency over time reported here may simply be a consequence of fitter older people migrating into Melton Mowbray in the time period between surveys. However, removal of those people who had moved into the area within the 10 years prior to the second survey from the analyses had minimal effect on the findings. Data on the number of older people who moved out of the area between the surveys were not available, although evidence from the death certificates of those who have died suggests that this is small. It is possible that the differences observed may be partly attributable to selective patterns of migration out of the practice between the two surveys.

The advantage of using an age-period-cohort framework in modeling longitudinal data is that it enabled investigation of changes in health within subgroups that were followed over time. Period and age effects, or cohort and age effects, can be identified in a way that is not possible with a single cross-sectional survey. Despite this, there remains the problem of identifying age, period, and cohort effects. As age is a linear combination of period and cohort effects (age = period-cohort, with cohort expressed as birthdate), in the absence of further information (supplied by theory or historical data), the identification of all three effects is not possible (Wolinsky, 1993). Alternative models, using age-period and age-cohort specifications, are presented here. Where the models fit equally well, any attempt to distinguish between them was speculative. Moreover, interpretation of the model parameters requires care, as the data amount to limited sampling of a complex dynamic situation. Nonresponse, the measures of physical functioning and perceived health, and the length of the interval defining the cohorts may all affect the final models. Although care was taken to standardize the health measures between surveys, comparability cannot be assessed. Nonresponse was very low in both studies and is unlikely to seriously affect the results. The problems of the measures and interval length will be discussed more fully later.

The results suggest a reduction over time in the proportion of older people who are dependent in at least one of five ADLs. This decrease in the prevalence of ADL dependence could be accounted for simply by cohort effects or by the combined effects of age and time period. The findings differ from those of other studies, but comparisons of trends in disability are complicated by differences in survey measures, age thresholds, and other design issues. Crimmins, Saito, and Ignegneri (1989) point to conflicting evidence in their review of research on prevalence of disability among people over 65 years and suggest that the threshold used to define the disabled population can have a critical effect upon the conclusions drawn.

In the analyses presented here, dependence is defined as the inability to perform at least one of five ADLs unaided by a person or appliance. Manton (1991), using a comparable ADL measure, found a slight decrease in prevalence of disability in the U.S. population aged 65 years and over between 1981 and 1988. Two Finnish studies (Antilla, 1991; Winblad, 1993) defined dependence in ADL as needing help from another person, but not from an appliance. This definition would indicate more severe levels of disability and although one of the studies (Winblad, 1993) found no change in the prevalence of disability between 1979 and 1989, the other (Antilla, 1991) found an increase. The Antilla study included only community-dwelling older people, and therefore the increase may have been due to a fall in the rate of institutionalization. Within the U.K., the only morbidity data over the same time period as ours is from the General Household Survey (Office of Population, Census and Surveys, 1988) although these data do not include older people resident in institutions. A small increase in the prevalence of disability among men aged 75 years and over between 1981 and 1988 was reported, with no change for women. Limiting long-standing illness was used as the measure of disability, thus capturing milder impairment than dependence in ADLs.

As newer cohorts have aged into the Melton Mowbray population, their members have been more likely to report less good health than members of earlier birth cohorts. This finding is in contrast to the improvement in health as measured by the ability to perform ADLs unaided. These poorer levels of self-perceived health between cohorts remained consistent when the population was subdivided by ability to perform all ADLs. The effect was particularly marked between the two younger dependent male cohorts surveyed. These data contrast with U.S. data, where cross-sectional estimates from the National Health Interview Survey showed the proportion of people aged 65 years and over with poor or fair health to have declined steadily between 1981 and 1988 (Waidmann, Bound, and Schoenbaum, 1995). Idler (1993) also investigated inter-cohort differences in self-perceived health from the Yale Health and Aging Project, and the dates of the survey (1982 and 1988) produced six-year cohorts which compare quite closely with those in Melton Mowbray. The U.S. cohorts born immediately prior to 1900 were found to have significantly better self-perceived health than later cohorts, after adjustment for age, a finding confirmed by the Melton Mowbray data. However, Idler (1993) found a positive relationship between age and self-perceived health, not found in Melton Mowbray, which may have been due to differences in the wording of the question or because of adjustment for self-reported chronic conditions as well as functional disability in the U.S. study. The persistence of significantly worse self-perceived health across increasing age groups in the Melton Mowbray data may be mitigated with more comprehensive adjustment for other comorbidity. Moreover, our data were limited by having only the three categories of good, fair, or poor self-perceived health whereas others have allowed five response categories — excellent, very good, good, fair, and poor,

