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- Mortality differential in Sardinia compared with Italy
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Partnership formation and dissolution over the life course: applying sequence analysis and event history analysis in the study of recurrent events

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Abstract

We present two types of approach to the analysis of recurrent events for discretely measured data, and show how these methods can complement each other when analysing co-residential partnership histories. Sequence analysis is a descriptive tool that gives an overall picture of the data and helps to find typical and atypical patterns in histories. Event history analysis is used to make conclusions about the effects of covariates on the timing and duration of the partnerships. As a substantive question, we studied how family background and childhood socio-emotional characteristics were related to later partnership formation and stability in a Finnish cohort born in 1959. We found that high self-control of emotions at age 8 was related to a lower risk of partnership dissolution and for women a lower probability of repartnering. Child-centred parenting practices during childhood were related to a lower risk of dissolution for women. Socially active boys were faster at forming partnerships as men.

Keywords: partnership formation, partnership dissolution, sequence analysis, event history analysis, recurrent events

1 Introduction

During the life course many events (such as marriages, child births, unemployment etc.) can occur several times to an individual. In this paper we present two approaches to the analysis of recurrent events for discretely measured data and show how these methods can complement each other when analysing co-residential partnership histories of a representative sample of Finnish men and women now in their fifties. The first method, *sequence analysis*, is a descriptive technique which we used to summarize all partner transitions made by individuals over the whole observation period. We grouped similar histories of forming and dissolving partnerships and searched for typical and atypical patterns. In contrast, *event history analysis* is a model-based method which we used to model the probability of making a transition to or from partnership in a given time interval as a function of possibly time-varying individual characteristics. Specifically, we examined how home background and socio-emotional characteristics in childhood were related to later partnership formation and stability, whether these effects differed between women and men, and if they played a part in a tendency to repartner.

1.1 Partnerships in a life course perspective

Establishment of an intimate relationship has been recognized as one of the milestones during the transition to adulthood (e.g. Shanahan, 2000). In the past, this typically meant the start of the first and only marriage. However, the choice of union type is now no longer confined to traditional life-long marriage, as cohabitation has become an integral part of family life in Western countries (Kennedy & Bumpass, 2008; Kiernan, 2001). Furthermore, it is increasingly common for people to enter a union more than once during their lives. As a result, partnership trajectories have become diverse according to the type and number of unions formed during the life course. Regarding the first union, cohabiting unions have been consistently found to be less stable than marriages (Poortman & Lyngstad, 2007). In the case of the second and higher-order unions, the picture is more complex. In general, second unions have been shown to be as stable as the first unions, when selection based on individual characteristics is controlled for (Aassve, A., Burgess, S., Propper, C., & Dickson, M., 2006; Lillard, Brien, & Waite, 1995; Poortman & Lyngstad, 2007; Steele, Kallis, Goldstein, & Joshi, 2005; Steele, F., Kallis, C., & Joshi, H., 2006).

It is likely that second and higher-order unions differ from the first union in that they often involve individuals with more complex life histories, including multiple spells of partnerships, children from previous relationships, and the continuing influence of previous partners and their family members (Poortman & Lyngstad, 2007; Teachman, 2008). Higher-order unions also involve individuals who have learned about the process of break up. Going through this often painful process may have caused people to be more cautious the next time (Furstenberg & Spanier, 1984), which may lead to less commitment to and fewer investments in the second union compared to the first. Furthermore, marriage market conditions have also changed because people are older when they search for a partner for the second time, and therefore the pool of potential partners is more restricted (Teachman, 2008). Thus, it is likely that the factors linked to the dissolution of second and higher-order unions are not the same as those linked to the disruption of the first union.

The life course perspective (Elder, 1998) suggests that partnership transitions are inter-related with other areas of life, such as parenthood. However, empirical evidence regarding the association between partnership dissolution and having children is somewhat mixed. Earlier research has found different, even opposite, effects of having children on partnership dissolution across countries and in different family situations with regard to, for example, the number, age, and residence of children (Coppola & Di Cesare, 2008; Lillard & Waite, 1993; Lyngstad & Jalovaara, 2010; Steele et al., 2005; Svarer & Verner, 2008).

1.2 Partnership transitions in context

A life course perspective suggests that decisions regarding life transitions are constrained by various contextual factors (e.g. Elder, 1998; Shanahan, 2000), as well as by the individual's development prior to the transitions (Räikkönen, Kokko, Chen, & Pulkkinen, 2012). Our study focused on the associations between partnership transitions and individual (i.e. gender and socio-emotional behaviour) and family characteristics.

Empirical studies have demonstrated that, in general, women undergo family-related transitions for the first time at a younger age than men (e.g. Elder, 1998; Kokko, Pulkkinen, & Mesiäinen, 2009; Räikkönen et al., 2012; Ross, Schoon, Martin, & Sacker, 2009). Furthermore, the timing of family transitions may also be more closely interlinked among women than among men (Kokko et al., 2009). It has been shown that early motherhood may weaken women's subsequent attachment to the labour market (e.g. Rönkä & Pulkkinen, 1998). No such association has been found among men (Rönkä, Kinnunen, & Pulkkinen, 2000).

To the best of our knowledge, the effects of childhood socio-emotional behaviour have not been studied in previous analyses of partnership formation and dissolution. However, indirect support for the links between childhood socio-emotional behaviour and adult partnership transitions can be found in previous research. First, there is evidence that child behavioural problems predisposes individuals to earlier parenthood (e.g. Kokko et al., 2009; Rönkä et al., 2000), especially among women (Kokko et al., 2009). In contrast, adaptive behaviour in childhood, such as shyness, has been shown to be related to later parenthood in men (Caspi, Elder, & Bem, 1988). Second, low self-control of emotions in childhood has been found to be a risk factor for later marital problems (Kinnunen & Pulkkinen, 2003). Third, there is evidence that high self-control of emotions in both genders, and social activity in women, contribute to favourable

adult development (Pulkkinen, 2009). On the basis of these earlier studies, we anticipated that high self-control of emotions would be connected to fewer and longer-lasting partnerships. Also, we expected that women with lower self-control of emotions and socially active men would form their first partnerships sooner.

An individual's family of origin may also influence union formation behaviours throughout adulthood. Accordingly, it has been shown that individuals who come from a less-advantaged family in terms of low socio-economic status (SES) tend to undergo their first partnership transition at an earlier age than individuals from a high SES background, for whom the later timing of transitions is more typical (e.g. Berrington & Diamond, 2000; Rönkä et al., 2000; Ross et al., 2009; Steele et al., 2006). Higher SES of the family of origin has also been linked to an increased risk of partnership dissolution (Bumpass, Martin, & Sweet, 1991; Lyngstad, 2006). In British cohorts, Steele et al. (2006) found that after a break-up, women from a higher SES background took longer to repartner, whereas Goldstein, Pan, and Bynner (2004) found no such effect among men. Family breakdown in childhood has been linked to earlier establishment of one's own partnership (Aassve, Burgess, Propper, & Dickson, 2006; Berrington & Diamond, 2000; Steele et al., 2006), as well as to a higher risk of partnership dissolution (Amato, 1996; Gähler, Hong, & Bernhardt, 2009; Steele et al., 2006), suggesting that union behaviours transfer at least to some extent from parents to their children.

Besides individual and family factors, the socio-historical context promotes variability in transition behaviours (e.g. Elder, 1998; Shanahan, 2000). The present study was based on longitudinal data collected for a representative sample of individuals born in Finland in 1959 (Pulkkinen, Lyyra, & Kokko, 2009; Pulkkinen & Kokko, 2010; Pulkkinen, 2009). Regarding partnership transitions in Finland, the mean age at first marriage was 25.9 years for women and 28.1 years for men in 1986–1990 (Statistics Finland, 2010). Cohabitation before marriage or as an alternative to marriage was very popular then, just as it is now (Statistics Finland, 1994). Among women born in 1938–42, 13% had cohabited, but among women born in 1958–62, 51% had cohabited before marriage and 33% as an alternative to marriage. Since the mid-1980s, the mean age at first marriage has risen: in 2009, the mean age was 30.2 years for women and 32.5 years for men (Statistics Finland, 2010). Most men and women marry only once; in 2009 11% of married women and 12% of married men had remarried. In 2009, the total divorce rate in Finland was 50% and the mean age at the time of divorce was 41.3 years for women and 43.8 for men. Of marriages entered into in 1985, 39% had ended in divorce by 2009. Due to the popularity of cohabitation in Finland, in this article our definition of a partnership includes both marital and non-marital cohabitational unions, which are treated as substitutes for each other.

2 Methods

2.1 Sample

We analysed data from the Finnish Jyväskylä Longitudinal Study of Personality and Social Development (JYLS). The study, established in 1968 by Lea Pulkkinen, includes all students from 12 randomly sampled second-grade school classes in Jyväskylä, Central Finland (Pulkkinen, 2009). All the pupils participated. The original sample consisted of 173 girls and 196 boys, of whom the majority (94%) were born in 1959. All participants were native Finns and they have been followed from age 8 to 50. During the follow-up, no systematic attrition has been found in the JYLS sample and the participants have continued to be representative of their Finnish birth cohort (Pulkkinen, 2009; Pulkkinen & Kokko, 2010).

During two data collection phases in 2001 at age 42 and in 2009 at age 50, life history calendars (LHC; adapted from Caspi, Moffitt, Thornton, Freedman, & others, 1996; Kokko, Pulkkinen, & Mesiäinen, 2009) were used to retrospectively collect information about partnership status, children, education and work, as well as other important life events. The occurrence, timing and duration of the transitions were recorded annually first from age 15 to age 42, and later from age 42 to age 50, during interviews in which altogether 275 participants (77% of the original sample still alive at age 50) gave reports based on their memory and visual aids provided by the LHC-sheet.

The information collected with the LHCs was confirmed and complemented using other sources, such as life situation questionnaires and interviews at ages 27, 36, 42, and 50. We were able to derive almost complete partnership data between ages 15–42, but missing information due to non-response during the last phase of data collection at age 50 led to incomplete histories for 22% of the

participants. The length of the follow-up varies between individuals because of the two data collection phases and small differences in their ages. Altogether 215 participants were followed for 36 years, 14 participants for 35 years, and 46 participants for only 28 years.

2.2 Variables

In addition to subjects' annual partnership histories, we used information from their parenthood histories to derive a time-varying binary indicator of whether or not the individual was a *parent* to biological or adopted children in a given year.

Socio-economic status (SES) based on father's occupation (or mother's if she was the sole provider or had a higher status), was coded 0 if blue-collar and 1 if a white-collar worker (Pitkänen, Lyyra, & Pulkkinen, 2005).

Family structure at age 14 was coded 0 if the participant lived with both parents and 1 if the parents had divorced or a parent had died (Kokko & Pulkkinen, 2000).

Child-centred parenting was an average score of five dichotomous variables based on age 27 recollections of parenting practices and home environment (parental relationship, physical punishment, maternal supervision, relationship with the father, and *family structure*; Kokko & Pulkkinen, 2000). Missing data were imputed (Pitkänen, Kokko, Lyyra, & Pulkkinen, 2008).

Child socio-emotional behaviour at age 8 was assessed using two subscales: *social activity* and *high self-control of emotions* (including emotional stability, constructiveness, and compliance; see Kokko, Pulkkinen, Mesiäinen, & Lyyra, 2008; Pulkkinen, Kokko, & Rantanen, 2012). Each item was rated by teachers on a scale from 0 (never) to 3 (often).

2.3 Statistical methods

Sequence analysis (SA) is a model-free data-mining type of approach that provides an overview of individual sequences over the whole observation period, including the most common transitions and time spent in each partnership state. The aim of SA is to measure pairwise (dis)similarity of the sequences, which is often followed by some kind of clustering method to find typologies of whole trajectories. *Event history analysis* (EHA; also known as survival, duration, or failure-time analysis) is used for the study of factors that influence the timing of transitions. The response variable in EHA is the duration between becoming at risk of experiencing the event of interest and the time that the event occurs.

2.3.1 Sequence analysis

SA was originally developed in bio-informatics to organize, classify, and parse protein and DNA sequence data (Durbin, Eddy, Krogh, & Mitchison, 1998). In the social sciences, Abbott introduced the use of SA in life course analysis in the mid-1980s (Abbott, 1983; Abbott, 1995; Abbott & Tsay, 2000). The basic idea in SA is to measure the distance or dissimilarity of two sequences consisting of the succession of categorical states describing the trajectories. Two major issues are essential for SA. The first concerns the composition of sequences: how many and what type of states? The second issue is related to determining the dissimilarities between the sequences: which dissimilarity measure to use and, for some measures, how to assign the "cost" of converting one state to another? Typical steps in SA include the following: 1) creating sequences using a finite set of states; 2) choosing and implementing a method for computing pairwise dissimilarities between sequences; 3) analysing the dissimilarities (e.g. cluster analysis and/or multi-dimensional scaling); 4) graphical illustration and examination of sequence data.

Definition of states

Technically, the number of states does not have to be restricted (though finite), but for practical and interpretational reasons the state space is often relatively limited. Definition of the states requires careful consideration. In the present application, for example, defining divorced as single, or distinguishing partnership states by the type of union instead of order, would give a different viewpoint. In previous research it has been common to group all co-residential partnerships together as one state (e.g. Aassve, Billari, & Piccarreta, 2007; Gauthier, Widmer, Bucher, & Notredame, 2010; Salmela-Aro, Kiuru, Nurmi, & Eerola, 2011) or to separate marriages from cohabitations (e.g. Barban & Billari, 2012; Elzinga & Liefbroer, 2007; Piccarreta & Lior, 2010). Usually these have been combined with information on children.

We coded annual partnership states for each individual based on the *order* of the partner: 1) living single (never had a co-residential partner), 2)

living with the first partner, 3) with the second partner, 4) with at least the third partner, or 5) living divorced/separated/widowed. Widowhood was very rare and thus it was merged with the other states of living without a previous partner. Transitions between the states were more restricted than in most studies of partnership sequences: only the last two could be revisited, except for the rare event of going back to a previous partner. Without separating partnerships by order it would have been difficult or even impossible to distinguish sequential partnerships.

Dissimilarities of sequences

There are several methods for measuring sequence dissimilarity, optimal matching (OM) being the most well-known (e.g. McVicar and Anyadike-Danes, 2002). In OM the goal is to find the best alignment of two sequences. Their dissimilarity is computed from the operations needed to transform one sequence into the other using insertions, deletions, and substitutions of states. Roughly, the more operations needed, the more distant the sequences are. The operations can be given different costs to reflect the amount of dissimilarity between the states. Another completely different type of approach by Elzinga is based on counting or measuring common sequence attributes such as sub-sequences (Elzinga, 2006; Elzinga & Liefbroer, 2007). These methods do not require definition of any costs.

In the present study, we use generalized Hamming distance (Hamming, 1950; Lesnard, 2010) which compares states at the same time positions in each sequence. This performs well in our data where the observed sequence lengths vary across individuals, and where the timing of the partnership transitions is regarded as very important. To assess the closeness of two partnership histories, sequences are aligned year by year (see Example 1). Shorter sequences are complemented with missing states to achieve equal sequence lengths required to compute Hamming distances. Partnership states at each age are compared and each comparison is given a cost (see Table 1). Only the ratio of the costs is important and usually the absolute numbers have no substantive meaning; multiplying the costs by a constant does not change the results. The dissimilarity of the histories is simply the sum of the costs.

Example 1

Computing generalized Hamming distances between artificial partnership histories. The costs are given for a comparison of partnership states at each age. See Table 1 for definition of states and costs.

Age	20	21	22	23	24	25	26	27	28
Sequence 1	S	S	S	P1	P1	P1	P1	P1	P1
Sequence 2	S	S	S	S	S	S	P1	P1	*
Cost	0	0	0	2	2	2	0	0	0

Dissimilarity = 6

Age	20	21	22	23	24	25	26	27	28
Sequence 1	S	S	S	P1	P1	P1	P1	P1	P1
Sequence 3	P1	P1	P1	P1	P1	D	P2	P3	P3
Cost	2	2	2	0	0	2	2	3	3

Dissimilarity = 16

Definition of the costs depends not only on the states themselves but also on the research question of interest: which states are regarded as close and which as distant? The most common strategies have been to assign the costs based on theory or transition probabilities between the states. The latter way is automatic and has been said to reduce subjectivity (Aisenbrey & Fasang, 2010; Gauthier, Widmer, Bucher, & Notredame, 2009). However, it is not suitable for many cases such as the present study, where most of the partnership transitions are impossible and the probabilities of the transitions provide little information on the dissimilarities between the states. Setting the costs is an ongoing debate and many modifications to the basic options have been suggested (e.g. Aisenbrey & Fasang, 2010; Gauthier et al., 2009; Halpin, 2010; Hollister, 2009; Lesnard, 2010).

Table 1. Costs for Hamming distance computations

		Sequence 2					
		S	P1	P2	P3	D	*
Sequence 1	Single (S)	0	2	3	5	5	0
	1st partnership (P1)	2	0	1	3	2	0
	2nd partnership (P2)	3	1	0	2	2	0
	3rd+ partnership (P3)	5	3	2	0	2	0
	Divorced/separated (D)	5	2	2	2	0	0
	Missing (*)	0	0	0	0	0	0

Note. Costs were defined to measure how distant different partnership states are regarded

We set costs that would lead to clusters that separate histories of stable and unstable partnerships from those with long periods of living single or divorced/separated. The last two were seen as distant states (cost = 5) because forming a partnership was regarded as one step in the developmental process to adulthood. Second partnerships were very common, so the cost of alignment with the first partnership state was set low (cost = 1). Aligning any state to a missing state was defined to have zero cost to ensure that sequences were grouped together according to the known parts of the histories, not with other sequences with missing information.

For the JYLS data, other dissimilarity measures including optimal matching, dynamic Hamming distance (Lesnard, 2010), the length of the longest common subsequence, and the number of common subsequences were considered together with different cost definitions. Generalized Hamming with the costs presented in Table 1 gave the most meaningful clusters and the best goodness-of-fit, as measured by the proportion of the variation explained by the clusters (pseudo coefficient of determination).

Clustering sequences

The dissimilarities between all partnership sequences are collected in a matrix that can be used to cluster similar histories together. We used Ward's agglomerative algorithm (Ward Jr., 1963). At each step, the algorithm combines the two clusters (at the first step, sequences) that minimize within-cluster variability and maximize inter-cluster variability. It is commonly used to cluster sequences since it usually produces more equal-sized clusters than other algorithms (Aisenbrey & Fasang, 2010). We also tested other clustering options but, as also found by Aassve et al. (2007), most of them (single, average, and complete linkage) resulted in one large cluster and many residual clusters with only a handful of sequences, even several clusters with only one sequence. This is not desirable for the purpose of interpretation and possible further analyses. With our dissimilarities, the "partition around medoids" method (PAM) (Kaufman & Rousseeuw, 2009) was the best competitor, but not as good as Ward in terms of pseudo-R^2 (for pseudo-R^2 see Studer, Ritschard, Gabadinho, & Müller, 2011). Choosing the best

number of clusters is not straightforward. Our decision was based on the dendrogram, interpretability of the clusters, and change in measures including pseudo-R^2, pseudo F (Studer et al., 2011), Hubert's C, and Hubert's Gamma (Hubert & Arabie, 1985). See Studer (2013) for a review of measuring the quality of clustering of sequence data.

External information can be taken into account after clustering or at the clustering phase. We used regression trees (Breiman, Friedman, Olshen, & Stone, 1984) to group similar partnership histories using information on subjects' home background and socio-emotional behaviour in childhood as predictors. The idea of regression trees is to recursively partition data into clusters using values of a predictor, creating binary splits for the values of a variable for which the highest pseudo-R^2 is achieved. The tree is grown until no further significant splits (assessed through a permutation F-test) are found (Studer et al., 2011).

