LIFE-COURSE OCCUPATIONAL SOCIAL CLASS AND HEALTH IN LATER LIFE: THE IMPORTANCE OF FREQUENCY AND TIMING OF MEASURES

INTRODUCTION

A universal feature of much life-course research, regardless of the discipline in which such research is situated, is a concern with increasing understanding of the way people live their lives in patterned and structured ways. However, when seeking to address these issues in quantitative research, challenges will often arise due to a necessary reliance on secondary analysis of survey data, meaning that decisions about the number and timing of life-course measures are constrained by the data. Furthermore, even if detailed information from across the life-course is available, researchers will often be required to judge how much information can feasibly and justifiably be lost in order to produce a meaningful 'summary' of the life course that is of practical use in statistical modelling. These challenges surrounding the measurement of life-course exposures and processes are arguably more relevant to those in later life than for any other age group, given that the volume and complexity of life-course data are only likely to increase as people age. From a public health perspective, understanding the processes that lead to relatively poor health expectancy in older age might help future generations to improve their chances of experiencing a fit and fulfilling 'third age' (Laslett 1989). If we are to be successful in increasing people's health expectancy as they age, investigation of life-course processes needs to become more focussed on the key transitional points at which we can improve people's long-term potential for good health.

Such considerations are increasingly important as longitudinal data become more readily available in a variety of global settings (Borsch-Supan et al. 2005; Strauss et al. 2010; Oleko et al. 2011; Banks et al. 2012). The UK is a pertinent example, having a long-established and ongoing portfolio of birth cohort studies (Wadsworth et al. 2006; Power and Elliott 2006; Elliott and Shepherd 2006) and panel studies (Taylor et al. 2010; Banks et al. 2012). In this context, there is an important body of research investigating associations between social class over the life-course and later health (Power et al. 2000;

Bartley and Plewis 2002; Adams et al. 2004; Bartley and Plewis 2007). In particular, theoretical and empirical work has characterised a number of ways in which exposures during the life-course might affect later health (Mishra et al. 2009; Otero-Rodriguez et al. 2011). For example, the accumulation model assumes that there is a dose-response relationship between exposure to "risks" and the development of disease, with gradual, long-term effects (Hertzman et al. 2001; Ben-Shlomo and Kuh 2002). The critical period model, arising from Barker's 'foetal origins' hypothesis (Barker et al. 1989) contends that the health consequences of exposure to hazards depend on the age at which such exposures occur and that the latent effects of childhood exposures are "embedded" in early life but only become apparent in adulthood (Elstad 2005).

When seeking to disentangle the importance of these different potential pathways between social exposures and biological outcomes, methodological issues surrounding the measurement of life-course exposures are often side-lined given the limited life-course information available in existing datasets. Even in birth cohort and panel studies that provide longitudinal data, this will often only be collected at irregular intervals and for younger participants will not yet provide a full life-course perspective. Nevertheless, it could be argued that the frequency and timing of life-course measures can have a significant impact on, for example, how exposure to disadvantage over the life-course is classified and distributed.

This paper contributes to the methodological development of life-course epidemiology by evaluating how the frequency and timing of measures of occupational social class over the life course influences the descriptive validity of such measures in operationalising cumulative exposure to disadvantage. We then investigate the use of a theoretically-informed model to operationalise trajectories of occupational social class. Finally, the value of these measures in identifying associations between life-course occupational social class and health in later life is examined. In particular, the accumulation and critical period models of the relationship between life-course exposures and later health are explored. A set of near-continuous life-course data based primarily on retrospective data is used as a

reference point against which simulated models of life-course occupational social class, designed to broadly replicate commonly-available forms of secondary data, are compared.

METHODS

The Boyd Orr Lifegrid Subsample

The data used in the present study originate from the Carnegie Study of Family Diet and Health, developed by Sir John Boyd Orr in the 1930s. A total of 1,352 families were originally recruited, with data collected on a range of social, health and anthropometric factors. The analyses presented here use data from a smaller, in-depth follow-up sample, referred to as the Lifegrid Subsample. The sample includes 139 men and 152 women aged an average of 68 years at the time of interview (range 63 to 78 years). A detailed description of the recruitment process has been published elsewhere (Blane 2005). During 1997–8, the 294 participants were interviewed in their homes using a lifegrid method (Berney and Blane 1997), providing detailed retrospective information on their residential, occupational and family circumstances. The lifegrid facilitates the collection of retrospective information and aims to increase the reliability of recall by collecting data from different life-course domains simultaneously, anchored by key external events in wider society. This retrospective information was combined with the prospective information from the childhood survey to produce near-continuous information from throughout respondents' lives, providing a rich resource for evaluation of different approaches to the measurement of life-course occupational social class.