with excellent as the referent category. Our category of good may contain people with less good health than in comparable surveys, although this might be expected to suppress differences between cohorts rather than affect the direction of the differences observed.

Hypotheses to account for worse self-perceptions of health in later birth cohorts depend upon the meaning attached to the subjects' responses. It may be that self-perceived health is capturing aspects of health not captured by the ADL measure, and that our findings reflect trends of increasing prevalence of mild chronic conditions but less severe disability. For example, intra-individual declines in self-perceived health have been found to be associated with increased depression and decreased self-efficacy (Rodin and McAvay, 1992). Under this hypothesis, declining self-perceived health has implications for the health care needs and future mortality of the elderly. Due to the absence of a self-perceived health measure for elderly people resident in institutions, trends in self-perceived health may have been confounded with a decline in the rate of institutionalization. However, results were similar for the community-based population, and for the total population under the assumption that elderly people in institutions had less than good self-perceived health.

Alternatively, self-perceived health may have dimensions beyond those of self-reported physical and mental health. In a review of seven studies of the association between self-perceived health and mortality it was concluded that self-perceived health "goes well beyond the information retrieved with traditional approaches to health status measurement" (Wolinsky and Johnson, 1992). Idler (1993) suggested that inter-cohort differences in self-perceived health could be attributable to the differing experiences of the cohorts in relation to developments in medical care over this century. If this is indeed the case, then contrasting trends in the U.S. and U.K. may be explained by different development of health care and attitudes toward aging and health in the two countries. Under this hypothesis, the implications of the results from Melton Mowbray for the future health of the population are less clear, and one consequence may be a reduction over time in the strength of the association between self-perceived health and mortality. However, analyses of the association between self-perceived health and five-year mortality for both 1981 and 1988 surveys did not support this. After adjustment for a variety of confounding factors, the relative risk of death for those rating their health as less than good was almost identical for the two time periods.

In addition to qualifications in the measures used, other limitations of the analysis must be taken into account. The age-period-cohort framework adjusts for the changing age structure of the population; although a period of seven years allows some scope for shift in age structure within cohorts, a shorter follow-up would have been desirable. The patterns of change described here occur over four seven-year cohorts observed at only two time points, and the relative brevity of the observation period means that conclusions must be tentative.

Finally our analysis makes no allowance for mortality, which has a profound effect in this population. There is no simple method available in the age-period-cohort framework to include the effect of mortality. Since the proportions investigated are conditional on survival, interpretation of the models must bear this in mind. Measures of health expectancy from multistate models (Rogers, Rogers, and Belanger, 1990; Rogers, Rogers, and Branch, 1989) would overcome this problem as both mortality and morbidity are combined in a single index. These models use transition rates between states of health, ill health, and death. However, to separate out age, period, or cohort effects from these models requires longitudinal data with a minimum time between waves (to ensure that transitions between states are not missed due to death) and with aging-in samples at younger ages in subsequent waves (to ensure better estimation of transition rates at younger ages). To date no such data exist for the United Kingdom.

*Conclusion*

This article reports a decline over succeeding cohorts in the proportion of elderly people with dependence in one or more ADLs, which was unlikely to be simply a result of in-migration of healthy people. This finding lends some support to the compression of morbidity theory (Fries, 1980). Moreover, reduction in disability across cohorts was accompanied by *worse* perceptions of health in the newer cohorts although the predictive effect of self-perceived health on mortality had not lessened over the same time period. If this predictive effect is maintained in the future, a cross-cohort decline in the self-perceived health of the Melton Mowbray population has serious implications for future mortality rates. Furthermore, if the inter-cohort differences in self-perceived health are indexing higher prevalence of mild chronic conditions, then increased demand for primary health care and assistance within the community can be expected, over and above that predicted due to the aging of the population. The findings reemphasize the importance of including measures which index both mild and severe disabilities in studies of population health.