We studied whether sex and socio-emotional characteristics and home background during childhood predicted future partnership histories using regression tree methods with the same Hamming distances as previously.

Graphical illustrations

There are many options for graphical description of sequence data. The most common choices include cross-sectional state distribution plots and sequence index plots. State distributions plotted for each time point show the change in the prevalence of states in the course of time. Sequence index plots show the whole partnership histories for the individuals. Plotting all sequences at once in a random order is usually not very informative. Clustering eases interpretation by grouping similar histories together, and multi-dimensional scaling or some other criterion is often used to order sequences more meaningfully.

Software

The TraMineR package in R (Gabadinho, Ritschard, Müller, & Studer, 2011) was used for the SA presented in this paper. Alternatives include TDA (Rohwer & Pötter, 2004) and the Stata packages SQ (Brzinsky-Fay, Kohler, & Luniak, 2006) and SADI (Halpin, 2014). To our knowledge, TraMineR has been the most versatile and widely used software for SA in recent years. However, the new SADI package in Stata appears to have the potential to become a strong competitor.

2.3.2 Discrete-time event history model

SA is a useful tool for obtaining an overview of histories. However, as the focus is the whole trajectory, SA cannot be used to study how the factors of interest – especially those which vary over time – are related to the timing and duration of each co-residential partnership. EHA is a highly flexible approach for the study of how individual time-invariant and time-varying characteristics influence the timing of partnership transitions.

Moving in with the first partner is a milestone for an individual, but it may not be the only partnership (marriage or cohabitation) that is established during their life time. Instead of focusing only on the timing of the first partnership we can analyse the duration of all episodes of living without a partner. These are periods during which an individual is continuously "at risk" of establishing a new partnership. Individuals not living with a partner in a given time interval constitute what is referred to as the "risk set" for partnership formation. An individual's first episode starts at the beginning of the follow-up and it ends when the individual moves in with a partner for the first time or is censored because of loss to follow-up. Individuals stay out of the risk set as long as they are living with the same partner. A new episode begins at dissolution when the individual is again "at risk" of forming a new partnership.

The durations of episodes from the same individual are likely to be correlated, which invalidates the independence assumption of standard statistical methods. This correlation is due to unmeasured time-invariant individual characteristics that affect the risk of forming any (new) partnership. The variation in the risks between individuals is generally called unobserved heterogeneity or individual frailty (e.g. Vaupel, Manton, & Stallard, 1979). Recurrent events data can be viewed as having a two-level hierarchical structure where the events are nested within individuals. These types of hierarchical data can be analysed with multilevel or random effects models (e.g. Goldstein, 2011; Raudenbush & Bryk, 2002).

Many life transitions, such as partnerships, are formed in continuous time, but it is not always possible or practical to collect data as such. Often, event times are recorded in time intervals such as months or years because finer measurement (e.g. daily accuracy in a study spanning several years) would not be informative. At other times it is not possible to observe the occurrence times as frequently as would be preferred. In both cases the discrete-time model can be used as an approxi-

mation to a continuous-time model (e.g. Allison, 1982).

The two LHCs from the JYLS study contain yearly information on individuals' partnership statuses. We were interested in both the formation and dissolution of partnerships. However, annual accuracy was not always frequent enough to distinguish between consecutive partnerships. To properly define who was in the risk set of moving in with a new partner (i.e. living without a partner) at the start of a given time interval, artificial six-month intervals were created and the partnership status of the latter part of the year changed to "single" for those who had dissolved and formed a partnership during the same year (29 cases from 24 individuals).

Random effects model for repeated partnership formation

In our annual data, a partnership beginning "at age t" occurs during the one-year interval $[t, t+1)$. Suppose that t_{ij} is the number of years for which individual j is observed in episode i, where an episode is a continuous period of time unpartnered. We form a data set with one record per year for each individual (a person-episode-period file) and define a binary indicator y_{tij} for each year $t = 1, \ldots, t_{ij}$ such that

$$y_{tij} = \begin{cases} 1 \text{ if episode } i \text{ of an individual } j \\ \quad \text{ends in partnership formation at } t \\ 0 \text{ otherwise} \end{cases}$$

The discrete-time hazard function is defined as

$$p_{tij} = P\left(y_{tij} = 1 \middle| y_{t'ij} = 0 \text{ for } t' < t\right),$$

which is the conditional probability that a partnership is formed during interval t of episode i of individual j given that they have not moved in with a partner before interval t.

A logistic regression model is commonly used to model the dependence of p_{tij} on the duration unpartnered by interval t and a vector of (possibly time-varying) explanatory variables $\boldsymbol{x}_{tij}$:

$$\log\left(\frac{p_{tij}}{1-p_{tij}}\right) = \alpha' \boldsymbol{z}_{tij} + \beta' \boldsymbol{x}_{tij} + u_j,$$

where $\boldsymbol{z}_{tij}$ is a vector of functions of t and $\alpha' \boldsymbol{z}_{tij}$ defines the baseline hazard function. Polynomials and step functions are common choices for modelling the time-dependency. Unobserved variation between individuals (frailty) is represented by u_j, which is usually assumed to follow a normal distribution $N(0, \sigma_u^2)$. The random effect shifts the log-odds of partnering up or down for the individual j while the effects of duration and covariates are assumed to be constant across individuals. Conditional on u_j, the durations of episodes for the same individual are assumed to be independent. A similar model is specified for the risk of partnership dissolution.

A two-state model

We can extend the above model to study transitions between two (or more) states. That model considers transitions from a single state to living with a partner and the individual is dropped from observation after forming a partnership (unless they separate and re-enter the risk set). In a two-state model the durations of all episodes living with and without a partner are examined. Exit from one state implies entry to the other. Examples of the use of multistate models to study partnership transitions include Aassve et al. (2006), Goldstein et al. (2004), and Steele et al. (2006).

We denote by S_{tij} the state of individual j's ith episode at the start of interval t. Now y_{tij} is the binary indicator of a transition of either type, forming (F) or dissolving (D) a partnership. The conditional probability of a transition from state s $(s = F, D)$, during interval t, given that a transition has not yet occurred in that episode, is now

$$p_{stij} = P\left(y_{tij} = 1 \middle| y_{t'ij} = 0 \text{ for } t' < t, S_{tij} = s\right),$$

and the multilevel event history model for transitions between the two states can be written as

$$\text{logit}\left(p_{stij}\right) = \alpha_s' \boldsymbol{z}_{stij} + \beta_s' \boldsymbol{x}_{stij} + u_{sj}, \quad s = F, D$$

Note that the baseline logit-hazard, covariates, coefficients, and random effects can all vary across states, as indicated by the s subscripts.

Software

Random effects models for recurrent events and multiple states can be fitted in most mainstream statistical software packages such as R, SAS and Stata, and also with more specialist software including MLwiN and Sabre. The packages may vary in the estimation procedures used, leading to differences in parameter estimates and computational times (see Steele (2011) for a detailed summary). In our study, event history models were fitted using the xtlogit procedure in Stata which implements maximum likelihood via Gauss–Hermite quadrature.

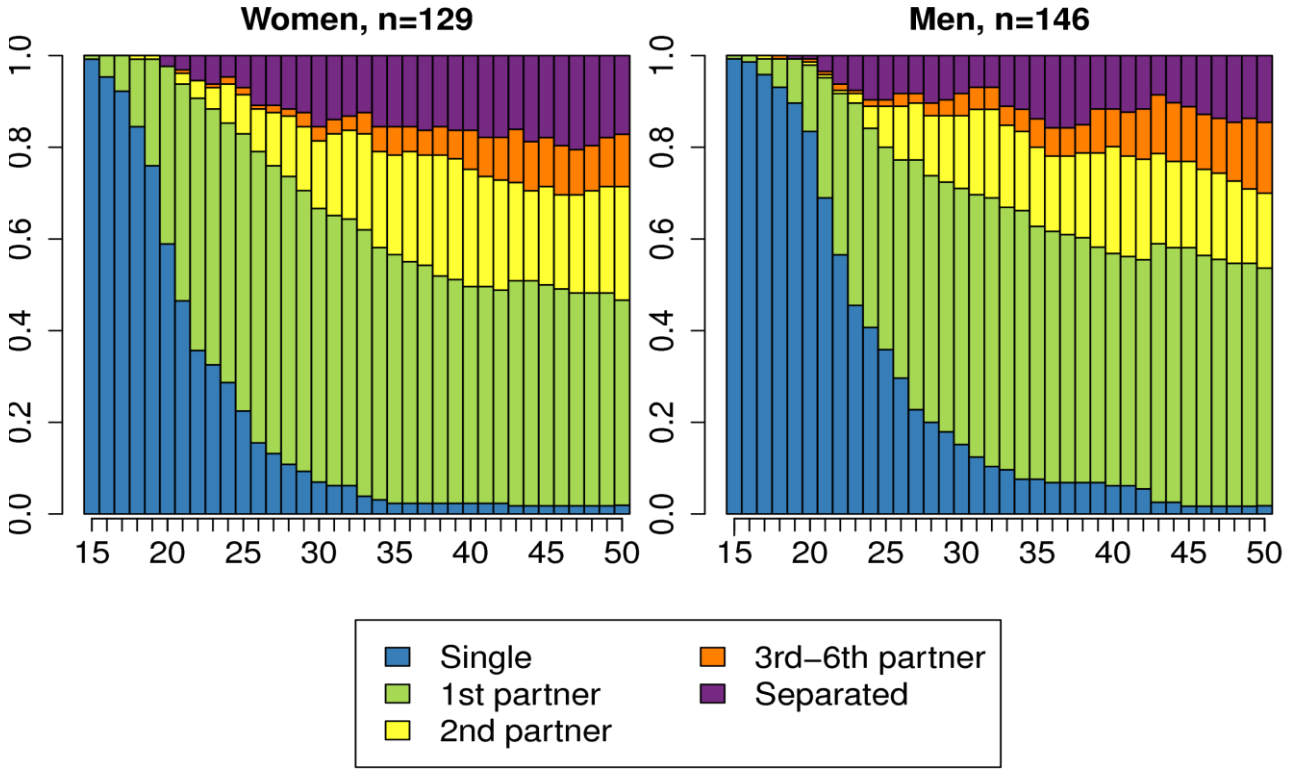
3 Results

3.1 Sequence analysis: trajectories of partnerships

Sequence analysis was used to provide an overall view of partnership histories, to obtain descriptive information on typical and atypical trajectories, and to explore how much childhood socio-emotional characteristics and family background predict future histories.

Figure 1 presents the prevalence of partnership states at each age for women and men. On average, men formed their first partnership later than women. Women spent more time living as divorced or separated than men, but from this figure we cannot see the duration of these periods.

Figure 1: State distribution plots of partnership histories for women and men between ages 15–50 in JYLS data



Notes. Missing states are not included in the yearly proportions. The change in proportions at 43 is due to individuals who were lost to follow-up.

Table 2 shows the average number of years that women and men spent in each partnership state. Women had longer first and second partnerships than men, but there was a lot of variation.

Table 2. Mean and standard deviation of years spent in each partnership state since age 15 for women and men in the JYLS data

	Women		Men	
State	Mean	S.D.	Mean	S.D.
Single	7.8	5.7	10.1	6.7
1st partnership	16.3	11.1	14.9	10.7
2nd partnership	5.2	1.6	4.3	7.4
3rd–6th partnership	1.6	5.0	1.9	5.1
Divorced/separated	4.0	5.8	3.0	5.2
Missing	1.1	2.7	1.8	3.6

Table 3 shows the most frequent types of history ignoring the time spent in each state. Two out of three individuals had settled in to their first or at most second partnership. Since the transitions between states are rather limited due to several being absorbing, there are few possible histories. Except for the differences in the number of partners and dissolutions, the histories only differ by whether or not the individuals had lived alone between their partnerships. Taking account of the durations of episodes adds little additional information: the number of the JYLS participants is limited compared to the length of the follow-up so most of the sequences are unique.

Table 3. The most common partnership histories in JYLS data, when durations are omitted

State	Freq.	%
S-P1	122	44.4
S-P1-D-P2	59	21.5
S-P1-D	25	9.1
S-P1-D-P2-D-P3	14	5.1
S-P1-D-P2-D	10	3.6
S	9	3.3
Total	239	86.9

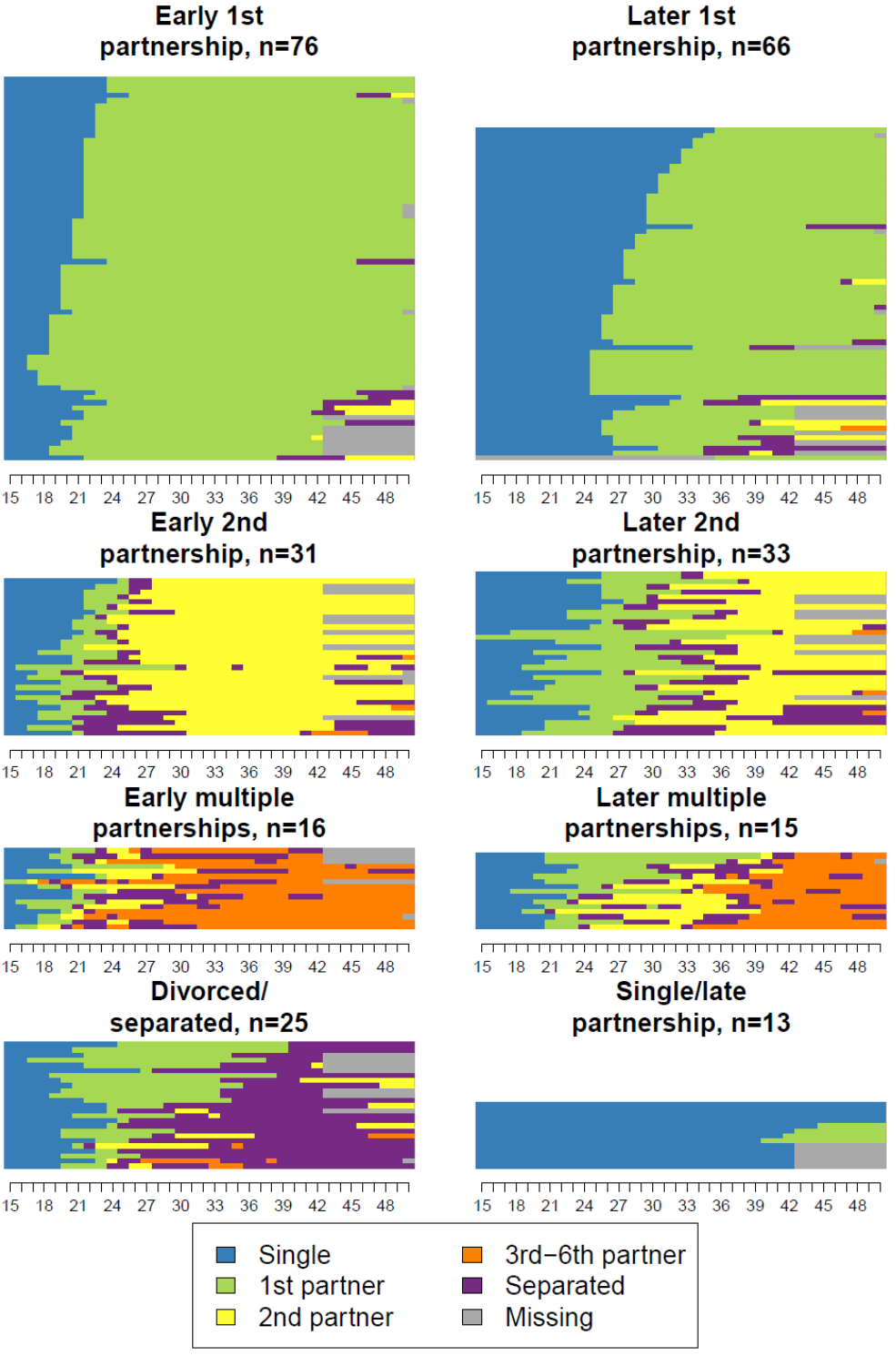
Notes. S=single, P1=1st partnership, P2=2nd partnership, P3=3rd–6th partnership, D=Divorced/separated/widowed.

3.1.1 Clustering sequences

Solutions with between 2 and 15 clusters from Ward's algorithm were studied, and the eight-cluster solution was chosen based on the criteria described in Section 2.3.1. These clusters explained 61% of the variation between the histories. Sequence index plots of the clusters are shown in Figure 2.

There were four larger clusters of relatively stable partnership histories with one or two partners that only differ in timing. Men were in the majority among those who have established a (typically long-lasting) late initial partnership, but in the "later second partnership" group the majority were women (Table 4). There emerged also two male-dominated clusters which included individuals with multiple partnerships, either earlier or later in life. Some of these individuals had experienced multiple partnerships but settled down after early adulthood, and others had not formed long-lasting partnerships at all. The last two clusters showed histories of living without a partner; some (typically women) had a partnership that ended in separation or divorce, while others (typically men) had never lived with a partner or had entered their first partnership very late.

Figure 2: Eight clusters of partnership histories using generalized Hamming distances as a measure of dissimilarity and Ward's method for clustering



Notes. Multidimensional scaling was used to order sequences.

Table 4: Proportion of partnership clusters and the percentage of women

Cluster	Size (*n*)	Size (%)	Women (%)
Early 1st partnership	76	27.6	55.3
Later 1st partnership	66	24.0	34.8
Early 2nd partnership	31	11.3	45.2
Later 2nd partnership	33	12.0	60.6
Early multiple partnerships	16	5.8	43.8
Later multiple partnerships	15	5.5	33.3
Divorced/separated	25	9.1	60.0
Single/late partnership	13	4.7	23.1
Total	275	100	46.5

3.1.2 Clustering with external information

Using the regression tree method described in Section 2.3.1, only two of the covariates were statistically significant predictors of cluster membership; these formed altogether three clusters of the data (Figure 3).

The first and the most effective split of the data was achieved with child-centred parenting (CCP). More child-centred parenting practices in the family of origin (CCP $>$ 0.4) was related to more stable partnership histories with usually one or two partners. The second split was for the lower values of CCP and self-control of emotions (SCE). On average, individuals with lower values of CCP and SCE had more partners compared to those who also had lower values of CCP but higher SCE. Altogether grouping on CCP and SCE explained only 3.5% of the variability between the partnership histories, so most important sources of sequence variation was the timing and the number of partnerships.

3.2 Event history analysis: transitions to and from partnerships

Event history analysis was used to examine the timing of partnership formation and dissolution and how the rate of partnership transitions depends on individual history and characteristics.

As can be seen from the partnership clusters in the previous section and again in Table 5, recurrent partnerships were common: almost a half of both women and men had established at least two partnerships (marriages or cohabitations) during the follow-up period. Third and subsequent partnerships were less common, especially among women.