Occupational social class

Guided by the lifegrid, participants provided detailed information on every job that they could recall holding throughout their lives. The occupations of respondents' parents were recorded prospectively during the original Boyd Orr survey and this information was used to define occupational class in childhood. Based on the job titles and descriptions provided, occupational social class was categorised based on the Registrar General's classification of occupations for the 1991 census. In conceptual terms, the use of the 1991 Registrar General's classification for the entire range of life-course data

meant that the measure would not take into account the socio-historical context of occupations. An alternative option would have been to obtain the classification scheme for each census and to have used the relevant version to define participants' occupational social class during each decade. However, rather than solving the problem of a lack of socio-historical context this would have invited a raft of additional issues related to the more general questions regarding the validity and changing meaning of the Registrar General's classification scheme (Szreter 1984; Brewer 1986). Moreover, on a more practical level, as the scheme was only revised once every decade, an essentially arbitrary decision would have to have been made as to where to make the 'cut-off' between different classification schemes, for example whether data from 1976 should have been classified using the 1971 or 1981 scheme. Furthermore, in a study examining long term trends in patterns of intergenerational social mobility in Britain, Lambert et al (2007) found that such social mobility trends were, in general, robust to the type of occupation-based social classification. Although this is not directly addressing the issue of whether occupational social class measures can be considered equivalent in different temporal contexts, it does support the conclusion that using a different version of the Registrar General's classification for each decade would have made little difference to the patterns of movement between socioeconomic positions that emerged in the analyses. With these issues in mind, it was decided that the more parsimonious strategy of using the same classification scheme for occupations across the life course was preferable.

There are long-running debates regarding the most useful and valid way in which to operationalise occupational social class in relation to gender eg. (Goldthorpe 1983; Heath and Britten 1984). In the present study, a dominant approach was used to classify each participant, with occupational social class defined by the most advantaged social class position of the participant or their spouse (if married), regardless of gender. In childhood, the dominant class of the participant's father or mother was used. After labour market exit, occupational social class was defined using the participants' last main occupation (or their spouse's main occupation if dominant). Any part-time occupations held for two years or less before retirement were considered to be 'insignificant' periods of employment

(Blane, Berney, Smith, Gunnell, & Holland 1999). Women who reported being housewives were classified based on their husband's occupation.

The indicator is used as a dichotomous variable with class defined as manual versus non-manual. Periods of unemployment are relatively uncommon in the sample: only 20% reported any experience of unemployment and among this 20%, the majority (58%) were unemployed for five years or less. With this in mind, and given the focus of this paper on class rather than economic activity, respondents who reported being unemployed were classified in the 'disadvantaged' category (manual class). Occupational social class was coded for every consecutive six-month period throughout each respondent's life. These data were used to produce an age-based, occupational social class time-line, consisting of a sequence of more than 120 data-points per respondent.

Replication of secondary data

Two different types of data were replicated using the full life-course data from the Boyd Orr Lifegrid Subsample.

1. Theoretical approach: Life stage data
2. A-theoretical approach: Panel study data

Theoretical approach: life stage data. The first approach assumes that the collection of life-course data has some kind of theoretical basis and can be seen as representative of the type of data that are often available either in cohort studies, or in cross-sectional surveys. It reflects the fact that cohort studies will often attempt to interview sample members at what are thought to be key 'stages' in their lives – for example, moving between different stages of education; becoming active in the labour market; reaching the statutory retirement age. Similarly, in cross-sectional studies, life-course information is generally restricted to only a few 'key events' or changes, likely those of particular interest to the original survey team. In terms of occupational social class, theories relating to social mobility are of particular relevance. To test, for example, theories relating to the association between

intergenerational mobility and later health (Hart et al. 1998) would require measurement of occupational social class in childhood (based on parents' occupations) as well as adult occupational social class. However, structural mobility may also be important, and is particularly relevant to the Boyd Orr Subsample members who lived through a period of great change in the constitution of the labour market.

The traditional 'social mobility' models that focus primarily on inter-generational movement between socioeconomic positions using only two time-points are limited by the fact that they do not include any information on when any transitions in position occurred (Sørensen 1986) and by the fact that they do not allow for a non-linear trajectory of social class through the life course. In the present study, we move beyond these simple origin/destination models and identify four key stages of the lifecourse that are specifically linked to occupational social class and, in turn, to social mobility. Our framework loosely follows the work of Davey Smith and colleagues, who constructed a cumulative measure of life-course based on secondary analysis of data from the West of Scotland Collaborative Study (Davey Smith et al. 1997). The first two points represent occupational social class in childhood, based on parents' occupations, and at labour market entry, based on the respondent's first reported job. In addition we include a measure at age 35 years, which in sociological discussions of social mobility, has been cited as the age at which "occupational maturity" has usually been attained (Goldthorpe et al. 1987). Although this age-defined stage is likely to be less relevant in a contemporary context of greater variation in employment patterns and career progression (Noble 2000), it remains a useful indicator for the Boyd Orr participants, who reached this age, on average, in the mid-1960s when people's labour market experiences tended to be much more structured (Goldthorpe et al. 1968).