These data are unique in the U.K. and as the analyses are necessarily limited, further data and research are necessary to confirm whether the patterns reported here reflect the U.K. experience. If the findings reported here are representative, they should prompt further research into the implications for future population health and health care needs. The divergence from results reported elsewhere, if supported by further U.K. evidence, also raises questions about the cultural sensitivity of the self-perceived health measure, which can only be addressed by qualitative research.

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Address correspondence to Dr. Carol Jagger, Senior Lecturer in Epidemiology, Department of Epidemiology and Public Health, University of Leicester, 22-28 Princess Road West, Leicester, LE1 6TP, U.K. Internet: cxj@le.ac.uk

## References

Aitken, M., D. Anderson, B. Francis, and J. Hinde. 1989. *Statistical Modelling in GLIM*. Oxford: Oxford University Press.

Antilla, S. 1991. "Functional Capacity in Two Elderly Populations Aged 75 or Over: Comparisons at 10 Years' Interval." *Journal of Clinical Epidemiology* 44:1181–1186.

Baker, R.J. and J.A. Nelder. 1978. *The GLIM System. Release 3*. Oxford: Numerical Algorithms Group.

Bebbington, A.C. 1991. "The Expectation of Life Without Disability in England and Wales: 1976–88." *Population Trends* 66:26–29.

Clarke, M., S.J. Clarke, A. Odell, and C. Jagger. 1984. "The Elderly at Home: Health and Social Status." *Health Trends* 16:3–7.

Cox, D.R. 1972. "Regression Models and Life Tables (With Discussion)." *Journal of the Royal Statistical Society Series B* 34:187–220.

Crimmins, E., Y. Saito, and D. Ingegneri. 1989. "Changes in Life Expectancy and Disability-Free Life Expectancy in the United States." *Population and Development Review* 15:235–267.

Fienberg, S.E and W.M. Mason. 1985. "Specification and Implementation of Age, Period and Cohort Models." In W.M. Mason and S.E. Fienberg (Eds.), *Cohort Analysis in Social Research*. New York: Springer-Verlag.

Fylkesnes, K. and O.H. Forde. 1992. "Determinants and Dimensions Involved in Self-evaluation of Health." *Social Science and Medicine* 35:271–279.

Fries, J.F. 1980. "Aging, Natural Death and the Compression of Morbidity." *New England Journal of Medicine* 303:130–135.

Idler, E.L. 1993. "Age Differences in Self-assessments of Health: Age Changes, Cohort Differences, or Survivorship?" *Journal of Gerontology: Social Sciences* 48:S289–S300.

Idler, E.L. and S.V. Kasl. 1991. "Health Perceptions and Survival: Do Global Evaluations of Health Status Really Predict Mortality?" *Journal of Gerontology: Social Sciences* 46:S55–S65.

Idler, E.L. and S.V. Kasl. 1995. "Self-ratings of Health: Do They Also Predict Change in Functional Disability?" *Journal of Gerontology: Social Sciences* 50B:S344–S353.

Idler, E.L., S.V. Kasl, and J.H. Lemke. 1990. "Self-evaluated Health and Mortality Among the Elderly in New Haven, Connecticut and Iowa and Washington Counties, Iowa, 1982–1986." *American Journal of Epidemiology* 131:91–103.

Jagger, C. and M. Clarke. 1988. "Mortality Risks in the Elderly: Five Year Follow-up of a Total Population." *International Journal of Epidemiology* 17:111–114.

Jagger, C., M. Clarke, and S.J. Clarke. 1991. "Getting Older Feeling Younger: The Changing Health Profile of the Elderly." *International Journal of Epidemiology* 20:234–238.