Figure 3. Regression tree of partnership histories with two significant splitting variables: child-centred parenting (CCP, scores 0–1) and high self-control of emotions (SCE, scores 0–3)

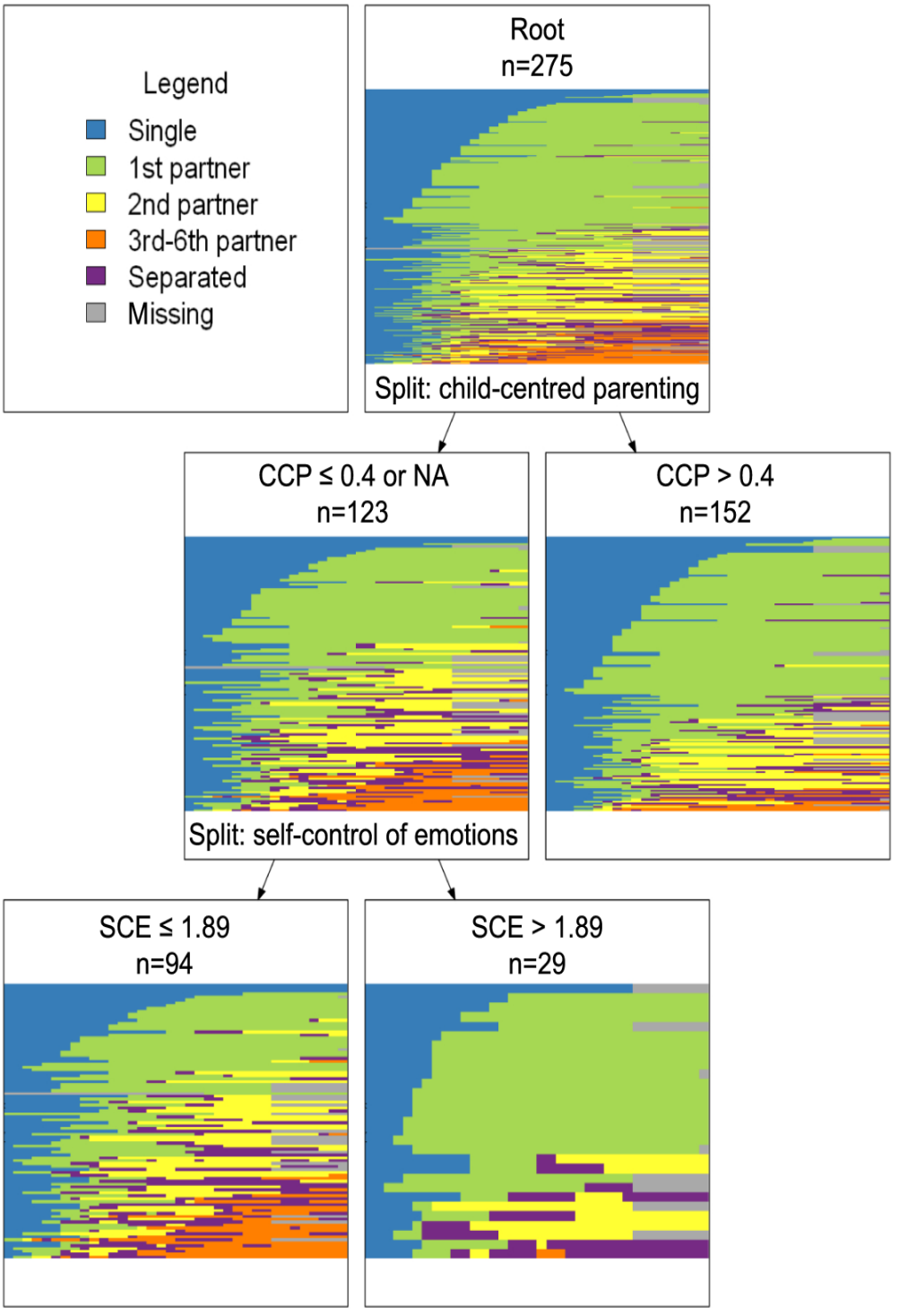


Table 5. Participants in the JYLS study by sex and the number of cohabitating partnerships

				3+ partners	
	No partners	1 partner	2 partners	Individuals	Partnerships
Women	3	66	43	17	25
Men	6	79	33	27	42

Notes. Higher-order partnerships (3th–6th) are combined into one category due to their small number.

Table 6 shows the means of the age at forming partnerships, duration of partnerships and time before forming new partnerships (not accounting for right-censoring). On average, first partnerships were formed around age 22 among women and age 24 among men. The youngest formed their first partnership (cohabitation) at 15 and the oldest at 35 (women) and 45 (men). On average, a new partnership was formed 2–3 years after dissolution of the previous partnership but there was considerable variation, with a maximum duration of over 20 years.

The average duration of first partnerships that ended in dissolution during the follow-up was about 8 years. Second partnerships were of a similar length to first partnerships for women and two years shorter among men. Higher-order partnerships lasted 4–5 years on average.

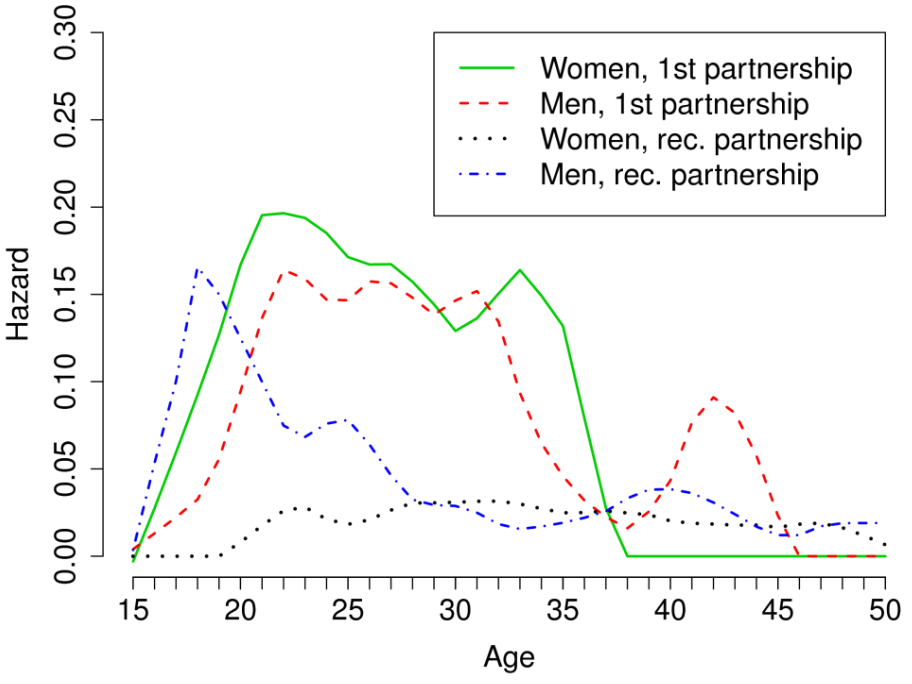
Table 6. Timing of partnership events: mean ages at forming partnerships, years since dissolution before forming a new partnership, and duration of partnerships that had ended in separation in the JYLS data

		Formation					Dissolution		
		Age		Time since diss.			Duration		
Sex	Partner	Mean	S.D.	Mean	S.D.	N	Mean	S.D.	N
Female	1st	22.17	4.16			126	8.54	6.51	68
	2nd	32.07	7.91	3.45	3.36	60	8.20	6.13	25
	3rd+	36.17	7.95	2.72	2.42	25	4.38	3.13	13
Male	1st	24.30	5.20			139	8.14	7.41	74
	2nd	31.22	7.53	2.68	3.19	59	5.97	6.30	31
	3rd+	36.56	9.04	2.39	2.74	42	4.92	4.30	18

Note. Right censoring was not accounted for.

Hazards of forming first and recurrent partnerships were computed from the data. The hazard at a given age is the proportion who were newly partnered from all individuals in the risk set (those who were not living with a partner yet/anymore). The hazard function is plotted in Figure 4 using locally weighted scatterplot smoothing (lowess) to show the change in the rate of partnership formation by age. We also see that on average women formed their first partnerships earlier than men. On the other hand, those men who *had* established and dissolved their first partnerships young (before age 25) seemed to form subsequent partnerships quicker than young women in the same situation. There was an especially high peak for teenagers, but the risk set at that age was very small. In this study, the oldest age at first partnership was 35 for women, but is some suggestion that for men the hazard of first partnership increased in their early 40s (although, again, the risk set is small).

Figure 4. Hazard functions of the formation of first and recurrent partnerships for women and men



Note. Hazards were smoothed with lowess (locally weighted scatterplot smoothing) using 20–25% of the closest points.

3.2.1 Partnership formation

Since preliminary analyses (not all shown here) revealed large differences between women and men in the timing of partnership formation and dissolution and in the factors related to these transitions, separate event history models were fitted for women and men. Based on the hazard functions shown in Figure 4, a piecewise constant function was chosen as the best representation of the baseline hazard for partnership formation. The timing of first partnership was categorized into three periods: early (15–22 years), on-time (23–32), and late (33–50). The last category is wider than would be preferred, since it is unlikely that, for example, a 33-year-old and a 50-year-old have a same risk for establishing especially the first partnerships. However, as no women in our sample established their first partnership after age 35 it was not possible to use narrower age categories. Time since, and the duration of the last partnership were also considered (using linear, quadratic, logarithmic, categorical functions of time) as well as the type of the previous partnership (marriage/cohabitation), but these variables did not show significant effects for either sex and were excluded from the models. Covariates measured in childhood were treated as time-invariant, while parenthood status and

existence of previous partners were time-dependent.

We first studied the main effects of the covariates and their interactions with age and a previous partnership indicator. Interactions with age were considered to test the proportional hazards assumption, while interactions with previous partnership were tested to determine whether covariate effects differ for first and recurrent partnerships. Variables with effects that were significant at the 5% level were then tested together in one model, with non-significant effects dropped one by one. None of the interactions between age and any covariate were significant.

Tables 7 and 8 show the final random effects models for partnership formation for women and men respectively. There was little evidence of unobserved heterogeneity among women (σ_u was estimated close to 0), but among men the additional of random effects led to a significant improvement in fit ($\hat{\sigma_u} = 0.607$, significance assessed through likelihood ratio test). The "risk" of forming an initial partnership was estimated to be the highest among 23–32 year-olds for both sexes, but the differences between the age categories were small and not statistically significant at the 5% level. Among men and women who had already dissolved at least one partnership, the risk of repartnering was significantly higher among 15–22 year-olds than for the other age groups.

Table 7. Logistic model of partnership formation for women

	Est.	s.e.	p	OR	OR 95% CI
Constant	−3.579	0.541	0.000		
Had previous partner(s)	1.841	0.670	0.006	6.302	(1.697,23.410)
Age 15–22	0.550	0.500	0.272	1.733	(0.650,4.620)
Age 23–32	0.975	0.507	0.054	2.651	(0.982,7.157)
Prev. partners * Age 15–22	1.883	0.716	0.009	6.571	(1.615,26.738)
Prev. partners * Age 23–32	−0.116	0.566	0.838	0.891	(0.294,2.702)
Has child(ren)	1.232	0.312	0.000	3.429	(1.861,6.318)
Prev. partners * Has child(ren)	−0.935	0.411	0.023	0.393	(0.175,0.879)
High SCE	0.025	0.138	0.856	1.025	(0.782,1.344)
Prev. partners * High SCE	−0.737	0.232	0.001	0.479	(0.304,0.754)
Higher SES	−0.058	0.208	0.782	0.944	(0.628,1.419)
Prev. partners * Higher SES	−0.889	0.394	0.024	0.411	(0.190,0.889)
Random effect SD σ_u	0.001	0.012			

Notes. Estimated coefficients and odds ratios (OR) are shown together with standard errors, p-values and 95% confidence intervals (CI) for the odds ratios. The last age category (33–50) was chosen as the reference category. SCE = self-control of emotions (scores 0–3), SES = socio-economic status based on the parents' (mainly fathers') occupational status during the subject's childhood (higher/lower).

Table 8. Logistic model of partnership formation for men

	Est.	s.e.	p	OR	OR 95% CI
Constant	−3.410	0.480	0.000		
Had previous partner(s)	0.127	0.499	0.799	1.136	(0.427,3.023)
Age 15–22	−0.795	0.451	0.078	0.451	(0.186,1.093)
Age 23–32	0.334	0.409	0.414	1.396	(0.627,3.109)
Prev. partners * Age 15–22	2.763	0.731	0.000	15.855	(3.787,66.373)
Prev. partners * Age 23–32	0.580	0.490	0.237	1.785	(0.683,4.668)
Has child(ren)	2.849	0.370	0.000	17.275	(8.372,35.643)
Prev. partners * Has child(ren)	−2.302	0.469	0.000	0.100	(0.040,0.251)
Social activity	0.251	0.137	0.067	1.285	(0.982,1.682)
Random effect SD σ_u	0.607	0.127			

Notes. Estimated coefficients and odds ratios (OR) are shown together with standard errors, p-values and 95% confidence intervals (CI) for odds ratios. The last age category (33–50) was chosen as the reference category.

Altogether three childhood factors were associated with partnership formation: socio-economic status (SES, Table 7), self-control of emotions (SCE, Table 7), and social activity (Table 8). Being from a higher SES family background was associated with a longer time to repartner for women. High self-control of emotions that was found to predict cluster membership in the regression tree analysis of SA, was also a predictor in the event history analysis of partnership formation: women who had higher self-control of emotions at age 8 had a lower risk of forming a new partnership following a dissolution. The effect of social activity was significant at the 10% level for men: being more socially active at age 8 was associated with forming partnerships sooner. The effect was the same for first and recurrent partnerships.

Parents were faster at forming first partnerships, although only ten participants had a child before forming any co-residential partnerships. There was some evidence that fathers also formed recurrent partnerships faster compared to childless men ($\hat{\beta} = 2.849 - 2.302 = 0.548$, s.e. $= 0.300$, p-value $=$ 0.068).

Child-centred parenting, which was found to be the most important covariate in the regression tree, was not a significant predictor of partnership formation for either sex after controlling for the effects of other covariates. Childhood family structure was not significant in either model after controlling for the other childhood variables.

3.2.2 Partnership dissolution

Partnership dissolutions were explored in a similar way to formations. Time was captured in the models by two different variables: the age at the start of the current partnership and the duration of the partnership. Different functional forms (linear, quadratic, logarithmic, and categorical) were studied for both variables. Covariates measured during childhood were treated as time-invariant; type of partnership (marriage/cohabitation), parenthood status, and existence of previous partners as time-dependent. Child-centred parenting and family structure (included in CCP) were correlated, which induced multicollinearity in the model for women. Both variables were considered important and included irrespective of the large standard error of CCP in the common model.

Tables 9 and 10 show the results from the event history models of partnership dissolutions for women and men respectively. The random effect

standard deviations were large but non-significant. The age effect was linear and decreasing for women. For men, the estimated effects of age and age squared formed a quadratic curve: the risk decreased until 42 years of age and then slightly increased (the age at which the hazard reached its minimum was found by taking the square root of the first derivative of the quadratic function). For men, the effect of the duration of the current partnership was linear and decreasing. For women, the risk of partnership dissolution was quadratic, increasing until 12 years into the partnership and then decreasing.

Table 9. Logistic model of partnership dissolution for women

	Est.	s.e.	p	OR	OR 95% CI
Constant	−1.589	0.594	0.007		
Age at partnership formation	−0.055	0.018	0.003	0.946	(0.913,0.982)
Partnership duration	0.095	0.055	0.086	1.100	(0.987,1.225)
(Partnership duration)^2	−0.004	0.002	0.046	0.996	(0.991,1.000)
Married	−1.109	0.249	0.000	0.330	(0.204,0.534)
High self-control of emotions	−0.397	0.173	0.022	0.672	(0.479,0.944)
Broken family at 14	0.532	0.248	0.032	1.702	(1.048,2.766)
Child-centred parenting	−0.636	0.476	0.182	0.529	(0.208,1.347)
Random effect SD σ_u	0.518	0.254			

Notes. Estimated coefficients and odds ratios (OR) are shown together with standard errors, p-values and 95% confidence intervals (CI) for the odds ratios.

Table 10. Logistic model of partnership dissolution for men

	Est.	s.e.	p	OR	OR 95% CI
Constant	1.211	1.495	0.418		
Age at partnership formation	−0.254	0.105	0.019	0.782	(0.637,0.961)
(Age at partnership formation)^2	0.003	0.002	0.055	1.003	(1.000,1.007)
Partnership duration	−0.040	0.019	0.032	0.961	(0.926,0.997)
Broken partnership(s)	0.757	0.272	0.005	2.132	(1.252,3.630)
Has child(ren)	−0.701	0.228	0.002	0.496	(0.317,0.776)
High self-control of emotions	−0.443	0.158	0.005	0.642	(0.471,0.875)
Random effect SD σ_u	0.385	0.247			

Notes. Estimated coefficients and odds ratios (OR) are shown together with standard errors, p-values and 95% confidence intervals (CI) for odds ratios.

Previous experience of dissolution increased the risk of subsequent separation or divorce among men but not among women. Married women were less likely to dissolve their partnerships compared to cohabiting women, but cohabiting and married men did not differ in their risk of dissolution. Motherhood did not change the risk of dissolution but fathers had a lower risk than men without children.

Three childhood characteristics were connected to the risk of dissolution: self-control of emotions, family disruption, and child-centred parenting. High self-control of emotions at age 8 decreased the risk of dissolution for both sexes and all partnerships, while child-centred parenting was associated with a lower risk of dissolution for women. The experience of a broken family during childhood was associated with a higher risk of partnership dissolution among women, but not men.

4 Summary and discussion

This paper had two aims: (i) to describe the use of complementary statistical methods, sequence analysis and event history analysis, in a study of recurrent events; and (ii) to apply both techniques in a study of partnership formation and dissolution over the life course.

4.1 Statistical analysis

Sequence analysis was used to build an overall picture of partnership histories from age 15 to 50. Using Ward's clustering method, eight clusters were found, which together explained over 60% of sequence variation. These differed from each other according to the number, timing, and duration of partnerships. Another clustering method, that uses external information for the division of the data, was also studied. Regression tree analysis was used to divide data into clusters based on childhood covariates. Two significant predictors of partnership histories – high self-control of emotions and child-centred parenting – were found, which altogether explained only 3.5% of the variability of partnership histories. In contrast, the three-cluster solution using Ward's method without external information resulted in $R^2 = 35\%$, which increased to 61% for the chosen eight-cluster solution. Hence, the predictive power of those covariates alone was very low, although this was to be expected as we did not account for many factors that previous studies have found to be related to partnership formation and dissolution (e.g. the presence and age of children, educational attainment, employment, income, religiosity, and health-related factors; see e.g. Aassve et al., 2006; Berrington & Diamond, 2000; Jalovaara, 2012; Lyngstad & Jalovaara, 2010; South, 2001; Steele et al., 2006). Many of these other factors are time-varying which is problematic with regression trees, and were therefore beyond the scope of the analysis. However, other life domains could be added as parallel sequences that can then be analysed with multi-dimensional sequence analysis methods (Gauthier et al., 2010; Müller, Sapin, Gauthier, Orita, & Widmer, 2012; Salmela-Aro et al., 2011). In a previous study, Eerola and Helske (2012) compared SA and EHA in a case of multiple parallel life domains using the same JYLS data.

Event history analysis was used to model the probability of partnership transitions between ages 15 to 50 as a function of individual (i.e., social activity and high self-control emotions) and family characteristics (i.e. child-centred home environment, SES, and structure of the family of origin). To account for dependency between the durations of repeated episodes, random effects models for partnership formations and dissolutions were fitted. For all but one model, there was no statistically significant unobserved variation between individuals once the childhood variables were included in the analyses, indicating that these factors captured a substantial part of the variation in partnership formation and dissolution that is due to time-invariant characteristics. A joint model of partnership formations and dissolution (as described in Section 2.3.2) was also fitted for women and men. The idea was to study whether there was correlation between the durations of episodes of living with and without a partner, for example because individuals who separate more rapidly tend to form new partnerships sooner than individuals whose partnerships last longer (as shown by Aassve et al., 2006; Steele et al., 2006 using British data). However, our sample was too small to estimate a joint model, leading to confidence intervals of correlation estimates ranging from −1 to 1.