The final point is an indicator of occupational social class at screening in 1997, at which point most of the respondents were retired (69%) or otherwise inactive in the labour market (17%). With regard to the study of health inequalities in later life, it is especially important to consider post-retirement as the 'ultimate' destination in a social mobility trajectory, in addition to its importance as the measure of socioeconomic position that is proximate to the outcome in question (Naess et al. 2004). However,

there are recognised difficulties with measuring socioeconomic position in post-retirement populations (Grundy and Holt 2001; Bowling 2004). This is largely due to occupation-based measures potentially having less relevance in retired populations than in those who are still active in the labour market (Martelin 1994). This has been used to justify the use of other indicators of socioeconomic position such as income, housing tenure and car ownership for post-retirement populations (Arber and Ginn 1993). On the other hand, it is countered that such measures of material circumstances are themselves a reflection of resources accumulated during the life-course and are largely determined by experiences and exposures during working life (Berney et al. 2000). With this in mind, in the present study participants' self-reported 'main occupation' was used to define their occupational social class in early old age. In previous research, main occupation has been shown to be a more accurate measure of post-retirement social class than 'last occupation', as many people will have a period of transition between work and retirement when they take, for example, a lower-paid, part-time job for a short time (Berney et al. 2000).

A-theoretical approach: panel study. The second approach uses the panel study as its template. In such studies, one or more follow-up interviews are carried out with the same participants, often every one or two years, but sometimes at longer intervals. Given that such studies are costly to carry out, from the perspective of life-course research it would be valuable to establish a minimum interval between interviews that would allow researchers to adequately capture people's life-course experiences. The present analysis aims to investigate how changing the frequency of measurement affects estimation of the duration of exposure to disadvantage, in comparison with the full life-course data. The 'simulated' interval between measurements ranged from one year to 20 years. Given that the respondents were not all the same age in 1997, there was a degree of variation in the total years of data available for analysis. To allow a straightforward and valid comparison of the different 'simulated' intervals, the time-line was truncated at either end to provide a uniform length of trajectory for all respondents. The timeline was started at age six years to reflect the minimum age at which the respondents were interviewed in childhood. In 1997, the youngest respondents were aged 63 years at interview but this only represented 12 respondents. To maximise the number of data-

points available while still including all respondents, the time-line was therefore truncated at age 64, with the occupational social class value at age 63 carried forward one year for the small number of respondents who had not yet reached aged 64. Given that the majority of respondents had left the labour market by age 65, there were in any case few changes in occupational social class after this age.

Health outcome: Limiting longstanding illness

Self-reported limiting longstanding illness (LLI) in 1997 was used as a summary measure of health in early old age. This measure has a long history in the UK as a general indicator of morbidity, stemming primarily from its inclusion in the 1991 census (OPCS/GROS 1991), and is established as a reliable measure of overall health (Blane et al. 1996). LLI has previously been linked to cumulative exposure to disadvantage, which supports the use of a life course approach in studies of this outcome (Bartley and Plewis 2002; Adams et al. 2004). In the Boyd Orr survey, respondents were asked:

> *"Do you have any long standing illness, disability or infirmity?*
>
> *Does this illness or disability limit your activities in any way (e.g. are there things that you cannot do anymore since you have had it)?"*

In the present analysis, the presence/absence of LLI was coded as a dichotomous variable, with a positive report of LLI recorded in those who answered 'yes' to both of the above questions. There were no missing responses and a total of 105 (35.7 per cent) respondents reported having a LLI in 1997.

Analysis

Measurement validity. To evaluate how well the simulated life stage and cohort data estimated cumulative exposure to disadvantage, the percentage of life time in manual occupational social class was calculated using the full life-course data and for each simulated measurement scheme. Pearson's product moment coefficient (r) was used to measure the correlation between the individual values of percentage of life time in disadvantage using the full life-course versus simulated data. R^2 values were

also calculated to provide an indication of the proportion of variance in the full life-course data explained by the estimated values.

Explanatory analysis. To examine the relationship between accumulated disadvantage and health in later life, the mean percentage of life time in disadvantage was compared using a t-test, according to the presence or absence of LLI in 1997. Separate analyses were carried out using the full life-course data and each of the simulated models.

The identification of 'critical periods' of exposure was investigated using a series of binary logistic regression analyses. Each regression model included occupational social class at a single year of age as the explanatory variable, with LLI in 1997 as the dependent variable. For this analysis, because occupational social class at a single point in time (rather than accumulated exposure) was the variable of interest, with no requirement for each respondent to have the same number of data-points, the age time-line was treated slightly differently. First, as childhood occupational social class was based on just one measure of parental occupational social class with the earliest change in class occurring at 12 year, ages 6-11 were combined as a single variable. Second, the time-line was truncated at the upper limit of 73 years because no further changes in occupational social class were reported after this age. Four additional models with occupational social class at each of the four points using the 'life stage' approach as the explanatory variables were also estimated. Age in 1997 and sex were included as covariates in all analyses.

To assess the impact of the timing of movement between occupational social classes over the life course on later health, participants were classified according to their sequence of exposures to manual or non-manual occupational social class in childhood, at labour market entry, at occupational maturity and in 1997. The number '1' was used to denote non-manual occupational social class and the number '2' to denote manual occupational social class. Thus, the sequence '1122' would represent an individual who was in a non-manual occupational social class in childhood and at labour market entry, and in a manual occupational social class at occupational maturity and in 1997. As noted above, the

aim was to build upon simple origin/destination models of social mobility that would traditionally consider just two measures of social class, one in childhood and one in adulthood. Of the 16 possible sequences, four were represented by fewer than five respondents and these were combined into a single 'atypical' category. The percentage of respondents reporting LLI in each trajectory group was then compared.