Jagger, C., M. Clarke, and R.A. Davies. 1986. "The Elderly at Home: Indices of Disability." *Journal of Epidemiology and Community Health* 40:139–142.

Jagger, C., N.A. Spiers, and M. Clarke. 1993. "Factors Associated With Decline in Function, Institutionalisation and Mortality in the Elderly." *Age and Ageing* 22:190–197.

Johnson, R.J. and F.D. Wolinsky. 1993. "The Structure of Health Status Among Older Adults: Disease, Disability, Functional Limitation and Perceived Health." *Journal of Health and Social Behaviour* 34: 105–121.

Liang, J. 1986. "Self-reported Physical Health Among Aged Adults." *Journal of Gerontology* 41:248–260.

Lindgren, A-M., K. Svärdsudd, and G. Tibblin. 1994. "Factors Related to Perceived Health Among Elderly People: The Albertina Project." *Age and Ageing* 23:328–333.

Manton, K.G. 1991. "The Dynamics of Population Aging: Demography and Policy Analysis." *Milbank Memorial Fund Quarterly* 69:309–338.

Mossey, J.M. and E. Shapiro. 1982. "Self-rated Health: A Predictor of Mortality Among the Elderly." *American Journal of Public Health* 72:800–808.

Office of Population, Census and Surveys. 1988. *General Household Survey No. 20*. London: Her Majesty's Stationery Office.

Office of Population, Census and Surveys. 1994. [Table of Population, 1971–1995]. *Population Trends* 76:57.

Perenboom, R.J.M., H.C. Boshuizen, and H.P.A. van de Water. 1992. "Trends in Health Expectancies in the Netherlands, 1981–1990." In J-M. Robine, C.D. Mathers, M.R. Bone and I. Romieu (Eds.), *Calculation of Health Expectancies: Harmonization, Consensus Achieved and Future Perspectives*. Colloque INSERM/John Libbey Eurotext Ltd.

Rakowski, W., J.A. Fleishman, V. Mor, and S.A. Bryant. 1993. "Self-assessments of Health and Mortality Among Older Persons." *Research on Aging* 15:92–116.

Robine, J-M. 1994. "Disability-free Life Expectancy Trends in France, 1981–1991, International Comparison." In C.D. Mathers, J. McCallum, and J-M. Robine (Eds.), *Advances in Health Expectancies. Proceedings of the Seventh Meeting of the International Network on Health Expectancy (REVES), Canberra, February 1994*. Canberra: Australian Institute of Health and Welfare.

Rodin, J. and G. McAvay. 1992. "Determinants of Change in Perceived Health in a Longitudinal Study of Older Adults." *Journal of Gerontology: Psychological Sciences* 47:P373–P384.

Rogers, A., R.G. Rogers, and A. Belanger. 1990. "Longer Life but Worse Health? Measurement and Dynamics." *The Gerontologist* 30:640–649.

Rogers, A., R.G. Rogers, and L.G. Branch. 1989. "A Multistate Analysis of Active Life Expectancy." *Public Health Reports* 104:222–225.

Roos, N.P., B. Havens, and C. Black. 1993. "Living Longer but Doing Worse: Assessing Health Status in Elderly Persons at Two Points in Time in Manitoba, Canada, 1971 and 1983." *Social Science and Medicine* 36:273–282.

Waidmann, T., J. Bound, and M. Schoenbaum. 1995. "The Illusion of Failure: Trends in the Self-reported Health of the U.S. Elderly." *Milbank Memorial Fund Quarterly* 73:253–287.

Winblad, I. 1993. "Comparison of the Prevalence of Disability in Two Birth Cohorts at the Age of 75 Years and Over." *Journal of Clinical Epidemiology* 46:303–308.

Wolinsky, F.D. 1993. "Age, Period and Cohort Analyses of Health Related Behaviour." In K. Dean (Ed.), *Population Health Research: Linking Theory and Methods*. Thousand Oaks, CA: Sage Publications.

Wolinsky, F.D. and R.J. Johnson. 1992. "Perceived Health Status and Mortality Among Older Men and Women." *Journal of Gerontology: Social Sciences* 47:S304–S312.


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