Sequence analysis and event history analysis provide complementary information on partnership formation. Sequence analysis is a descriptive tool that gives an overall picture of the histories and compresses them in a form that is relatively easy to interpret. Sequences are often shown as colourful lines in an index plot, from which it is – especially

after clustering – easy to see the timing of important partnership transitions and the approximate duration of different episodes. Clustering helps to describe the data and to identify similar patterns in partnership formation by providing typologies of partnership trajectories. However, choosing the number of clusters is to some extent subjective. It is therefore important to consider a range of solutions and to regard the division of life sequences into clusters as suggestive. One should also be cautious about attaching too much meaning to a cluster or a label assigned to it, as the labels given to the clusters are only approximate since borderline cases could also be assigned to other clusters. For example, in the present study most of the members of the "later 1st partnership" cluster had stayed with their first partner but there were also several members who had lived separated or with a new partner for a long time.

Analysis of individual-level event histories is better for drawing inferences about the effects of covariates on the timing of recurring partnership transitions. It can account for censoring and unobserved individual characteristics that affect the timing and duration of partnerships. However, with discretely measured recurrent events, forming the data set can be time-consuming and the size of the person-episode-period type-of-data may be large even when the number of individuals is small, leading to long estimation times when random effects models are used.

Although SA and EHA are both methods for studying longitudinal life course data, their approaches in capturing time are different in many respects and they provide versatile information on the phenomenon of interest. In SA, the focus is on the holistic pattern of the histories and analysis is retrospective in nature. In contrast, in EHA the interest lies in the transitions and the direction of inference is prospective: how much time passes before an event happens. Each episode is as important as the others, no matter how short. In SA, however, especially with the most popular alignment methods for computing sequence dissimilarities such as OM and Hamming, small deviations from a general pattern might not be very influential. For example, in terms of our (rather restricted) state-space (Table 1), hypothetical sequences P1-P2-D-P3-D-P3-P3 and P1-P2-D-P3-P3-P3-P3 would have been regarded as very similar even though the former person had four partners and five transitions and the latter one only three partners and three transitions. The definition of the state-space also matters: had we not separated partnerships by order, distinguishing successive partnerships would have been even more difficult or indeed impossible (as with P1 and P2 in the example sequences above). In such cases, if it is important to treat each episode as distinct, other dissimilarity criteria such as those based on counting common subsequences might be better suited.

SA and EHA are, of course, not the only options suitable for studying discrete longitudinal life course data. For example, trajectory analysis (Nagin, 1999) and latent class analysis (LCA; e.g. Vermunt, Tran, & Magidson, 2008) come in the middle ground of the approaches presented in this paper by using statistical models to create homogenous clusters of similar trajectories. Semi-parametric trajectory analysis can be used for studying binary trajectories such as the histories of living single/in partnership. However, the method is not suited for categorical trajectories with more than two unordered categories. For categorical data, LCA has been used to group trajectories. The standard version of LCA does not take into account the correlation between observations measured in different time periods, but several modifications have been proposed to adjust for the temporal correlation. See Barban and Billari (2012) for a comparison of LCA to SA.

4.2 Partnership formation and dissolution

Different factors related to childhood and current life situation were found to be connected to partnership formation and dissolution for women and men. Contrary to previous research (e.g. Berrington & Diamond, 2000; Rönkä et al., 2000; Ross et al., 2009; Steele et al., 2006), we did not find a significant effect of SES of subjects' fathers on the timing of their first partnerships. In common with previous research by Goldstein et al. (2004) and Steele et al. (2006), the SES of the childhood family was also not connected to men's risk of repartnering, but women with higher SES background had a lower risk.

Many previous studies have shown an increased dissolution risk for higher-order unions, but this has been assumed to be at least partly due to selection on unobserved individual characteristics. Studies that have considered such characteristics have not found an excessive risk of dissolution for recurrent partnerships (Aassve et al., 2006; Lillard et al., 1995; Poortman & Lyngstad, 2007; Steele et al., 2005;

Steele et al., 2006), although few have studied men. Our finding that repartnered men had a higher risk of dissolution was in contrast to studies of British (Aassve et al. 2006) and Norwegian (Poortman and Lyngstad 2007) men, which did not find differences in the dissolution risk by partnership order.

In common with previous studies (e.g. Andersson, 2002; Liefbroer & Dourleijn, 2006; Manning, Smock, & Majumdar, 2004), married women were less likely to dissolve their partnerships (first as well as recurrent) compared to cohabiting women. In contrast, cohabiting and married men did not differ in their risks. Motherhood did not change the risk of dissolution but fathers had a lower risk compared to childless men. However, the models only accounted for having (biological or adopted) children in general. By choosing this conceptualisation of parenthood, some information about the effects of children on the risk of dissolution of partnership is inevitably lost. Earlier research has found different, even opposite, effects of the presence, number, and age of children on partnership dissolution across countries (Coppola & Di Cesare, 2008; Lillard & Waite, 1993; Lyngstad & Jalovaara, 2010; Steele et al., 2005; Svarer & Verner, 2008).

Of the socio-emotional characteristics considered, high self-control of emotions at age 8 was the strongest explanatory variable of partnership transitions. As expected, individuals with high self-control of emotions, indicated by emotional stability and constructive and compliant behaviour (Kokko et al., 2008), had a lower risk of partnership dissolution. For women the probability of repartnering was also lower but, contrary to our expectations, there was no association with the timing of the first partnership. Furthermore, high self-control of emotions was also related to fewer and more stable partnerships for participants who had experienced less child-centred parenting practices during childhood. These results suggest that high self-control of emotions was associated with a more stable family life, even for those individuals with a less supportive family environment in childhood. It is possible that a stable partnership was a part of a cycle of good social functioning linked to child's high self-control of emotions (Pulkkinen, 2009).

In accordance with our expectations, high social activity in childhood was related to men's tendency to form first and also subsequent partnerships faster. Among women, social activity was not related to the timing or pace of partnership events. This difference could be partly due to diverse forms of social activity in boys and girls. In a previous study, Pulkkinen (1995) found that high social activity in boys was more often linked with unfavourable behaviour.

4.3 Limitations and strengths

When interpreting our results, there are some limitations that should be noted. First, our analyses consider only one age cohort of one nationality. Therefore our findings may not generalise to older and younger age cohorts and other nationalities, although many of our results were consistent with previous studies. Second, information on partnerships was gathered using the Life History Calendar (LHC), presented to the JYLS participants during the age 42 and age 50 personal interviews (in 2001 and 2009, respectively). The LHCs covered a time span from age 15 to 50. The long recall period may raise questions about the accuracy of the participants' memory and the validity of the LHC data. However, we do not consider this to be a serious flaw because prospective data on these transitions were also gathered in the JYLS study and these data have been informally used to check the validity of the LHC data (Kokko et al., 2009). Furthermore, previous studies have shown that information gathered with the LHC is reliable (Caspi et al., 1996; Freedman, Thornton, Camburn, Alwin, & Young-DeMarco, 1988). A third limitation of our study is that, in common with most other birth cohort studies where life histories are collected retrospectively, we do not have data on the childhood characteristics and partnership histories of the partners of cohort members.

The two data collection phases led to a high proportion of partnership histories that were right-censored at age 42 (the time of the first phase). We were therefore forced to use missing states for these shorter sequences, which in turn led to problems in the definition of costs in SA. Clustering results made most sense when the cost for aligning any state to a missing state was set to zero. However, this cost setting resulted in Hamming dissimilarities that are not metric distances, as assumed by most clustering methods. Since the chosen clusters were reasonable, and in any case considered suggestive, the use of non-metric dissimilarities is most likely not very serious.

Even though the JYLS study is long and extensive, the moderate sample size imposed many restric-

tions in model building. For example, we were unable to model partnership formations and dissolutions jointly. Moreover, when specifying a piecewise constant baseline hazard function we were forced to use broad age intervals. We considered only a simple indicator of being a parent which did not account for the different aspects of family structure that other studies have found to be related to the risk of partnership formation and dissolution (such as the number, age, and residence of the child(ren) or blended families). We also faced challenges due to the coarse annual measurements and had to be careful when defining the risk sets: for some individuals there seemed to be no unpartnered episodes between two partnerships.

Although the use of the JYLS data imposed methodological restrictions, strengths of the data are the rich covariate information and exceptionally long period of follow-up (from age 8 to 50). This enabled the examination of childhood individual and family characteristics as precursors of partnership transitions measured up to middle-age. In particular, childhood socio-emotional characteristics have not been studied before in this context. As can be seen from the non-significant random effect variances in some of the models, we could capture a notable part of the variation due to time-invariant individual characteristics that in previous studies have simply been left to the unobserved random part. The research question concerned the effects of childhood characteristics on the timing and stability of partnerships. These childhood measures were not used as proxies for the socio-emotional qualities of an adult. Nevertheless, a significant relationship between childhood socio-emotional characteristics and adult personality has been found in the JYLS data (Pulkkinen et al., 2012).

Another contribution of this paper was to demonstrate and compare use of SA and EHA, which to our knowledge is the first attempt to apply both methods in a study of recurrent life events.

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Associations of head circumference at birth with early-life school performance and later-life occupational prestige

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Abstract

Head circumference at birth has been suggested as a marker of foetal brain development. New-borns with small head size have been shown to have lower intelligence scores in childhood. It is, however, unclear whether this relationship extends into adult life, and more importantly, whether adult status attainment and lifetime success is affected as a result. Furthermore it is unclear how social origin at birth attenuates the relationship between foetal brain development, childhood cognitive outcomes, and lifetime status attainment. Using the Uppsala Birth Cohort Multigenerational Study, a unique population-based database of 14,192 individuals followed from birth into advanced old age, we demonstrate that those born with small head circumference experience reductions in both early-life school performance and lifetime occupational prestige. These effects are not subject to modification by parental social class: small head size at birth is associated with lower grades and lower occupational prestige among individuals born into both advantaged and disadvantaged social classes. Employing causal mediation analysis, we also demonstrate that the link between head circumference at birth and adult occupational prestige is mainly the result of a direct effect, although a portion of this effect is also mediated by early-life school performance which also contributes to occupational attainment trajectories. These findings demonstrate the importance of early-life environments for cognitive development as well as lifetime status attainment.

Keywords: head circumference, brain development, childhood cognitive ability, school grades, life-time occupational prestige, life-course, Sweden, population-based, longitudinal

Introduction

The foundations for brain development are laid down during the foetal stage of life. At birth, brain volume is about a third of the healthy adult brain volume (Holland et al., 2014). Measures of head size at birth, such as bi-parietal diameter or head circumference (HC), are widely used in assessing foetal growth, dating pregnancies, and in the detection of foetal abnormalities (Chitty, Altman, Henderson, & Campbell, 1994). The correlation between clinically measured HC and total brain volume is considerable (r=0.55, (Lindley, Benson, Grimes, Cole, & Herman, 1999)), allowing birth head circumference to be considered a marker of in-utero brain development (Cooke, Lucas, Yudkin, & Pryse-Davies, 1977). Foetal brain development affects postnatal cognitive outcomes (Webb, Monk, & Nelson, 2001) and several studies in children have shown that those born with smaller brains, as indicated by low HC at birth, also have lower scores on cognitive tests in early life, with the effect discernible even among babies born within the normal range of birth size (Broekman et al., 2009; Gale et al., 2006; Heinonen et al., 2008).

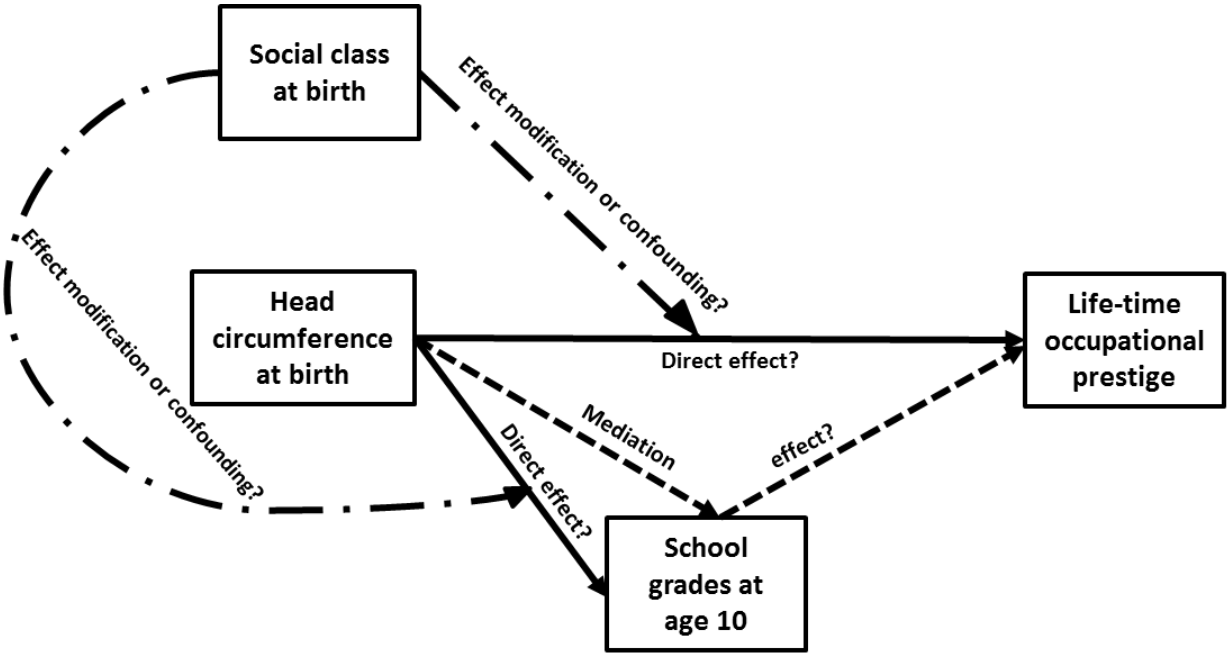
Whereas extensive previous literature has explored the long-term effects of gestational age or birth-weight (Black, Devereux, & Salvanes, 2007; Moster, Lie, & Markestad, 2008; Richards, Hardy, Kuh, & Wadsworth, 2001), studies on the long-term effects of birth HC are few and often report conflicting results. An association between bi-parietal diameter at birth and IQ in 48-74 year-olds has been reported, although HC at birth was not associated with intelligence scores in the same individuals (Martyn, Gale, Sayer, & Fall, 1996). Additionally, HC at birth was not related to either general cognitive ability or logical memory in mid- to late-life (Gale, Walton, & Martyn, 2003; Zhang et al., 2009). However, a recent study demonstrated that HC at birth, together with other measures of birth characteristics, predicted cognitive outcomes among 68 year-old men (Raikkonen et al., 2013). Whether an association between birth HC and adult cognitive outcomes in fact translates into real-life success, such as adult status attainment or occupational prestige, has not yet been investigated.

Extensive previous literature has also indicated that parental socioeconomic status is a predictor of cognitive outcome in childhood (Bradley & Corwyn, 2002; Duncan, Brooks-Gunn, & Klebanov, 1994), and it is also associated with various indicators of later-life status attainment and success (Deary et al., 2005; Fischer et al., 1996). Although previous studies interested in the long-term effects of foetal development have also integrated measures of early socioeconomic status, this has generally been limited to an attempt to control for possible confounding effects of social origin (Matte, Bresnahan, Begg, & Susser, 2001; Richards, Hardy, Kuh, & Wadsworth, 2002; Silva, Metha, & O'Callaghan, 2006). It has largely been overlooked that brain development takes place within a socioeconomic context (Hackman, Farah, & Meaney, 2010), and that biological effects can manifest themselves differently depending on the social environment surrounding development. For example, previous research in Sweden has reported that preterm birth is related to poorer school achievement among children whose parents have low levels of education; among children of more highly educated parents, preterm birth has a much more limited detrimental effect (Gisselmann, Koupil, & De Stavola, 2011). On the other hand, two studies have reported no evidence of effect modification by social class in relation to the association between birth weight and subsequent cognitive outcomes (Jefferis, Power, & Hertzman, 2002; Matte et al., 2001). To our knowledge, no previous research has examined the issue of effect modification by social class in relation to head size at birth and subsequent cognitive or human capital outcomes.

To date, no study has examined whether birth HC is associated with childhood cognitive ability as well as adult status attainment over the life course of the same cohort. By introducing adult status attainment into a life-course model it becomes possible to examine how prerequisites for human capital accumulation (childhood cognitive ability) are leveraged into the outcomes of human capital accumulation (adult status attainment or prestige) and how this process is affected by an indicator of in-utero development of the brain (birth HC). Furthermore, it is unclear from previous literature what role social class of origin plays in the relationship between foetal brain development and later-life outcomes. In this paper we investigate whether in-utero brain development, measured by HC at birth, affects (i) school grades reported at age 9-10 and (ii) later-life status attainment captured by occupational prestige, in the same individuals

followed-up over the life course. We assess both direct and indirect effects, as well as explicitly test whether social origin is a confounder, or rather an effect modifier, for the link between HC at birth, school grades in childhood, and later-life status attainment (see Figure 1 for conceptual framework). These questions are examined using a unique population-based database, the Uppsala Birth Cohort Multigenerational Study, which combines high-quality Swedish register data with manually-collected archival information on individuals followed from birth until 80-94 years (Koupil, 2007).

Figure 1. Conceptual framework of the study

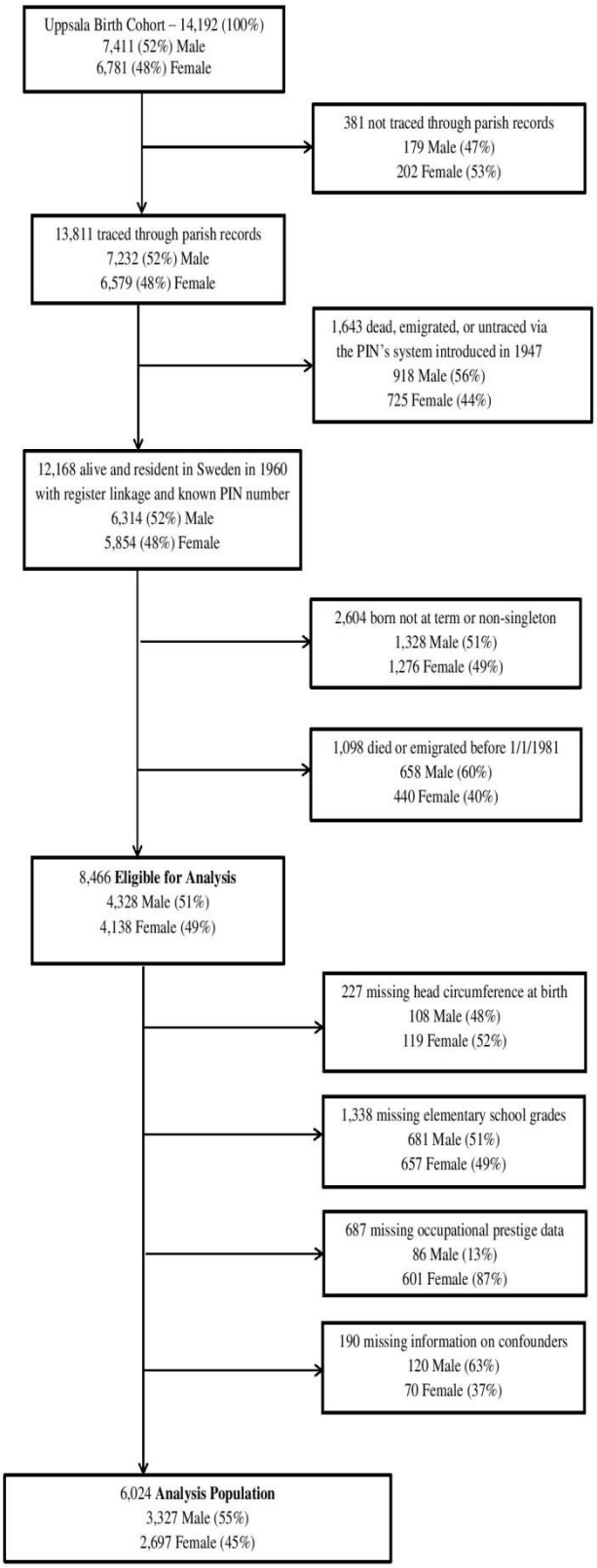


Methods

Study population

The Uppsala Birth Cohort Multigenerational Study (UBCoS) comprises all live births at the Uppsala University Hospital between 1915 and 1929, which accounted for an estimated 75% of births in the city of Uppsala and 50% of births in surrounding rural parishes (Goodman & Koupil, 2012). The study was approved by a Regional Ethics Committee in Stockholm, Sweden. This population has previously been shown to be broadly representative of the Swedish population during that historical period in terms of infant mortality and subsequent fertility (Goodman & Koupil, 2009, 2012). From a total of 14,192 births, 13,811 were successfully traced through parish archives until death, emigration or until being assigned a personal identification number in 1947. Of these, 12,168 were alive and resident in Sweden in 1960, constituting the population assessed for eligibility, for whom record linkage provided detailed information over their lives. After excluding those who did not meet our inclusion criteria, or who had missing data, our analysis population amounted to 6,024 individuals (Figure 2).