RESULTS

Measurement validity: accumulation

Figure 1 shows the descriptive validity of percentage of life time in manual occupational social class based on increasing intervals between measurements, according to their correlation (R) with the same cumulative measure based on the full life-course data (6-monthly measurements), and the proportion of explained variance (R^2) in the latter measure. In general, the pattern is unsurprising in that the correlation and explained variance both decline as the interval between measurements increases. However, overall the values remain high regardless of the frequency of measurement. The correlation remains above 0.9 for all but the 19-year interval, where it drops only slightly to 0.87. Similarly, the R^2 values show that the percentage of life time in manual occupational social class estimated using measures at increasing intervals explains at least 75% of the variance in the measure calculated using 6-monthly measures, and again only drops below 80% for the 19-year interval. The only other notable deviation from a broadly linear pattern occurs when the interval between measurements reaches 16 years, at which point there appears to be a steeper drop in both the R and R^2 values.

The values for correlation and explained variance associated with accumulated exposure to disadvantage estimated using the four-point life stage approach are included at the end of the axis in Figure 1. Both values are lower than for any of the 'equal interval' measures, with a correlation coefficient of 0.83 and 69% of the variance in the full life-course data explained.

Explanatory analysis: accumulation

Using the full life-course data, the mean percentage of life time in a manual occupational social class was not significantly different in those with and without LLI in 1997 (49.3 per cent versus 45.5 per cent). Age- and sex-adjusted logistic regression analysis further confirmed that cumulative occupational social class was not a significant predictor of LLI in 1997 using the full life-course data, nor using any of the other measurement intervals based on the a-theoretical approach. However, using the life stage approach, people with LLI spent longer in a manual occupational social class than those without LLI (56.7 per cent versus 48.8 per cent). In an independent samples t-test, this difference was statistically significant (*P*=0.030). Moreover, in logistic regression analysis adjusting for age and sex, percentage of life time in manual occupational social class using the four-point life stage approach was a significant predictor of LLI (odds ratio = 1.01 [1.00 to 1.02];*P*=0.025).

Explanatory analysis: critical periods

Figure 2 shows the odds ratios and 95 per cent confidence intervals for LLI in 1997 according to occupational social class from childhood to age 73 years. The only significant associations with LLI were for exposure to manual occupational social class in adolescence. The strongest association was observed for occupational social class at age 14 years, with being in a manual occupational social class at this age conferring an odds ratio of 2.14 (95 per cent confidence intervals 1.21 to 3.79) for LLI in 1997 (*P*=0.009). Statistically significant associations were also observed at ages 15 years (odds ratio= 1.73 [1.00-2.98]; *P*=0.048) and age 16 years (odds ratio= 1.93 [1.12-3.32]; *P*=0.017).

Throughout most of the adult life-course, the odds ratios were close to one. However, given the relatively small sample size, we highlight a number of additional associations that were significant at the 10% level or were close to significance. In particular, manual occupational social class in childhood showed a positive association with LLI (odds ratio=1.7 6[0.93-3.32]; *P*=0.080). At post-retirement ages relatively strong, positive associations between being in a manual occupational social class and LLI and were once again observed, moving towards statistical significance and reaching significance at 10% by age 73 (odds ratio=1.71 [0.95-3.08]; *P*=0.074).

Using the life stage approach (Figure 3), the only statistically significant association with LLI in early old age was for occupational social class at labour market entry. Being in a manual occupational social class at this point conferred an odds ratio of 1.88 for LLI (95 per cent confidence interval 1.09 to 3.25; *P*=0.023).

Explanatory analysis: trajectories

Overall, the trajectories of occupational social class measured using the four-point life stage approach were relatively homogenous and stable in the majority of respondents. Nearly two-thirds of respondents fell into the top five categories: 2111 (17%); 2211 (14%); 2212 (12%); 2222 (12%); and 1111 (9%). As might be expected, the most common trajectories involved being in manual class in early life with subsequent movement into non-manual class, reflecting structural social mobility during the period in question. Figure 4 shows the proportion of respondents reporting limiting longstanding illness in 1997 by occupational social class trajectory. Although there were no statistically significant differences between trajectories (not unexpected given the small sample sizes in each group), it is notable that the two trajectories with the highest (2211; 46%) and lowest (1211; 15%) proportions reporting LLI differed only in relation to occupational social class in childhood, with those in a manual occupational social class having a greater risk of LLI in later life than those in a non-manual class in childhood, despite both groups being in a manual class at labour market entry.

DISCUSSION

The results presented in this paper indicate that the timing of measurements used to operationalise occupational social class over the life course has important implications both in descriptive terms and for the results of explanatory analyses investigating associations with health in later life. Using a theoretically-informed 'life stage' approach with the potential to measure the number, timing and sequence of exposures to disadvantage adds strength in relation to understanding linkages between social exposures and health outcomes, including processes such as accumulation and critical periods.

In descriptive terms, the life-stage approach placed additional weight on 'transient' periods in manual occupational social class, particularly at labour market entry, leading to higher estimates of the proportion of life in disadvantage than were found with the full life-course data. This reflects sociological and demographic literature suggesting that late adolescence/early adulthood is a relatively unstable period of life in many life course domains (Berrington 2001; Macmillan and Eliason 2004; Patton and Viner 2007). However, the life stage approach still gave a reasonable estimate of the duration spent in disadvantage, with a correlation coefficient of 0.83 when compared with the full life-course data. Furthermore, as will be discussed below, a theoretical approach provides certain advantages in interpreting both descriptive and explanatory findings.