Figure 2. Study population flow



Head circumference at birth

We were interested in the effects of in-utero brain development within the normal range of deliveries, and therefore restricted our sample to term, singleton babies. As a result, we excluded multiple births (N=293), pregnancies lasting less than 37 weeks (N=678) or more than 41 weeks (N=1,274), as well as unknown gestation durations (N=359).

We used occipito-frontal circumference as our measure of head circumference as this has been previously shown to be an appropriate index of brain weight among infants (Cooke et al., 1977), but also because occipito-frontal measurements were collected for the entire UBCoS population over the study period of 1915-1929. Measurements of bi-parietal diameter, another measure of foetal head growth, began in 1924 and are therefore available for only a fraction of study participants. Occipito-frontal circumference was measured to the nearest 0.1 cm by placing a tape measure across the most prominent part of the forehead (supraorbital ridges, usually 1-2 fingers above the eyebrows) and around the most prominent part of the back of the head (occiput). The measure indicates the largest circumference of the head. The range of HC in the sample of term singleton deliveries was 23-46.1 cm. We expressed these values in terms of gestational-age-standardized Z-scores, which were then categorized into three groups to denote small gestational-age-standardized HC (STD<-1), average gestational-age-standardized HC (-1≤STD≤1), and large gestational-age-standardized HC (STD>1). A continuous specification of the HC variable with polynomial functions was also tested, although we decided to use standard deviation cut-offs for comparability with previous literature (Gale et al., 2006). Head circumference measurements were recorded for 8,239 individuals (97%) who passed prior inclusion criteria. On average, HC at birth was lower for girls than for boys, as well as for babies born into disadvantaged SES backgrounds. The correlation between gestational-age-standardized HC and birth weight standardized for gestational age was 0.58.

Early-life school grades

We extracted information on grades collected during the spring term of elementary school's third year, when individuals were mostly nine or ten years old. School grades have been previously shown to be associated with cognitive ability and IQ (r≈.5) in Sweden and elsewhere (Gustafsson & Reuterberg, 2000; Neisser et al., 1996; Rosander, Bäckström, & Stenberg, 2011). We extracted marks from the following seven subjects: arithmetic and geometry, writing and grammar, speech and reading, Christian religion studies, handwriting, local geography and history, and workbook exercises from different subjects.

Subjects were marked using the grades C (lowest), Bc, B, Ba, AB, a and A (highest), with additional qualification with pluses and minuses. We re-coded the marks from 0 (Grade C) to 18 (Grade A) in accordance with the scoring system suggested by the Swedish education authorities in 1942 (SOU, 1942). We calculated an overall third grade mean score after standardizing marks in each subject individually. Factor analysis confirmed that a single latent factor explained much of the observed variation in the marks (first Eigenvalue 3.71, second 0.79).

School grades were successfully obtained from the archives for 6,901 (84%) individuals who fulfilled prior inclusion criteria. They were more likely to be untraced among children of higher socio-economic status (SES), likely reflecting weaker coverage of private schools in the dataset (Goodman, Gisselmann, & Koupil, 2010).

Lifetime status attainment – adult occupational prestige

We measured individuals' lifetime status attainment through a prestige score associated with their longest-held occupation in adulthood. We used the Standard International Occupational Prestige Scale (SIOPS) (Ganzeboom & Treiman, 1996), which is a continuous scale (range 6-78) that emphasizes subjective perceptions of social rewards, such as approval, respect, admiration, and contempt inherent in occupations (Rose, 2005). It is flexible with respect to national, social, and cultural settings since it was developed as a result of averaging prestige scales from 60 countries. This occupational prestige score was assigned to the most frequently reported occupation found in the censuses of 1960, 1970, and 1980. Health professionals (prestige score: 70) and higher education professionals (prestige score 60) were some of the most common high-prestige occupations in the data, whereas cleaners (prestige

score 21) and low-level clerks (prestige score 30) were some of the most common low-prestige occupations.

Individuals with missing or unreported occupational information were excluded, amounting to 10% of those who passed prior inclusion criteria. Of the 687 with unknown occupations, women were over-represented (87%), likely as a result of being housewives. We ran a sensitivity analysis where females with unreported occupational information were assigned a SIOPS score equivalent to an ISCO code 5121, "housekeepers and other workers" which is a paid position. Since substantive results remained unchanged we opted for not including these individuals in the final analysis to avoid misclassification. If an individual had held different positions across all three censuses (about 20% of cases), we based their lifetime occupation on the 1970 poll (i.e., when they were 41-55 years old), as research has demonstrated that in comparable cohorts of Swedish men and women, improvements in occupational prestige flatten out after 40 years of age (Härkönen & Bihagen, 2011). Mortality did not bias the assignment of prestige scores due to our requirement that study subjects survive until January 1, 1981, allowing us a window of three population censuses to determine individuals' lifetime occupation.

Social class at birth

Family social class at birth was based on father's occupation if present (80%), or mother's occupation if not (20%). It was derived in accordance with the Swedish socioeconomic classification scheme with a category "house-daughters" added to identify unemployed single mothers living with their parents at the time of the birth of their child. We, in accordance with a previous study based on similar material (Mishra, Chiesa, Goodman, De Stavola, & Koupil, 2013), generated a binary indicator of social origin that distinguishes between advantaged background (children of higher and intermediate non-manual workers; entrepreneurs and farmers; skilled manual workers) and disadvantaged background (low non-manual workers; unskilled production/service workers; house-daughters).

Statistical analysis

We estimated a series of progressively-adjusted ordinary least squares regressions predicting elementary school grades and lifetime occupational prestige, concluding with a fully-adjusted model that also included parental social class at birth. Sex, birth year, maternal age at childbirth, birth order, and birth weight were considered as potential confounders. We tested for interactions between HC and social class at birth when predicting childhood school grades as well as occupational prestige. Next, we examined the relationship between birth HC and school grades as well as adult occupational prestige within the levels of social origin, suspecting that social origin might be an effect modifier, rather than a confounder. We then investigated how social origin and HC at birth work together in shaping childhood school grades and long-term occupational prestige.

Finally, we employed mediation analysis to establish whether the relationship between birth HC and occupational prestige is direct or mediated via childhood school grades. A method for causal mediation analysis that builds on the counterfactual framework was applied (Imai, Keele, & Tingley, 2010). The assumption of sequential ignorability required for identification of causal mediation was tested using a method suggested for sensitivity analysis (Imai, Keele, & Yamamoto, 2010). Causal mediation and sensitivity analyses were conducted in STATA using the modules "medeff" and "medsens" developed by Hicks & Tingley (2011).

Results

Of the original 14,192 UBCoS participants, 8,466 were born singleton, at term, and were alive and resident in Sweden on 1 January 1981, constituting the population eligible for analysis. Of these, 6,024 had non-missing information on head circumference, elementary school grades, occupational prestige, socioeconomic, and other background variables, making them the analysis population in the study (Figure 2). Background characteristics of the study participants are presented in Table 1. Study subjects were more likely to be male, born to mothers aged 25-29 years, and come from non-privileged social backgrounds. Mean level of school grades as well as occupational prestige was lower in individuals coming from disadvantaged social backgrounds. Similarly, both school grades and occupational prestige averages were lowest among the subgroups of participants with small HC at birth.

The final analysis population differed significantly from the 2,442 of those eligible, but excluded due to missing data on covariates, with respect to family social class at birth (e.g. 12% born to parents of higher non-manual families among those excluded vs. 8% among those included, p<0.001). Social class differences were largely a result of excluding individuals with missing elementary school grades due to limited coverage of private schools preferred by high-SES parents. In addition, the proportion of women was higher among the excluded 2,442 individuals (60%, vs. 45% among those included, p<0.001). This is likely a result of removing subjects with missing occupations, among whom women were over-represented.

Table 1. Baseline characteristics of the study population: Uppsala Birth Cohort Multi-generational Study (6,024 men and women)

Variable	Range/categories	Percent	Mean grades (SD)	Mean prestige (SD)
Gender				
	Male	55%	-0.11 (0.72)	40.6 (11.9)
	Female	45%	0.12 (0.73)	35.3 (11.1)
Birth order				
	1	38%	0.11 (0.74)	39.6 (11.7)
	2-3	38%	0 (0.71)	38.3 (11.8)
	4-5	14%	-0.05 (0.74)	37.2 (11.1)
	6-16	10%	-0.08 (0.73)	35.1 (10.2)
Mother's age at birth				
	15-19	5%	0.02 (0.77)	36.8 (10.3)
	20-24	26%	-0.03 (0.71)	37.2 (11.0)
	25-29	29%	0.05 (0.73)	39.3 (11.9)
	30-34	21%	0.07 (0.74)	39.0 (11.8)
	35-39	13%	0.01 (0.75)	38.5 (11.5)
	40-49	6%	0 (0.73)	37.2 (11.6)
Family social class at birth				
	Advantaged social class	42%	0.12 (0.75)	39.8 (12.2)
	Disadvantaged social class	58%	-0.04 (0.72)	37.2 (10.9)
Birth weight (standardized by gest. age)				
	Low (Z-score <-1)	13%	-0.03 (0.73)	37.8 (11.1)
	Average (Z-score -1 to 1)	71%	0.04 (0.74)	38.4 (11.6)
	Heavy (Z-score>1)	16%	0.02 (0.71)	38.4 (11.5)
Head circumference (gest. age-standard)				
	Small (Z-score <-1)	12%	-0.02 (0.73)	35.7 (11.2)
	Average (Z-score -1 to 1)	75%	0.04 (0.73)	38.6 (11.7)
	Large (Z-score >1)	13%	0.01 (0.74)	39.1 (11.4)

Notes. Mean grades represent an average of marks in seven school subjects, each separately standardized with $\bar{x}$=0 and S=1
Occupational prestige is measured using a continuous scale ($\bar{x}$=38.3; range= 6-78)
Advantageous social class: high/mediate non-manuals, entrepreneurs/farmers, and skilled manuals
Disadvantaged class: lower non-manuals, unskilled manuals in production, unskilled manuals in service, house-daughters

Head circumference at birth, school grades, and occupational prestige

We began by analysing the effects of birth HC on school grades (Table 2). In the minimally-adjusted model, small HC was associated with a reduction in mean standardized school grades (p<0.001). Subsequent adjustment for maternal age at birth, birth order, and birth weight resulted in marginal attenuation of the negative effect estimate of small HC at birth on elementary grades, which remained statistically-significant (p<0.001). A similar pattern was observed after further adjustment for social origin at birth (all estimates from the fully-adjusted model available in supplementary material), where some attenuation in the effect magnitude did occur, but the negative relationship between small HC at birth and elementary school grades remained statistically significant (p<0.001). Children born to parents of advantaged social class received higher school marks at age 9-10 (p<.001). No statistically significant effect of larger HC at birth on school grades at 9-10 years was found in any of the models.

Table 2. Head circumference (HC) at birth and school grades at age 9-10 (N=6,024) Linear regression, OLS estimates

	Regression coefficients (95% confidence intervals) Outcome: school grades at age 9-10		
	Model 1	**Model 2**	**Model 3**
Small HC	-0.119*** (-0.177, -0.061)	-0.102*** (-0.163, -0.043)	-0.097*** (-0.157, -0.037)
Average HC	0 (ref)	0 (ref)	0 (ref)
Large HC	0.031 (-0.023, 0.084)	0.035 (-0.021, 0.092)	0.031 (-0.025, 0.087)
Advantaged SES at birth			0.156*** (0.118, 0.193)
R^2	0.04	0.06	0.07

*Notes. *** p<0.01, ** p<0.05, * p<0.1*
Robust confidence intervals in parentheses
Model 1: adjusted for sex & birth cohort
Model 2: adjusted for sex, birth cohort, birth order, maternal age at birth, birth weight (gestational age-standardized)
Model 3: based on model 2, additionally adjusted for social origin at birth (advantaged vs. disadvantaged)

The effects of HC at birth on lifetime occupational prestige are shown in Table 3. In a minimally-adjusted model, we found that individuals with small HC at birth experienced a reduction in prestige score associated with their longest-held adult occupation (p<0.001). This relationship appeared robust to further adjustments for birth characteristics and, eventually, social class at birth (all estimates from the fully-adjusted model are available in supplementary material). Social origin was a statistically significant predictor of occupational prestige score, with advantaged parental social class at birth associated with a high-prestige individual occupation in adulthood (p<0.001). As in the case with school grades, only small HC at birth was linked with suboptimal outcomes – larger HC did not affect occupational prestige attainment.

Table 3. Head circumference at birth (HC) and later-life occupational prestige (N=6,024). Linear regression, OLS estimates

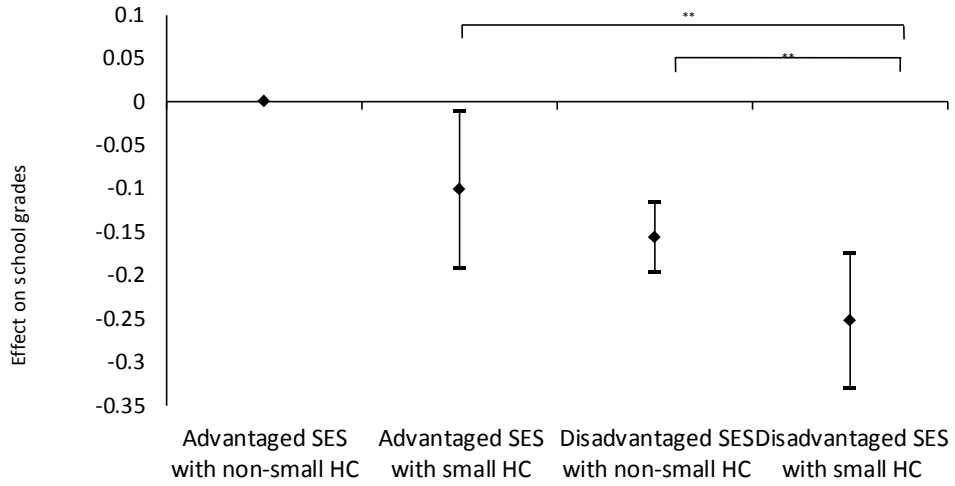
	Regression coefficients (95% confidence intervals) Outcome: lifetime occupational prestige		
	Model 1	**Model 2**	**Model 3**
Small HC	-1.805*** (-2.688, -0.921)	-1.636** (-2.571, -0.701)	-1.551** (-2.484, -0.619)
Average HC	0 (ref)	0 (ref)	0 (ref)
Large HC	-0.355 (-1.201, 0.490)	-0.434 (-1.301, 0.432)	-0.499 (-1.361, 0.363)
Advantaged SES at birth			2.271*** (1.676, 2.877)
R^2	0.06	0.09	0.10

*Notes. *** p<0.01, ** p<0.05, * p<0.1*
Robust confidence intervals in parentheses
Model 1: adjusted for sex and birth cohort
Model 2: adjusted for sex, birth cohort, birth order, maternal age at birth, birth weight (gestational age-standardized)
Model 3: based on model 2, additionally adjusted for social origin at birth (advantaged vs. disadvantaged)

Modification by social origin

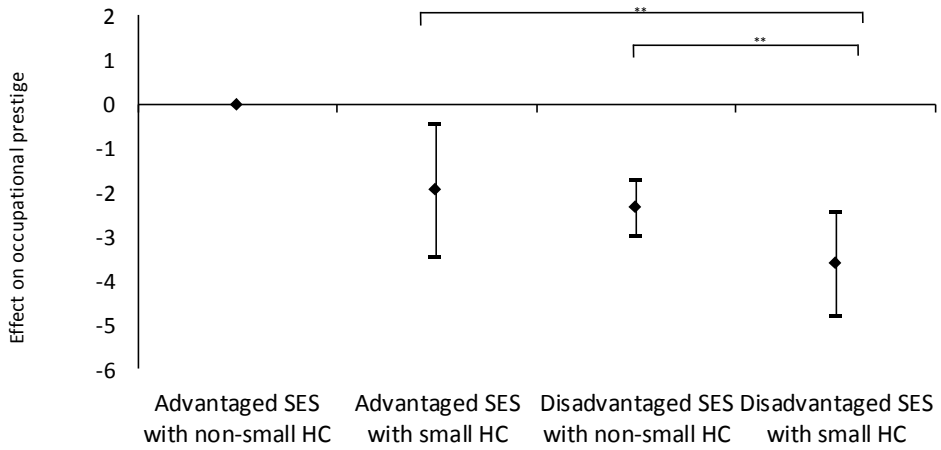
To examine interactions between birth HC and social class with respect to school grades and occupational prestige, we converted a three-level HC variable (small; average; large) into a binary indicator distinguishing between small head size vs. the rest. We found no evidence of interaction between social class at birth and small HC when considering elementary school grades (p=0.14) or adult occupational prestige (p=0.59). Furthermore, small HC at birth was found to be associated with a reduction in grades and prestige amongst children born to parents from either advantageous or disadvantageous social classes (supplementary material, Table A2). Finally, in order to visualize the combined effect of social class and HC at birth with respect to elementary school grades and occupational prestige, we examined the effects of four indicator variables denoting four possible combinations between social origin (advantaged or not) and HC at birth (small or not) (Figures 3 & 4; model estimates in supplementary material, Table A3).

Figure 3. Combined effect of parental social class and head circumference (HC) at birth on school grades. Linear regression estimates



Notes. *95% confidence intervals*
Adjusted for sex, birth year, birth order, maternal age at birth, birth weight (gestational age-standardized)
Top lines denote statistical difference between estimated parameters.
Estimates available in Table A3 in supplementary material

Figure 4. Combined effects of parental social class and head circumference (HC) at birth on lifetime occupational prestige score. Linear regression estimates



Notes. *95% confidence intervals*
Adjusted for sex, birth year, birth order, maternal age at birth, birth weight (gestational age-standardized)
Top lines denote statistical difference between estimated parameters.
Estimates available in Table A3 in supplementary material

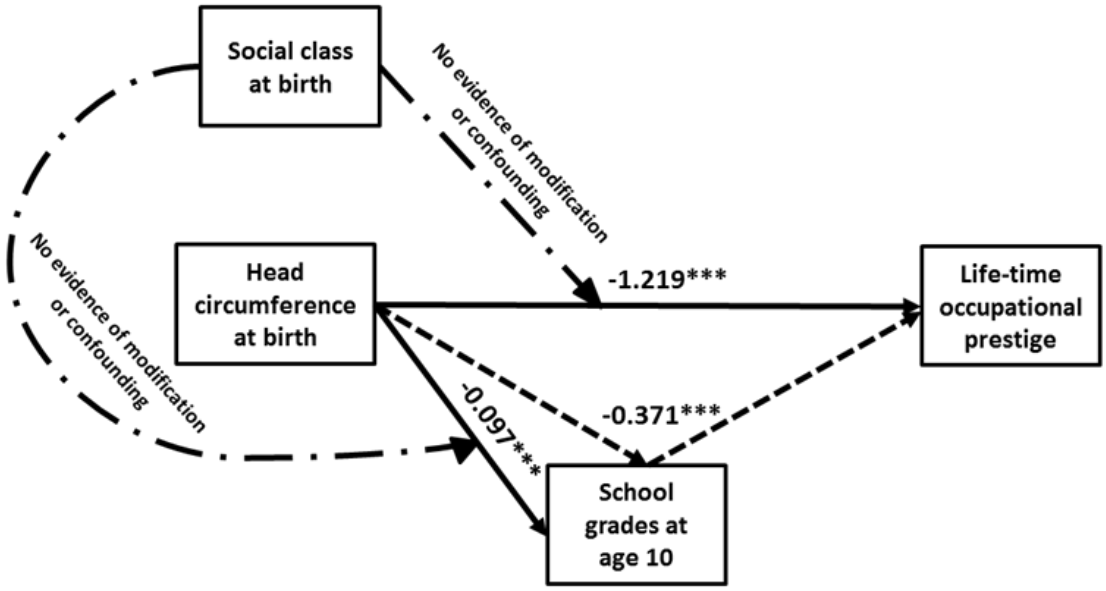
As can be seen in Figures 3 and 4, the greatest benefit in terms of school grades, as well as adult occupational prestige was reserved for individuals with non-small head size born to parents of advantaged social class, since any departure from this state reduced both short-term and long-term cognitive and occupational outcomes. The estimated effect of disadvantaged social origin in combination with small HC was statistically different from the effect of disadvantaged social origin with normal head circumference, as well as the effect of advantaged social class with small head size. There was, however, no statistical difference between the latter two estimates, with the effect of advantaged origin with small HC being statistically similar to the effect of disadvantaged social class with non-small HC.

Mediation analysis: head circumference, school grades, and occupational prestige

Results of the mediation analysis as well as of the main study findings are presented in Figure 5. With respect to mediation analysis, HC at birth (modelled as a binary indicator distinguishing between small head size vs. the rest) was related to long-run occupational prestige both directly (adjusted average direct effect: -1.219; 95% CI: -2.212 to -0.293) and indirectly via elementary school grades (adjusted average causal mediation effect (ACME): -0.371; 95% CI: -0.579 to -0.189). The total adjusted effect of birth HC on adult occupational prestige, including the mediation by elementary school grades was -1.591 (95% CI: -2.580 to -0.650). The negative effect estimates imply a strong negative association between small head size and grades, which are positively related to adult occupational prestige. A quarter of the total effect of head size on occupational prestige was mediated by elementary school grades.

Results of the sensitivity analysis indicated that the correlation in omitted variables between the mediation and the outcome models would have to be 0.20 in order for the causal mediation effect to be invalidated. This means an unobserved confounder would have to explain a considerable 20% of the variance in both school grades and occupational prestige in order for the mediation estimates to become substantively changed.

Figure 5. Mediation of HC effects by school grades and main study findings



Notes. Estimates of the HC-prestige path and the HC-grades-prestige path (dash) are obtained from the causal mediation analysis:
Direct effect: -1.219 (95% CI: -2.212 to -0.293)
Average causal mediation effect (ACME): -0.371 (95% CI: -0.579 to -0.189)
Total effect: -1.591 (95% CI: -2.580 to -0.650)
ρ (correlation of errors between mediator and outcome models) at which ACME will be invalid: 0.20
All models estimated as part of the mediation analysis are adjusted for sex, birth year, birth order, maternal age at birth, birth weight (gestational age-standardized), and social class at birth
Estimate of the HC-grades path are obtained from a fully-adjusted OLS model with HC as exposure and school grades as outcome (Table 3)
"No modification/confounding" arrows indicate no evidence of confounding or effect modification of the HC-prestige and HC-school grades pathways by social class of origin (Supplementary material Table A2; Figures 3 & 4; interaction analysis; SES-adjusted OLS models)

Discussion

In this study we examined whether head circumference at birth, an indicator of brain development in utero, was associated with elementary school performance and lifetime occupational prestige. Among individuals born at term, we found that those whose birth HC fell one standard deviation below the mean experienced reductions in both elementary school grades and lifetime occupational prestige. These findings remained robust after adjustment for confounding due to birth characteristics as well as parental social class at birth. We also established that the association between HC at birth and short-term cognitive outcomes or lifetime occupational prestige was not subject to effect modification by social class of origin. Finally, using mediation analysis, we demonstrated that HC at birth was linked to long-run occupational prestige directly, as well as indirectly, by predicting early cognitive ability which then also affected occupational prestige, although the direct effect was the dominant one (Figure 5).

A major strength of this study is that we examined whether the effects of brain size at birth extend beyond such proximate outcomes as school grades in childhood and continue to affect outcomes of later-life occupational achievement and success in the same individuals over the life-course. Some (Kunugi, Takei, Murray, Saito, & Nanko, 1996; Martyn et al., 1996; Raikkonen et al., 2013), but not all (Gale et al., 2003; Zhang et al., 2009), previous studies have reported an association between birth HC and later cognitive ability. However, instead of assessing cognitive performance in later life, we assessed occupational prestige which has both cognitive (the correlation between intelligence and occupational attainment is about .40 (Strenze, 2007)) and social prerequisites, and which also can be viewed as a measure of lifetime status achievement. It has been reported previously that head circumference at birth, together with other birth outcomes, is associated with cognitive performance and cognitive change in adult life (Raikkonen et al., 2013). Our findings extend this literature by demonstrating that the negative effects of small HC at birth are discernible in childhood, and linger on to also affect status attainment in adulthood. Our second contribution is the demonstration that the link between birth HC and adult status attainment is not only present, but is also primarily direct and only somewhat mediated by the short-term effect of birth HC on childhood school grades, which then help shape adult occupational outcomes.

Our results are also consistent with previous literature reporting an association between foetal brain development and early-life cognitive ability (Broekman et al., 2009; Veena et al., 2010), although we used information on school grades at age 9-10 in the absence of explicitly-measured IQ. The reasons why some infants are delivered with small HC are manifold. Maternal under-nutrition is one of the primary causes of small birth head circumference, although both genetic (Toga & Thompson, 2005) and various environmental factors are also implicated (Doberczak, Thornton, Bernstein, & Kandall, 1987; Källén, 2000). A model of foetal programming predicts that in-utero development might be constrained in order to maximize overall survival chances in the turbulent environment (Gluckman & Hanson, 2004). Consequently, investments in repair mechanisms or reserve tissues, such as excess neurons or synaptic capacity in the brain are likely to be reduced (Broekman et al., 2009). While the brain-sparing hypothesis suggests that brain development ought to be shielded from adjustments aimed at postnatal fitness advantage in hostile environments (Godfrey & Barker, 2001), evidence suggests that those endocrine mechanisms that restrict foetal growth can also compromise neural development (Goland et al., 1993; Meaney, Szyf, & Seckl, 2007; Schneider, Moore, Kraemer, Roberts, & DeJesus, 2002; Seckl & Holmes, 2007; Winick & Noble, 1966). Programming of the hypothalamic-pituitary-adrenal (HPA) axis could play an important role in this process, with the HPA modification being an intermediate step between limited nutrition, foetal maturation, and postnatal pathophysiology (Seckl & Holmes, 2007). Following the modification of the HPA, anabolic effects of the growth hormone are antagonized, resulting in changes in organ development and maturation, including the brain (Broekman et al., 2009). Therefore, the link between small head size at birth and cognitive outcomes could arise not only due to growth restriction that reduces brain volume, but also due to the relationship between the modifiers of foetal growth restriction (changes in the expression of the HPA axis) and postnatal cognitive outcomes.

It has been shown previously (Gale et al., 2006) that the effects of birth head circumference on childhood intelligence are weakened when later-life measurements of childhood head size are used instead. Postnatal estimates of head circumference might be more precise than measurements collected during delivery. Others, however, have indicated that both prenatal and postnatal measurements of head circumference can predict cognitive abilities among children at 56 months of age (Heinonen et al., 2008). We did not have access to later estimates of head size and, therefore, cannot provide cues on the relative importance of different critical periods during brain development. Nonetheless, a reduction in the effect size of birth head size in favor of subsequently-measured estimates of head circumference, as reported by some, should indicate that a common causal pathway connects head size at birth, postnatal head growth, and childhood cognitive function (Veena et al., 2010).

Our study also demonstrated that the relationship between birth HC and school performance in childhood or occupational outcomes in adulthood is not readily explained by confounding or effect modification by social class of origin. We reported only additive effects of birth HC and social origin with respect to childhood grades and lifetime prestige. Essentially, disadvantaged social origin and small birth HC each imply a reduction in short-term as well as long-term cognitive and human capital outcomes. A combination of these disadvantages is associated with a proportionally greater reduction in the outcomes considered, although birth HC is detrimental irrespective of the social class an individual may have been born into. Strengthened by no evidence of an interaction between social origin and HC, we conclude that social origin and birth HC mainly act independently in shaping childhood school grades as well as general lifetime attainment. A previous study found that social class at birth modified the relationship between gestational age and early school performance (Gisselmann et al., 2011). On the other hand, no evidence of effect modification by social origin was reported in two previous studies linking birth weight and childhood cognitive outcomes (Jefferis et al., 2002; Matte et al., 2001) and our findings are consistent with these results, although we also report no modification when a distant outcome is considered, something not shown to date.

Our finding of no effect modification by social origin is relevant to our earlier discussion about the underlying causes of small HC at birth. Maternal under-nutrition is undoubtedly one of the primary causes of small birth HC, and it is also likely related to socioeconomic opportunities. We reported here, however, that infants of affluent and disadvantaged parents are equally vulnerable with respect to childhood school grades and adult occupational prestige if born with small HC. While inadequate nutrition during pregnancy might apply to disadvantaged mothers, it is unlikely to be a decisive factor determining the birth outcomes of children born to affluent parents. Thus, it has been hypothesized previously that in high-SES families with abundant access to economic resources, occurrence of low birth-weight is likely underpinned by psychosocial factors or behavioural characteristics (Foster et al., 2000). In addition to nutrition, previous research has identified maternal stress (Mulder et al., 2002) and pesticide exposure (Berkowitz et al., 2004) as correlates of small HC at birth and these factors might be at work here, at least when affluent families with small HC deliveries are considered.

Finally, we employed mediation analysis to examine the extent to which the link between head size at birth and adult occupational prestige was direct, or rather mediated by early cognitive ability at age 10. We demonstrated that a quarter of the association between head size at birth and occupational prestige was mediated by elementary school performance, with the bulk of the effect being due to a direct link between birth HC and occupational attainment. To our knowledge, ours is the first study that has attempted such analysis. A previous study tested whether the association between birth weight and psychological distress at ages 45-51 was mediated by IQ at age 7, and found no evidence of mediation by early-life IQ (Wiles, Peters, Leon, & Lewis, 2005). Although the direct effect was found to be a predominant one in our study as well, we also report that a rather sizeable quarter of the total link between birth HC and adult occupational prestige was due to mediation by early school performance.

Limitations

Since we had no direct information on childhood cognitive ability, we instead examined the relationship between birth HC and school grades at

age 10. Childhood cognitive ability and school grades are correlated (r≈.5) (Gustafsson & Reuterberg, 2000; Neisser et al., 1996; Rosander et al., 2011) and grades are also associated with other indicators of low cognitive ability such as being held back in school or having a recognized learning difficulty (Goodman & Koupil, 2009). Moreover, our factor analysis of raw school grades indicated that a single latent factor explained most of the variation in school performance, much the same way general mental ability (g) underlies intelligence test scores.

We chose the Standard International Occupational Prestige Scale over the more commonly-used International Socioeconomic Index of Occupational Status (ISEI) which ranks occupations in relation to their average education and income levels to show how occupational structure influences the ability to convert education into income. Although an effective tool at capturing formal attributes of occupations, ISEI is less suitable for this particular cohort which largely refrained from transitioning to tertiary education. Furthermore, ISEI was developed for occupations of full-time, male adults. Estimates for women were made, but with data for men working in predominantly female occupations (Rose, 2005).

About 30% of the eligible cohort members were excluded from the final analysis. Loss of eligible individuals from the analysis population was mainly due to missing data on school grades (55% of the total with missing data). School grades were more likely to have been untraced among children of the highest socio-economic background who were more prone to attend private schools where archival coverage was weaker. Furthermore, we excluded 687 individuals for whom occupational information could not be traced. These were almost exclusively women, whom we suspected to be housewives. In a sensitivity analysis, we classified women with missing occupational information as employed as "housekeepers and other workers" and assigned them a prestige score associated with this paid position. Substantive results remained unchanged and we decided to exclude the group with missing occupational data to avoid misclassification of exposure. We also examined differences in educational attainment and found only minor discrepancies between the excluded and the study population (incomplete elementary education: 46% vs. 49%; completed elementary: 39% vs. 35%; beyond completed elementary: 15% vs. 16%, respectively). It is, therefore, unlikely that considerable bias was introduced when adjustments for missing data were made.

Conclusions

Individuals with small head circumference at birth experienced reductions in childhood school grades as well as later-life occupational prestige. This relationship was not due to confounding or effect modification by social class of origin. Further, HC at birth impacted long-run occupational prestige mainly directly, but also indirectly, by influencing school grades at age 9-10, which in turn affected occupational prestige. Our results add to the evidence on the importance of foetal brain growth for later life educational and social outcomes.

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Examining mortality differentials between a long-living community in Sardinia and the Italian population: a longitudinal analysis

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Abstract

Progressive gains in life expectancy have brought increasing aging of developed countries' populations and stimulated researches with respect to the limit of lifespan, the increasing presence of centenarians and the possible determinants of their "successful" ageing. In the international framework the population of the region of Sardinia was characterized by exceptional longevity. Through the comparison of life tables' rates and life expectancy estimates of birth cohorts born in the period 1872-1910, this paper reports analyses of differences in overall mortality between Italy and the long-living community of Sardinia. The adoption of a longitudinal approach allows us to explore whether the previously detected differences at advanced ages are also observable in other age groups. In addition, the study focuses on the occurrence of mortality crossover as an indicator of significant mortality differences between populations. Results show that differences between the two populations are not limited to oldest old ages. Crossover points in mortality rates are observed in the first years of life and at age 50 years. Both intersections represent the points where differences in life expectancy are the highest. At age 5 years differences are of 1.8 years for females and 3.6 years for males, while at age 50 years they are respectively 1.5 years for females and 3.7 years for males. The observed differences suggest that possible explanations for differential mortality and crossover might be related to selection process timing and dynamics which could be determined by genetics, and specific causes of death, as well as by behavioural and environmental factors.

Keywords: differential mortality; crossover; longitudinal analysis; life table; Italy.

1. Introduction

In recent decades, continuous improvements achieved in human survival have stimulated studies and researches in various disciplines about the limit of lifespan (Olshansky et al., 1990; Parsons, 1996; Kannisto, 1996; Robine et al., 1997; Gavrilov & Gavrilova 2001; Vallin & Meslé, 2001; Carnes et al., 2003; Barbi et al., 2008), the increasing presence of centenarians and their main characteristics (see, among others, Jeune & Vaupel, 1995; Vaupel, 2000; Vaupel & Robine, 2002; Coles, 2003; Robine & Caselli 2005; Maier et al., 2010) and the possible determinants of their "successful" ageing (see, among others, Allard et al., 1996; Franceschi et al., 2000; Caselli & Lipsi, 2006; Willcox et al., 2006; Christensen et al., 2006; Franceschi et al., 2007; Murabito et al., 2012; Brooks-Wilson, 2013).

In the international framework, it has been shown that certain populations are characterized by exceptional levels of longevity (Poulain et al., 2013).

These include Okinawa in Japan (Willcox et al., 2001; Robine et al., 2003; Poulain & Naito, 2004; Cheung & Robine, 2007; Poulain, 2011), the peninsula of Nicoya in Costa Rica (Rosero-Bixby, 2008; Davinelli et al., 2012; Rehkopf et al., 2013), and the region of Sardinia in Italy (Deiana et al., 1999; Passarino et al., 2001; Poulain et al., 2004, 2011; Gatti & Salaris, 2004; Caselli & Lipsi, 2006; Caselli et al. 2006; Salaris, 2010, 2014; Orrù, 2011; Pes et al., 2013; Salaris et al., 2013).

Sardinia has been the subject of several studies on longevity, as it is generally considered a suitable setting: i) for genetic studies, due to its geographical and genetic isolation (Cavalli Sforza et al., 1997; Lampis et al., 2000; Fraumene et al., 2003; Pilia et al., 2006; Strait et al., 2009); ii) for studies of cardiovascular diseases (CVD), given the low mortality rates recorded in the island (Caselli & Lipsi, 2006; Muntoni et al., 2009; Scuteri et al., 2009); iii) for researches on centenarians, found to be geographically limited to the inland area of the region (Poulain et al., 2004; Gatti & Salaris, 2004; Orrù, 2011); iv) for studies of oldest ages in male survival in general (Passarino et al., 2001; Poulain et al., 2011).

The aim of this current contribution is to improve understanding of mortality differentials between Italy and one of the identified and documented long-living communities in Sardinia, namely the municipality of Villagrande Strisaili (section 3), through the comparison of mortality trajectories of historical birth cohorts born in the period 1872-1910 (section 4).

A longitudinal perspective allows us to overcome the age fragmentation that analysis of differential longevity usually involves, as the focus is generally limited to oldest old ages, and so extends the comparison to the entire life span. This approach helps in understanding how mortality trajectories evolve in the two populations over the life course and to look at the different levels of longevity observed, particularly among males, as the outcome of a more complex process which is influenced by the pace and intensity of mortality at earlier ages. The research questions that arise are therefore the following: are the detected differences at advanced ages also present in the other age groups? Or does mortality risk variation across the life course lead to the occurrence of mortality crossovers?

With this aim, the study extends the analysis of mortality age variations in the two settings to the entire life course, including the study of early and young-adult mortality, and devoting special attention to the detection of possible mortality convergence points as indicators of significant changes in mortality risk associated with age (section 5). The study finally sets out the possible explanations for differential survival and mortality crossover between the studied populations (section 6).

2. Differential mortality and mortality crossover

In the study of differential mortality researchers have often focused on the so-called mortality crossover, which is usually detected through the comparison of mortality rates. It is considered an indicator of significant variations in mortality risk associated with age. It is not such an unusual event (Liu & Witten, 1995), as differences in mortality between populations or population subgroups rarely stay constant, but rather produce intersection points (Liu et al., 2008). The crossover occurs at the age of highest difference and corresponds to the shift, for the initially advantaged population, from relatively low to relatively high mortality rates and it is determined by a mortality acceleration (Hirsch et al., 2000).

A growing body of literature has documented mortality crossover in different populations suggesting several factors are responsible for the observed intersection and convergence of mortality rates. Among the relevant factors race and ethnicity are the most studied. Often the analysis looks with interest at the role of specific causes of deaths (Nam et al., 1978; Nam, 1995; Hummer 1996; Corti et al., 1999; Johnson, 2000; Hill et al., 2000; Lynch et al., 2003; Thornton, 2004; Stansbury et al., 2005) and at socioeconomic status (Hoffmann, 2005; Yao & Robert 2011; Sautter et al., 2012). Crossover proves also to be caused by selection effects of exceptional events such as famine (Song, 2010) and it was detected when comparing particular long-living regions – as for example in Okinawa - with the national framework (Poulain & Naito, 2004; Poulain, 2011).

There are two major scientific hypotheses for the occurrence of a mortality crossover. The first explanation considers the issue of data quality. Bad data, and particularly age misreporting, leads to

false mortality crossover (Coale & Kisker, 1986; Elo & Preston, 1994; Preston et al., 1999). The second school of thought interprets it in terms of frailty. The population is assumed to be highly heterogeneous and a selection process occurs over the life cycle; frail individuals are eliminated early on, while robust subgroups survive to older ages (Vaupel et al., 1979).