Using the 'a-theoretical' approach with equal intervals between measures, the general trend was that correlation with the full life-course data increased as the interval between measurements reduced. This suggests that if the aim is to measure cumulative exposure to disadvantage, the shorter the interval, the better. However, given financial constraints that would likely limit the number of measures that would be feasible to collect, it is useful to note that there only appeared to be substantial drop in accuracy when the interval between measures rose above 16 years (yielding a minimum of five data-points in the present sample), providing some guidance as to how a balance might be achieved between efficiency and accuracy of measurement. Moreover, even with measurements only every 20 years (four data-points) the correlation coefficient remained high at 0.90, suggesting that this would be adequate in certain contexts.

It should, however, be emphasised that these findings are likely to reflect, in part, the relative stability of the Boyd Orr cohort in a number of life-course domains. Born in the 'inter-war' period, they are part of the apparent 'golden cohort' in Britain that show more favourable mortality rates than the generations either before or after them (Murphy 2009). They lived much of their early adult lives in a relatively favourable economic climate, and most were married in the 1950s and early-1960s when they were in their twenties. They tended to follow a traditional route to family formation, with

marriage occurring before childbearing. All of these factors were likely to interact to produce relatively stable occupational social class trajectories, as demonstrated in this paper. In younger cohorts with potentially more heterogeneous and individualised life-courses, it might be that more frequent measures would be required to adequately capture variations in the life course. In such a context, the importance of the timing of measures – over and above their frequency – becomes even more apparent. Identifying key 'life stages' is one way to reduce to increase the efficiency of life-course measures, raising the chance that important transitions and changes in social exposures will be captured using the minimum number of data-points.

In explanatory analysis, occupational social class at ages 14-16 years (using the full life-course data) and at labour market entry (using the life stage data) were identified as a potential 'critical periods' for predicting LLI in later life. Given that the mean age at labour market entry was 15 years (in a cohort for whom 14 was the minimum school leaving age), the life stage approach did appear to be picking up on the association observed using the full life-course data. Given that the analysis is based on observational data, we can only speculate as to the underlying reasons for the emergence of this 'critical period' and cannot offer any causal explanations. However, a plausible biological pathway could relate to the endocrine changes that tend to occur in adolescence around the time of puberty, which could affect an individual's susceptibility to the effects of social exposures such as disadvantaged social class and in turn have long-acting effects. It could also be relevant that labour market entry tends to be part of the process of the 'transition to adulthood' that is characterised by changes in a number of life domains such as family and living arrangements (Corijn and Klijzing 2001), the nature and timing of which could feasibly be influenced by an individual's occupational social class at this point, in turn becoming an important determinant of future life experiences.

Relating this finding back to the cumulative model of percentage of life time in manual occupational social class and the fact that the life stage approach placed more emphasis on class at labour market entry than the full life course data, it could be argued that the life stage approach was for practical purposes 'weighting' this critical period of exposure in the cumulative model. In methodological

terms, the explanatory findings further highlight the potential difficulties disentangling the relative contributions of different life-course processes such as critical periods and accumulation (Hallqvist et al. 2004). Not only did the life stage approach produce the highest estimate of the overall percentage of life time in disadvantage but, because manual occupational social class at labour market entry appeared to be a 'critical period' of exposure in relation to LLI, this approach identified a significant difference in cumulative exposure to manual occupational social class between those with and without LLI, which was not the case using the full life-course data.

A further notable finding from the analysis of 'critical periods' was that occupational social class in 1997 was also a potentially important predictor of LLI, although only in post-retirement and only significant at the 10% level at the latter end of the life course. This reminds us that, although life-course process of disease development are important to investigate, we should not underestimate the impact of proximal exposures on health outcomes (Naess et al. 2004). In a study of the British Household Panel Study, Wiggins and colleagues (2007) found that those following 'structurally advantaged' trajectories were most likely to have a good quality of life score in later life but that this association was not particularly strong, emphasising the possibility that "contemporary circumstances may overlay life-course histories in ways that may militate against life-course disadvantage" (Wiggins et al. 2007, p.272). The findings also highlight the fact that, even in later life, there are potentially modifiable social circumstances that might be targeted to improve health (Blane 1999).

The analysis of the sequence of exposures to disadvantage allowed a further layer of interpretation of the results relating to critical periods and accumulation. As noted above, labour market entry appeared to be the most important period of exposure to manual occupational social class in terms of predicting the risk of LLI in later life. However, in the analysis of trajectories, both the lowest and highest prevalence of LLI were observed in those who were classified as being in manual occupational social class at labour market entry, and in non-manual class at occupational maturity and in 1997. These two groups differed only in that those most likely to report LLI started off in manual occupational social class in childhood, whereas those least likely to report LLI started life in non-manual occupational

social class. As such, one interpretation of the present findings might be that the 'critical period' of labour market entry only confers a significant impact if also preceded by disadvantage in childhood. Given the small numbers in some of the trajectory groups it is difficult to be entirely confident about this substantive finding but the methodological implications are still important. Examining the overall trajectories of socioeconomic position was shown to be instructive in that, if the sequence of exposures to advantage/disadvantage had been ignored, the result described above might not have been identified. For example, if using a simple cumulative approach, individuals following trajectories 1211, 1121 and 2111 would all have been assigned to the same group, given that they all experienced one period in manual occupational social class and three in non-manual occupational social class. However, the prevalence of limiting longstanding illness was much higher in the latter two groups, at 33% and 27%, respectively, compared with only 15% among those following trajectory 1211.