As argued by Lynch et al. (2003; pg. 457) "*mortality crossover, however, is only one aspect of mortality that can be considered when evaluating differences between populations. Mortality compression and deceleration - the rate at which the mortality hazard curve changes shape (steepens) across time and the age at which mortality rates cease to grow exponentially across age - constitute important aspects of mortality that must also be considered to understand overall mortality pattern differences*".

In particular, the concept of mortality deceleration is related to that of unobserved heterogeneity and of mortality selection (Wrigley-Field, 2012), as population mortality rates change according to the changing composition of the population. Timing and characteristics of mortality selection might be due to genetic and biological features of the population, and/or to external factors like wars and epidemics which can produce the so-called "mortality shocks" in a population. However, the latter have been shown to produce their effects in the short term, but do not affect the rate of aging of a population (Zarulli, 2012).

3. The community of Villagrande Strisaili

Villagrande Strisaili is located at 700 meters above sea level in the province of Ogliastra in the in-land area of Sardinia and it belongs to the so called Blue Zone of longevity in Sardinia, which consists of 14 municipalities where a significant number of centenarians were recorded as well as a low sex ratio value (Poulain et al., 2004).

At the first general population census after Italy unified in 1861, the municipality recorded 1,251 inhabitants and a decade later the residents were 1,111 (Angioni et al., 1997). Since 1861 its population grew continuously until the census of 1971, when for the first time there was a reduction in the population. This change has been determined, as in many other communities in the inland area of Sardinia, by important migration flows that during the '60s and '70s triggered the depopulation of smaller centres (Gatti & Puggioni 1998). In the most recent decades, we continue to observe a declining trend, although - compared to the past – it is mainly a consequence of structural aging of the population, rather than of out-migration flows (Esposito, 2012). According to the latest available ISTAT (2014) data on resident population at January 1st 2013, Villagrande has 3,324 inhabitants.

4. Data and Methods

4.1. Birth cohorts studied

Birth cohorts from 1872 to 1910 for Italy and for Villagrande Strisaili are followed longitudinally from birth to oldest-old ages. The focus on these birth cohorts was firstly determined by data availability, as cohort life table estimates for Italy are accessible from the Human Mortality Database (HMD) since 1872. Secondly, the decision to include birth cohorts until 1910 guarantees that the population under study consists of individuals that today are at least 100 years old and the number of still living individuals is limited in both populations, although the analysis here is limited to survival up to 80 years old. For Villagrande Strisaili, an average of 50 births per year are recorded; the total number of cases considered in the present study in the birth cohorts 1872-1910 are 1,955 of which 1,009 are males and 946 females. Table 1 presents the distribution of deaths and censored cases by age and sex.

Table 1. Distribution of deaths and censored cases of Villagrande Strisaili birth cohorts 1872-1910 by age and sex

Age	MALES			FEMALES		
	Survivors	Deaths	Censored cases	Survivors	Deaths	Censored cases
0	1.009	240	7	946	241	4
5	762	36	1	701	36	0
10	725	30	0	665	18	0
15	695	32	9	647	13	2
20	654	51	11	632	29	0
25	592	22	8	603	24	2
30	562	25	16	577	24	3
35	521	15	6	550	18	1
40	500	18	2	531	20	0
45	480	24	1	511	18	0
50	455	12	0	493	12	1
55	443	22	0	480	22	0
60	421	26	1	458	29	0
65	394	27	0	429	35	0
70	367	38	1	394	35	0
75	328	77	1	359	55	0
80 and over	250	242	8	304	300	4

4.2. Data sources

Data for Italy were extracted from the Human Mortality Database (HMD) life table estimates by cohort for the total Italian population (including the village of Villagrande Strisaili), which were constructed by HMD using data from official vital statistics and census counts published by the Italian National Statistics Office (ISTAT). The data for birth cohorts in Villagrande Strisaili comes from the VIllagrande Longevity Database (VILD), a reconstructed family database of all individuals born in Villagrande Strisaili from 1866 to 1915, whose survival was in this study observed until 2010 (Salaris, 2010). Data was collected from civil status registers, population registers and parish registers thanks to the availability of the Diocese of Lanusei (with regard to parish registers) and to the Demographic Office of the municipality of Villagrande Strisaili (for all other registers) in accordance with national data privacy regulations and in compliance with the time limits specified therein. Data was aggregated to avoid identification of subjects. Although historical data requires a great effort for data collection, it allows us to take into consideration the entire population, avoiding selection biases introduced by individual consent. All individuals, dead or alive at the time of the study, are considered thanks to their demographic data. The data coverage is complete and with no selection or sampling of population subgroups. This approach allows us to establish a unique link between historical data and current level of longevity. Through the analysis of births, marriages and deaths each individual was followed from birth to death. Data collection covered the period from 1866 to 2010 and provides a level of coverage of 95% of known survival. Conversely, the remaining 5% consists of individuals who were born in the village but whose age at death is not known.

4.3. Data quality

Life table estimates for Italy are of good quality and the HMD provided researchers with a reliable set of annual complete life table functions (Meslé & Vallin, 2009). Raw data comes from period data and subsequently was organized by birth cohort

(Wilmoth et al., 2007). With regard to coverage and completeness of the data, it should be specified that the HMD calculates death rates on the present population and that estimates took into account deaths of Italian residents that occurred abroad, which were proportionately distributed by age. The official statistics did not include information on deaths during World Wars I and II; however, death counts in the HMD were adjusted to include military deaths (Glei, 2009). With regard to life tables for Villagrande Strisaili, data issue is more complex and implied a careful validation process of raw data. In more detail, data validation was considered possible under-registration of births and related deaths (Breschi et al., 2012); the effect of migration flows (Meslé & Vallin, 2002); and age misreporting (Ewbank, 1981; Preston et al., 1999). Finally, in order not to exclude individuals with partial information on survival, the study set up a censoring strategy, using the last information available (i.e. still living individuals at the end of observation period, migration date, birth of last child, date of marriage, military examination, Confirmation religious ceremony) as a truncation date of the observational window. In this manner individual survival has been at least underestimated. Right truncated cases represent 4.6% of the population under study and this percentage varies from 7.1% of males to 1.8% of females (Table 1).

4.4. Methods

HMD life table functions for Italy were calculated by HMD according to their protocol considering the extinct and almost extinct cohort method, which assumes a stationary population and no international migration (Wilmoth et al., 2007). The latter assumption is reasonable only for advanced ages (Meslé & Vallin, 2002) and it also holds for Villagrande Strisaili (Salaris, 2010). Life tables for the Villagrande Strisaili population have been built according to Preston et al. (2001) formulas for single decrement life tables and estimated separately for males and females. The SPSS software (v. 17.0) was used to obtain basic life table estimates. The analysis considered individual data, which were aggregated by 5-year intervals. Terminal events (deaths) and censored cases (ends of observation) were summed at each 5-year age interval. Mortality rates (m_x) directly derive from the software outputs and were estimated according to the exact exposure time of the individuals involved (exact age at death and at censoring). Life expectancy estimates instead were estimated from the basic life table functions provided by the software. For infants below age 5 years, the formulas used for a_0 come from adapted values from Coale and Demeny (1983, cited by Preston et al., 2001) for West model life tables as proposed by Preston et al. (2001). For both Italian and Villagrande Strisaili life tables, open age category at 80 years was estimated adopting formulas suggested by Preston et al. (2001: 48) and by the Human Mortality Database Protocol for Cohort Life Tables (Wilmoth et al., 2007).

Due to the limited size of the Villagrande Strisaili population, all birth cohorts in the period 1872-1910 were analysed as a unique group, using the mean value of the selected life table function for all birth cohorts. The analysis considered the overall mortality level in the two populations, without controlling for other variables. This choice is for some aspects controversial, as it assumes that the survival experience of individuals born over a period of about 40 years is similar and does not take into account the possible confounding effects of individual characteristics and/or cohort experience. However, prior analysis of birth cohort data from Villagrande Strisaili showed that, despite no observation of a secular trend in survival among decennial cohorts, mortality differentials between cohorts were limited to adult ages and shown not to have impacted on the ageing process (Salaris, 2014).

5. Results

5.1. Comparison of mortality rates

Table 2 reports age-specific mortality rate estimates from birth to age 80 years for Italy and Villagrande Strisaili by sex. The reported rates refer to the average mortality risk at each time interval. Mortality estimates in the two populations converge and intersect in different points but among them two points deserve particular attention as differences proved to be statistically significant. Crossovers are detected in correspondence of curves' intersection (Figure1, Figure 2).

Table 2. Mortality rates (m_x) comparison for Italy and Villagrande Strisaili birth cohorts by age and by sex

Age	MALES			Age	FEMALES		
	Italy	Villagrande Str.			Italy	Villagrande Str.	
	mx	mx	se		mx	mx	se
0-4	0.0800	0.0542	0.0035	**0**	0.0760	0.0585	0.0037
5-9	0.0078	0.0097	0.0016	**5**	0.0083	0.0105	0.0018
10-14	0.0036	0.0085	0.0015	**10**	0.0043	0.0055	0.0013
15-19	0.0061	0.0095	0.0017	**15**	0.0057	0.0041	0.0011
20-24	0.0118	0.0164	0.0023	**20**	0.0067	0.0094	0.0017
25-29	0.0093	0.0076	0.0016	**25**	0.0065	0.0081	0.0017
30-34	0.0080	0.0092	0.0018	**30**	0.0063	0.0085	0.0017
35-39	0.0076	0.0059	0.0015	**35**	0.0060	0.0067	0.0016
40-44	0.0079	0.0073	0.0017	**40**	0.0060	0.0077	0.0017
45-49	0.0088	0.0103	0.0021	**45**	0.0062	0.0072	0.0017
50-54	0.0114	0.0053	0.0015	**50**	0.0077	0.0049	0.0014
55-59	0.0161	0.0102	0.0022	**55**	0.0105	0.0094	0.0020
60-64	0.0239	0.0128	0.0025	**60**	0.0156	0.0131	0.0024
65-69	0.0362	0.0142	0.0027	**65**	0.0243	0.0170	0.0029
70-74	0.0557	0.0219	0.0035	**70**	0.0392	0.0186	0.0031
75-79	0.0866	0.0533	0.0060	**75**	0.0642	0.0332	0.0045
80+	0.1334	0.0465	0.0064	**80**	0.1031	0.0636	0.0069

Figure 1. Mortality rates (m_x) comparison for Villagrande Strisaili and Italy for female birth cohorts (in logarithmic scale)

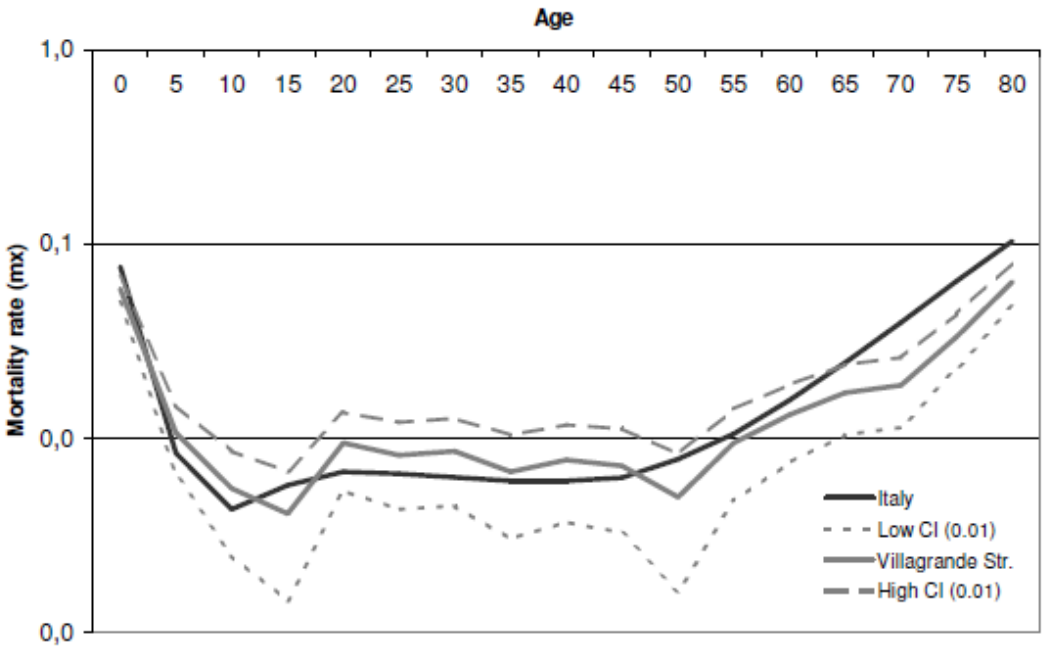
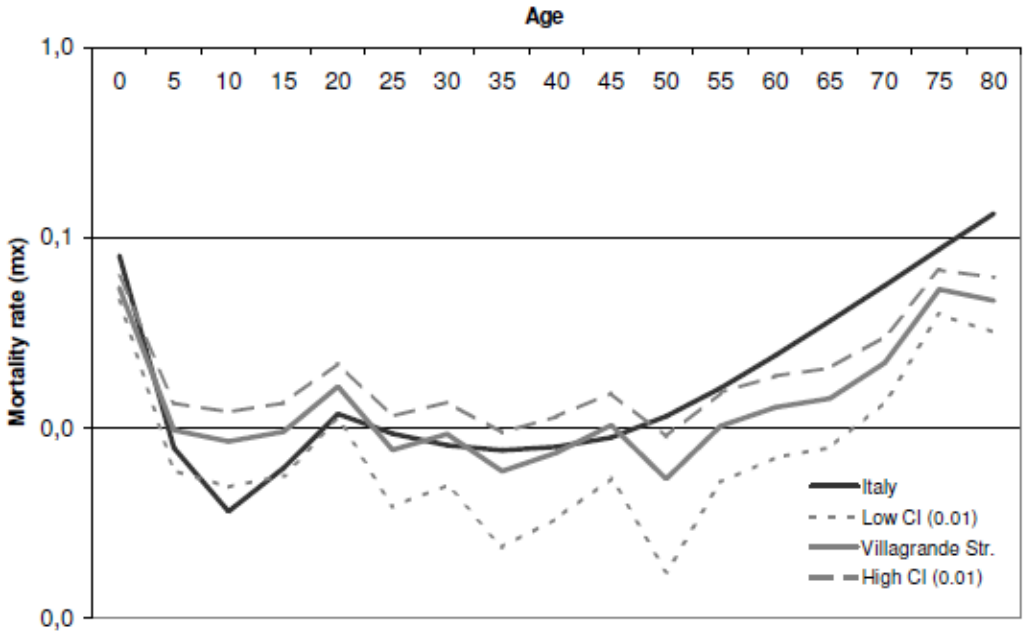


Figure 2. Mortality rates (m_x) comparison for Villagrande Strisaili and Italy for male birth cohorts (in logarithmic scale)



The first intersection point for both males and females is observed in correspondence of age 0 to 4 years old, noting that the risk of death in the first four years of life is lower in Villagrande Strisaili than in Italy. Italian male birth cohorts record 32.3 percent higher mortality rates than their peers born in Villagrande Strisaili, while for females this difference is 23.0 percent.

What appears particularly interesting is that after 5 years old, a worsening of survival conditions in Villagrande Strisaili, compared to the national estimates, is clearly observed. This change proves to be particularly marked for males, who from age 5 to age 20 years in Villagrande Strisaili have increased risk of death. At age 10-14 years the difference in mortality rate are statistically significant and Villagrande Strisaili males experience a 134.3 percent higher risk of death than their national peers.

The mortality rates trend during young adulthood do not markedly differ in the examined populations and estimates converge to similar values. In consequence the proportion of newborns that reach 50 years old is similar in both birth cohorts in Italy and in Villagrande Strisaili: in Italy 47.4 percent of males and 52.1 percent of females; in Villagrande Strisaili 45.1 percent of males and 52.1 percent of females.

Relevant differences again emerge at the onset of ageing when a second relevant crossover can be observed. At age 50 years mortality starts to grow exponentially in both populations and for both sexes. In general, the risk of death for individuals in Villagrande Strisaili is lower than for their national peers. For females, we observed that until age 50 years Villagrande Strisaili records a higher mortality risk and after intersection it experiences a reduced susceptibility to mortality. However, differences between the two populations are not particularly marked and become statistically significant (p-value = 0.01) only after age 65 years. As figure 2 shows, differences between males are particularly marked from age 50 years onwards, and as a person ages the risk of death in Villagrande Strisaili is lower than in Italy. Differences from age 55 years are statistically significant (p-value = 0.01) and are estimated to be 37 percent higher for the Italian population than for Villagrande Strisaili.

5.2 Differences in life expectancy

Figure 3 and Figure 4 show life expectancy (e_x) estimates for Villagrande Strisaili and Italian birth cohorts from birth to 80 years, respectively for females and males. Although differences might appear limited (especially between females), the values represented according to the second y-axis on the right side of the graphs show more clearly when and how the two populations differ in terms of survival.