Whether the differences observed between the analyses using the theoretical life stage approach and the full life course data are regarded as a positive consequences of the approach largely depends on whether it is considered more important to have a descriptively valid measure of occupational social class that is independent of the outcomes of interest and remains consistent across different applications, or one that is specifically tailored to a particular hypothesis that is being tested. The idea that a generally applicable, descriptively valid way of operationalising life-course occupational social class could be developed remains an attractive proposition in many ways and would certainly facilitate comparative research. However, in both theoretical and practical terms, the best way in which to measure life-course occupational social class will almost certainly depend on the specific research setting and the questions under investigation.

Limitations

In the present study, the role of educational attainment – which is known to be an important determinant of both class and health (e.g. Singh-Manoux et al. 2002) – was not considered. Unfortunately, there is no information available on educational level for participants of the Boyd Orr survey wave used in the analyses presented here. Information on education was collected in a follow-

up wave in 2004, however there was significant attrition to the survey, with only 207 respondents remaining. It is also important to note that there is minimal variation in educational level among the cohort that is the focus of this study, which limits the discriminatory power of this measure. For example, more than half of the respondents left school at the minimum statutory age of 14 years, and only around 10% of individuals stayed at school until the age of 18 years. Nevertheless, sensitivity analyses including education, based on the smaller 2004 sample, were carried out (further details available from the authors on request). In logistic regression analysis, neither educational achievement nor age at leaving school showed any statistically significant associations with LLI in later life. Moreover, adjusting for education did not change any of the associations between socioeconomic position and health at any of the four points using the life stage approach to measuring life-course socioeconomic position. Potential interactions between education and socioeconomic position were also examined, but did not produce any significant findings.

A practical limitation of the present analyses was the relatively small sample size, which limited the scope for stratified analyses. In particular, it would have be desirable to carry out sex-specific analyses, given that socioeconomic and labour market experiences are often highly gendered (Dex 1987). Evaluation of such differences was also limited by the way in which occupational social class was measured, with many women classified by their husband's occupation. Nevertheless, previous research suggests that associations between class and health in later life are largely unaffected by the approach used to classifying women's occupational social class, whether by their own or their husband's last occupation (Arber and Ginn 1993), which suggests that any biases in the present study would have been minimal.

A gender bias could also have arisen due to the retrospective nature of the data, given a tendency for women to recall past events more accurately than men (Casey et al. 1991). More generally, if the validity of the retrospectively-collected data was systematically compromised according to *any* relevant characteristic (eg. age, occupational social class, health status) then this may have influenced

the results. For example, it has been reported that in retrospective studies, where inaccurate recall of childhood class occurs there is a tendency for participants to 'exaggerate' their father's status and that such disagreements are more common in socially mobile individuals (Batty et al. 2005). In addition, recent evidence from a cross-sectional study in Australia suggests that individuals who are in a disadvantaged socioeconomic position at the time of interview (as measured using a variety of indicators including education, income and employment status) are less likely to be able to provide retrospective information about their childhood socioeconomic position than those who are currently in a more advantaged position (Chittleborough et al. 2008). However, the fact that the Boyd Orr Lifegrid Subsample data used prospectively collected data on childhood occupational social class to an extent lessens such concerns. Moreover, in the Australian study mentioned above, it was found that parent's main occupation – which was the indicator of childhood occupational social class used in the Boyd Orr Lifegrid Subsample study – was among the best-performing indicators of early-life socioeconomic position in terms of recall. With this in mind, the benefits of the Boyd Orr Lifegrid Subsample as a rich source of life-course data were thought to outweigh the limitations of the sample size and the retrospective nature of these data.

Conclusions

To conclude, it appears that in many ways, using an limited number of measurements to operationalise life-course occupational social class has only a minor impact on either descriptive or explanatory findings. What became apparent throughout the analyses was that the life-course trajectory of occupational social class was, for most individuals, relatively stable. As such, operationalising the life course using information from only a small number of time-points may be satisfactory for many purposes, particularly if underpinned by a theoretical approach. The participants of the Boyd Orr Lifegrid Sub-Sample were of relatively advanced age and their life-course was able to be reconstructed with a fair degree of accuracy and explanatory value using only four data-points. The findings suggest that producing a descriptively and theoretically valid summary of life-course occupational social class does not necessarily require a large number of datapoints, and that such measures can reveal important associations with later health.

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Figure 1: Correlation and variance explained when percentage of life time in manual occupational social class is calculated using increasing intervals between measures, compared with values obtained when measures are taken every six months.

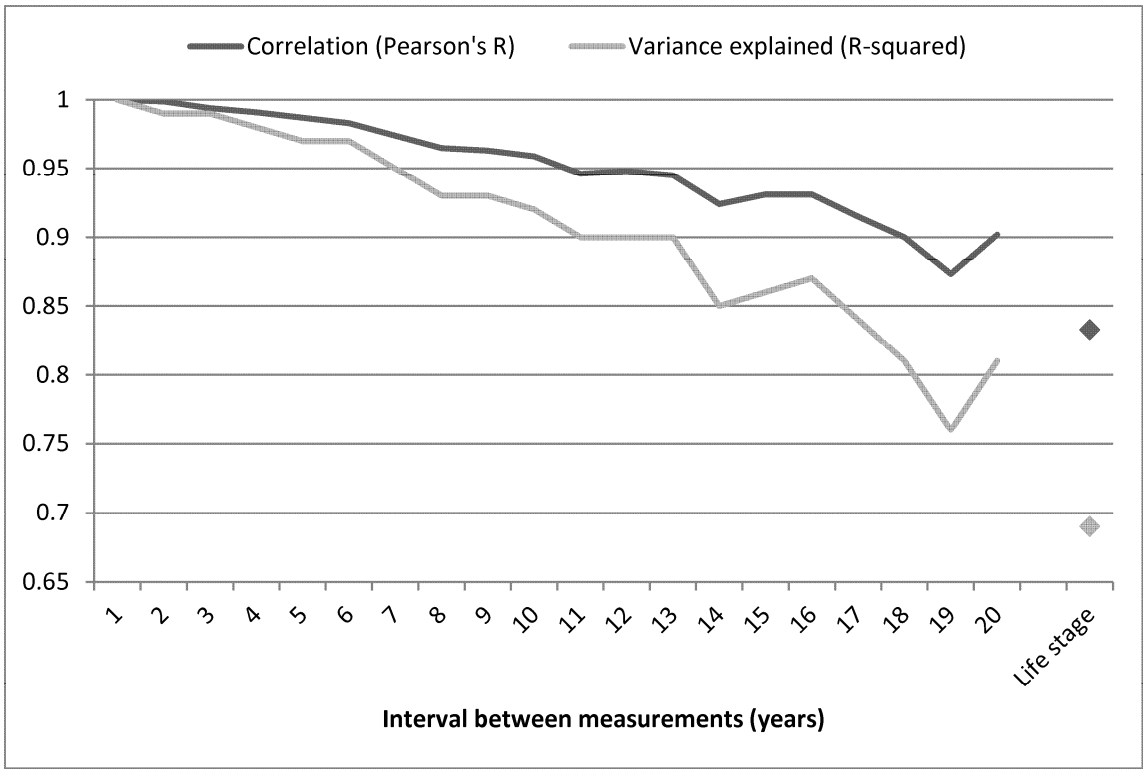
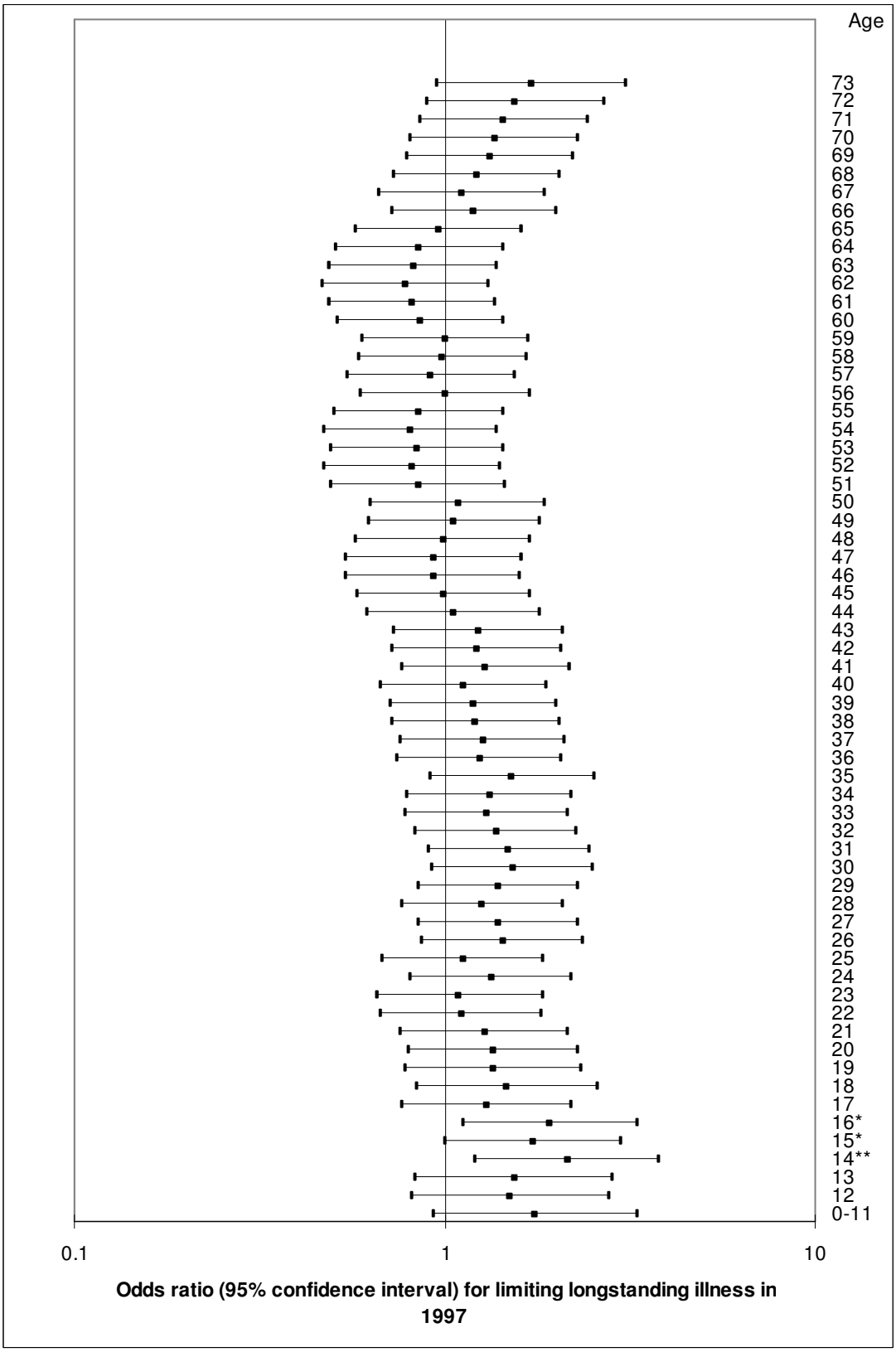


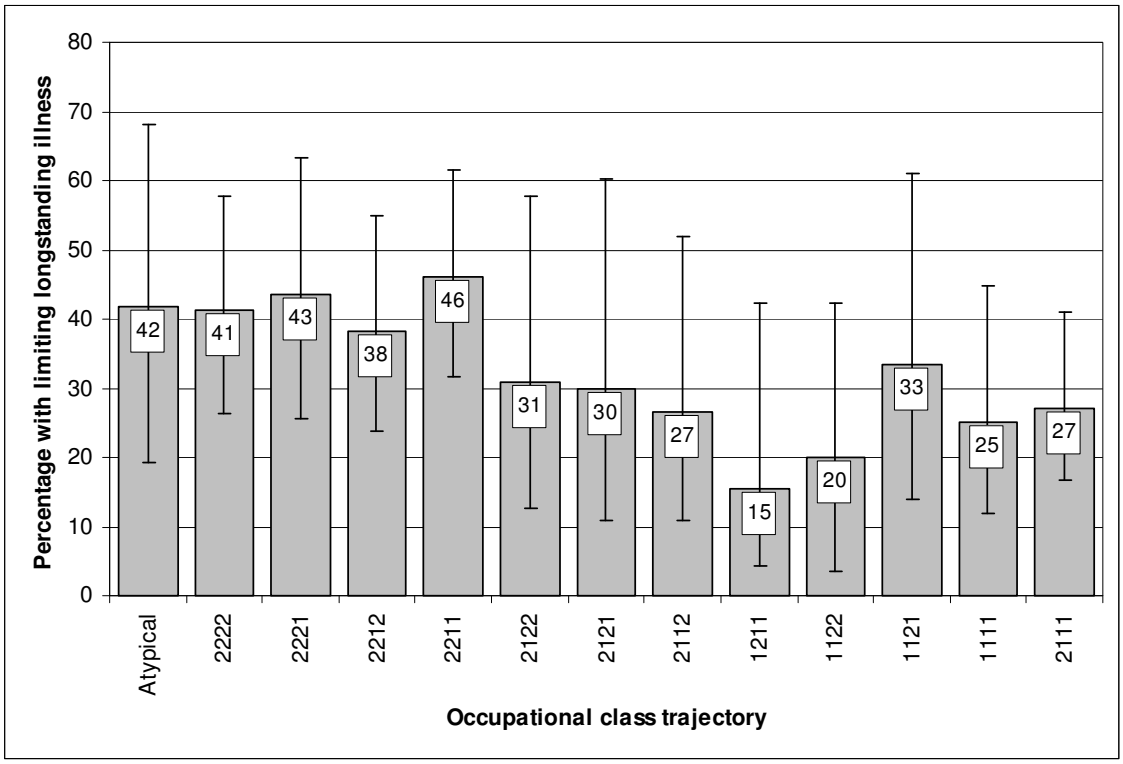
Figure 2: Odds ratios (95% confidence intervals) for LLI in 1997 associated with being in a manual (as opposed to non-manual) occupational social class at age 0 to age 73 years, adjusted for age & sex.



*=*Significant association at 0.05 level* **=*Significant association at 0.01 level*

Figure 3: Odds ratios (95% confidence intervals) for LLI in 1997 associated with being in a manual (as opposed to non-manual) occupational social class at four points of the life course using a life stage approach, adjusted for age and sex.

Figure 4: Proportion of respondents reporting limiting longstanding illness in 1997 by occupational social class trajectory.



Note: '1' denotes non-manual occupational social class, '2' denotes manual occupational class. The four points in each trajectory refer to class in childhood, at labour market entry, at occupational maturity and in early old age.