Figure 3. Female life expectancy estimates for Villagrande Strisaili and Italian birth cohorts (1872-1910)

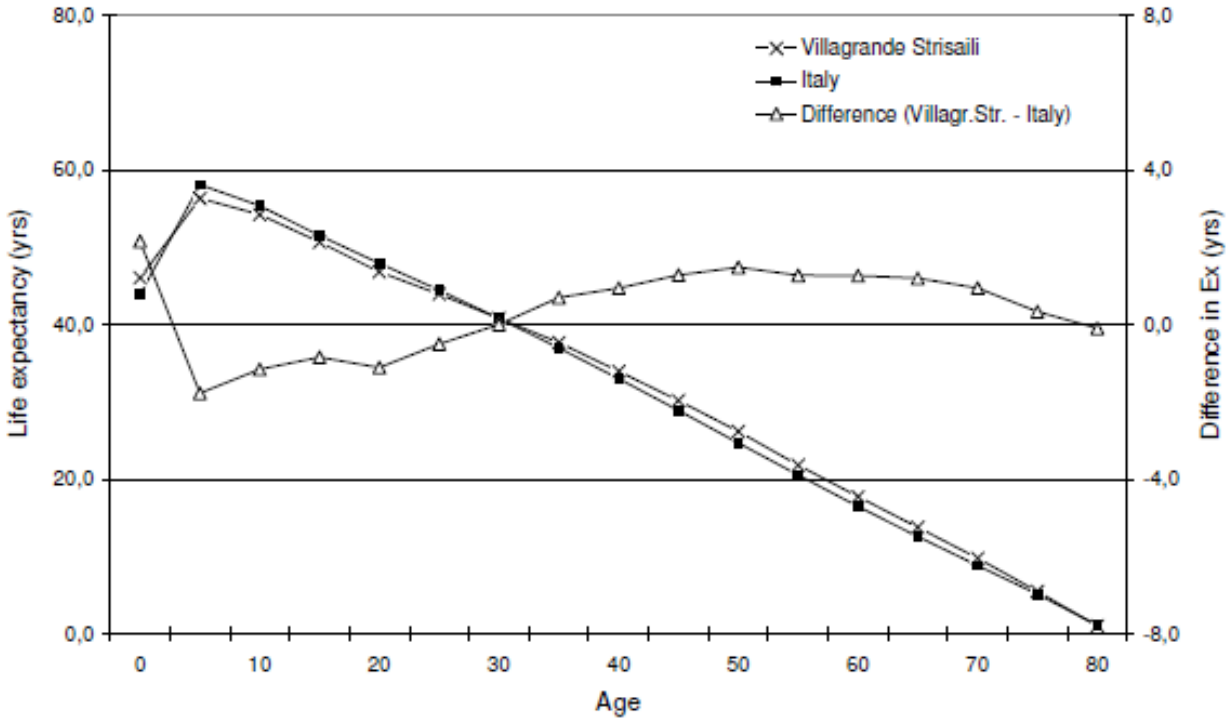
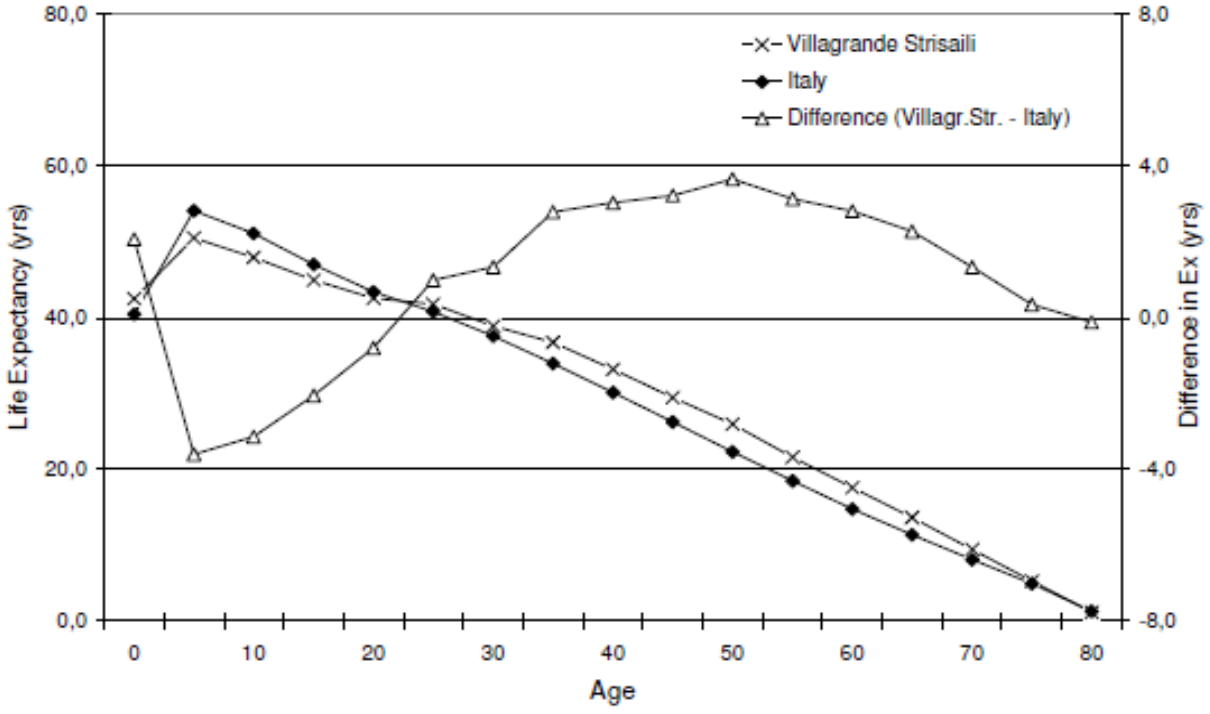


Figure 4. Male life expectancy estimates for Villagrande Strisaili and Italian birth cohorts (1872-1910)



Life expectancy (e_x) at birth for females is 46.1 years for individuals born in Villagrande Strisaili and 43.9 years for their Italian peers. For males, in Villagrande Strisaili an e_x value of 42.5 years and for Italy 40.4 years are recorded, underlining a slightly higher life expectancy at birth in Villagrande Strisaili than in Italy. At birth, differences are 2.2 years for females and 2.1 years for males.

At age 5 years females have an e_x of 56.3 years for Villagrande Strisaili and 58.1 for Italy, while among males e_x at the same age is 50.5 years for Villagrande Strisaili and 54.1 years for Italy. Differences are from 1.8 years among females to 3.6 years among males and this produces an intersection of the two e_x curves at 5 years old. From age 5 years to adulthood (20-30 years) e_x estimates for the Italian population are higher than for Villagrande Strisaili and the two e_x curves intersect at age group 20-25 years for males and at age group 30-35 years for females. This higher mortality recorded in Villagrande Strisaili during this age period could be the result of a postponement of early death. Therefore, the survival advantage recorded in Villagrande Strisaili in the first year of life – as evidenced in the analysis of mortality rates - is not maintained at subsequent ages, but generates an excess mortality during the transition from childhood to adulthood.

Since the crossover point between the e_x curves of females is at 25 years, Villagrande Strisaili and Italian birth cohort estimates proceed as two parallel lines. At age 50 years the highest difference is recorded in the two populations and e_x of females in Villagrande Strisaili exceeds estimates for the female Italian population by 1.5 years. Differences are more marked for males, where the crossover occurs earlier at age 20 years. Starting from that age the excess of life expectancy of Villagrande Strisaili males varies from 1.0 years at 25 years and reaches a maximum at age 50 years when the difference between Villagrande Strisaili and the Italian population is 3.7 years, suggesting that the two populations greatly differ at the onset of the aging process.

6. Discussion

The adoption of a longitudinal perspective for the study of mortality differential between a long-living community in Sardinia and the Italian population confirms prior findings which pointed out that at more advanced ages the two populations present a different level of susceptibility to mortality (Caselli & Lipsi, 2006; Poulain et al., 2011). However, the differences are shown not to be limited exclusively to the oldest old ages.

Firstly, the results of this analysis show that the inclusion of all age groups, from birth to 80 years old, allows us to detect the occurrence of two relevant points of crossover. On the one hand, this result points out differences in mortality variations during the life course in the examined populations, but - on the other hand - it calls into question the appropriateness of a comparison of populations so different in size, as well as the quality of the data (Coale & Kisker, 1986; Scherbov & Ediev, 2011). With respect to the first factor, the available period data on general mortality level shows that the mortality experiences of the examined populations have similar profiles (Salaris, 2014). There are no significant differences in the impact of important historical events like WWI, WWII and Spanish flu epidemic (Tognotti, 1996; Cannas, 2007; Salaris, 2010). Moreover, the examined birth cohorts - despite the observed differences in early and young adult mortality - record similar proportions of survivors that reach 50 years old.

The first crossover occurs in the first years of life. At age 5 years differences in life expectancy are of 1.8 years for females and 3.6 years for males, lower in Villagrande Strisaili compared to Italy. A second marked intersection takes place at age 50 years, where differences are respectively of 1.5 years for females and 3.7 for males, but this time life expectancy is higher in Villagrande Strisaili compared to national estimates. The observed differences in mortality in the first years of life raise questions about data quality and in particular about the possible distorting effect of errors in registration of stillbirths and infant deaths. As discussed in detail in section 4, on the one hand it is not possible to exclude this type of bias (Breschi et al., 2012) as so far, given the poor living conditions experienced on the island at the turn of the 20th century, it is difficult to find a convincing explanation for this phenomenon of low early mortality. However, on the other hand, numerous studies at the macro and micro levels have confirmed the particularly favourable situation for early survival in Sardinia and the good quality of the data (Coletti, 1908; Bellettini, 1987; Pozzi, 2000; Gatti, 2002; Salaris, 2010). To overcome possible

biases in early mortality estimation in Villagrande Strisaili, individual data on possible cases of under-registration of births and related deaths as well as the effects of migration flows were carefully examined.

The second crossover point takes place at age 50 years and this result appears to be robust with regard to data, as it depends on ageing mechanisms of survivors. The data used for Villagrande Strisaili was submitted to a rigorous validation procedure to avoid cases of age misreporting and to achieve the maximum level of complete information on survival, assuring good quality of the data we used. This allowed us to exclude the occurrence of a false crossover related to poor data coverage, completeness and quality.

Secondly, in this study the observed differences in mortality rates suggest that a possible explanation of differential mortality and crossover might be related to selection processes, timing and dynamics. In this perspective the longitudinal approach turns out to be particularly useful to better understand mortality age variations across the life course in the examined populations.

The occurrence of first crossover – observed in the first years of life – might be explained by what happens after age 5 years. In Villagrande Strisaili, in fact, from age 6 years to adulthood an excess mortality of its population particularly for males compared to Italy is observed. This means that the postponement effects of early mortality from the first two years of life to subsequent ages observed by numerous researchers on Sardinian data until age 5 years – the conventional limit for the study of child mortality - in actual fact also continues after this age. The initial favourable conditions for children that have been observed in Sardinia prove therefore to be temporary. This result might be explained by the changing attitude that parents in Sardinia had towards their children once they reached 2 years old as documented by Coletti (1908). The author reports that children experienced an obsessive care in the first years of life, but were almost left alone once independently starting to move and talk. In general, there was a large labour participation of children who worked alongside their parents or, if needed, for other families (Salaris 2013). This leads to the hypothesis that the detected differences in the first years of life and the subsequent crossover may be explained by the timing of the elimination process of frail individuals in the two populations. In the Italian population the elimination of frail individuals takes place in the first years of life, while in Villagrande Strisaili it starts from the second year of life and more markedly from age 6 years to adulthood. The doubtable low level of mortality recorded in Villagrande Strisaili therefore corresponds in reality to an excess mortality at subsequent ages that balances the level of mortality in the two populations and makes mortality risk converge to similar values in both populations since at age 50, i.e. at the onset of the aging process, they record close proportions of survivors.

The occurrence of the second point of intersection in both sexes at age 50 years shifts the attention to the ageing process. In Villagrande Strisaili a mortality deceleration can be observed, and individuals are eliminated at a lower rate compared to their national peers, with differences being more marked for the male population. Selection processes due to ageing mechanisms prove to differ in the examined populations, occurring in Sardinia during a longer period of time and at a slower pace than that observed at early stages of life. Only a life course perspective allows us to observe this result.

Thirdly, in view of the identified mortality differentials it is appropriate to reflect on the possible explanation for these differences and the occurrence of crossovers, which in the literature are generally attributed to ethnicity/race and/or specific causes of deaths (Nam et al., 1978; Nam, 1995; Hummer, 1996; Corti et al., 1999; Johnson, 2000; Hill et al., 2000; Lynch et al., 2003; Thornton, 2004; Stansbury et al., 2005). In the Italian context, it seems more opportune to reflect on genetic differences, rather than on race. From a genetic point of view, Sardinia differs considerably from other European populations (Cavalli-Sforza et al., 1997) and the persistence of these differences to the present has certainly been favoured by its geographical isolation (Sanna, 2006). Genetic studies point out that genes certainly play a role in the aging process, whether these genes are longevity genes or genes involved in the control of age-related diseases (Cadore et al., 2006). In general, the effect of genes was shown not to remain stable but rather to determine a certain level of susceptibility to specific diseases and to death (Christensen et al., 2006). Accordingly, it is plausible to hypothesize that the Sardinian

population could have favourable genes for a successful aging process in their genetic pool, which implies a reduced susceptibility to certain causes of death (Pilia et al., 2006; Poulain et al., 2011).

Differences in the epidemiological profile between Sardinia and the mainland can be traced back to the past as, according to period data from Unification until the first decades of the 20th century, Sardinia was, with Piedmont and Liguria, one of the regions that recorded better survival estimates at adult ages (i.e. at ages 25-64 years and 65 years and over), particularly with regard to the male population (Caselli, 1987). The available data on mortality by cause for the period 1888-1891 and 1908-1912 allows us to stress that in Sardinia, compared to the national framework, if we exclude the high incidence of deaths due to malaria, lower standardized rates were registered for circulatory system diseases, vascular lesions, and cancer (Pozzi, 2000).

According to more recent investigations, a low level of mortality due to cardiovascular diseases (CVD) at age 80 years and over is recorded in Sardinia (Caselli & Lipsi, 2006). The role of CVD emerges also in the work of Muntoni et al. (2009) who point out that in spite of the increasing levels of several risk factors (i.e. high blood pressure and smoking habits) mortality for CVD in Sardinia remains low. Undoubtedly the lower incidence of CVD, and related deaths, cannot represent the only cause of "advantage survival" in the aging process of the Sardinian population compared to the mainland, but it certainly plays an important role. However, the findings of this study refer to overall mortality and this does not allow us to speculate further on the possible role of cause specific mortality.

Although the effects of genetics and causes of death are the most investigated, differences in survival cannot be attributed to these two factors alone, but - as demonstrated in numerous studies focusing on different populations around the world – rather appear as the result of a more complex process where the contribution of factors such as lifestyle, physical activity, nutrition, social and family context, religion, external events and physical environment, have been demonstrated to affect individual health status and survival.

Finally, looking at the overall results it is possible to highlight the value of a longitudinal perspective which provides new insights in the interpretation of differential mortality when Sardinia and Italy are compared. It allows the comparison of the survival trajectories of cohorts experiencing the same historical conditions at the same age (Wilmoth et al., 1990). The use of cohort and/or period-cohort data in fact permits better detection and description of differences between populations or subgroups, because parallel life histories and time effects can be considered (Caselli & Capocaccia, 1989). Particularly, the birth cohorts examined in this study represent those generations that have greatly benefited from changes and improvement in life style in general and medical treatment in particular, unconsciously participating in the epidemiologic transition that has characterized the history of many developed countries during the last century. Understanding the timing of significant changes during the life course provides useful indications of the relevant turning points in the contextual and historical time on which to focus further insights.

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Vulnerability as a heuristic concept for interdisciplinary research: assessing the thematic and methodological structure of empirical life course studies

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Abstract

Changes in human lives are studied in psychology, sociology, and adjacent fields as outcomes of developmental processes, institutional regulations and policies, culturally and normatively structured life courses, or empirical accounts. However, such studies have used a wide range of complementary, but often divergent, concepts. This review has two aims. First, we report on the structure that has emerged from scientific life course research by focusing on abstracts from longitudinal and life course studies beginning with the year 2000. Second, we provide a sense of the disciplinary diversity of the field and assess the value of the concept of 'vulnerability' as a heuristic tool for studying human lives. Applying correspondence analysis to 10,632 scientific abstracts, we find a disciplinary divide between psychology and sociology, and observe indications of both similarities of—and differences between—studies, driven at least partly by the data and methods employed. We also find that vulnerability takes a central position in this scientific field, which leads us to suggest several reasons to see value in pursuing theory development for longitudinal and life course studies in this direction.

1. Introduction

The study of human lives has become one of the most progressive areas of social science research over the past quarter-century, spreading across the social and behavioural sciences. With this change has come an acknowledgement that human personality and social pathways in transforming societies develop over a long stretch of time (Elder, 1994; Mayer, 2009). From this 'long way of thinking' (Elder, 1994, p. 4) has emerged a longitudinal and life course perspective that is tied to major progress in longitudinal data collection (Mayer, 2009). Longitudinal and life course analysis today has extended across disciplinary boundaries and specialty areas within particular disciplines (in developmental psychology see, e.g., Bronfenbrenner, 1979; in social history see, e.g., Elder, 1994; and in gerontology see, e.g., Streib & Binstock, 1990). We sympathise with the idea that the study of the life course is a progressive field with some degree of intellectual unity (Butz & Torrey, 2006), but too often it is still pursued within fragmented disciplines.

Now entering its stage of maturity, Mayer (2009) concluded in his seminal work that progress in longitudinal data collection and methods has driven disciplines toward greater methodological convergence in their studies of social phenomena across the life course. Moreover, longitudinal methods motivated the study of the life course from distinct or even disparate intellectual territories. However, the newly existing data

sources, new methods, and potential new theory development call for a more profound assessment of larger populations over a longer stretch of time, and a systematic examination of the whole life course within and across different domains and within and across institutional contexts.

Our article has two research aims. Research Aim 1 is to empirically assess whether life course studies share thematic and methodological common ground, in terms of topics covered, life stages studied, and methods used. The Research Aim 2 is to assess the current use of the concept of vulnerability in life course studies. By now, there is consensus among life course scholars that theory development beyond orienting concepts has not yet lived up to its full potential (e.g., Elder, 1985; Mortimer & Shanahan, 2003; George, 2003; O'Rand, 2006; Heinz & Marshall, 2005; Settersten, 2003), and that the lack of interdisciplinary concepts is all the more important to scientific progress as more new data sources and longitudinal methods are available (Mayer, 2009). Giving credit to these arguments, we assess whether the concept of vulnerability can be a viable heuristic for interdisciplinary life course research: We assess how frequently this concept is used and, more importantly, we position it into the field structure that we have explored in the first research aim, to assess whether it is used equally in terms of making reference to the same concept in the different disciplines.

We understand vulnerability as a lack of resources or as a social weakness (Ranci, 2010). Spini, Hanappi, Bernardi, Oris, & Bickel (2013) suggested that, for individuals or groups that are in a zone in which functionality is only secured at the limits of available resources, vulnerability may be manifested if the individual or group is challenged by critical events or depleted by chronic stresses or environmental pressures. Until the limits of available resources have no observable adverse consequences, vulnerability often remains latent. Other concepts, such as insecurity, relate to well-defined insecurities; for instance, job insecurity relates to job instability and employment precariousness (Elman & O'Rand, 2002). There is general agreement that this concept mainly refers to the perception that one's current job might be lost (Esser & Olsen, 2011) and such perception increases feelings of powerlessness and a lack of control (Greenhalg & Rosenblatt, 1984). The concept of risks has received considerable attention in the last decade in the social sciences after the publication of the book entitled *Risk Society* by Beck (1992). Risks are indeed associated with vulnerability, but the terms are not synonyms. Following Sirven (2007), risks are expressed by the probability that an event occurs whose consequences are generally known (for a main definition of risk see, e.g., Knight, 1921). He describes risks as the conjunction of a particular event that might possibly occur and people's vulnerability to experience such an event. Following this perspective, we can describe vulnerability in terms of what can happen to a population, given that certain events occur (i.e., events shape vulnerability), whereby the occurrence of such events is influenced by people's vulnerability itself (vulnerability shapes the probability of an event or hazard, as Sirven states).

Moreover, this concept is inextricably linked with human development at the intersection of the biological, psychological, and social domains (Baltes, Lindenberger, & Staudinger, 1998; Armingeon & Bonoli, 2006; Bronfenbrenner, 1989; Heinz & Marshall, 2005; Kohli, 2007). We restrict ourselves to dimensions of 'vulnerability' that pertain more broadly to social science in contrast to the biological or corporeal aspects of human development. We further exclude the medical and epidemiological studies for the same reason.[1]

Previous applications of the concept of vulnerability can be found in various fields. However, studies have used a range of sometimes complementary, sometimes divergent concepts to express the various aspects of 'vulnerability' (e.g., Pearlin, 1989; Bronfenbrenner, 1989; Lyonette, Crompton, & Wall, 2007; McNamara, Pitt-Catsouphes, Matz-Costa, Brown, & Valcour, 2007; Scherer, 2009). In the study of 'new social risks', scholars have repeatedly associated vulnerability with family discontinuity and labour market uncertainty (e.g., Armingeon & Bonoli, 2006; Esping-Andersen, 1990; O'Rand, 2003; Hanappi, 2011; Western, Bloome, Sosnaud, & Tach, 2012). Related studies can be divided into two fields: One that emphasises the fact that individualisation trends cause new responsibilities, hardships, and stress in the life course (Kohli, 2007; Ehrenberg, 1995; Martucelli, 2006). The second field proposes that individualisation tends to be overstated because, according to empirical research, individual

risks have not replaced the risks that were experienced by entire social classes. In Ireland, Whelan and Maitre (2013) find significant interactions between social class and the life-cycle - generating poverty and risk patterns of economic vulnerability - a result that is largely confirmed by a cross-sectional analysis of Ireland, the United Kingdom, Denmark, Finland, Austria, Belgium, France, Germany, and the Netherlands (Pintelon, Cantillon, Bosch, & Whelan, 2013). Likewise, in a study using event history analysis of the European Community Household Panel, Vandecasteele (2011) found structural and biographical explanations of poverty to be complementary and pointed to major poverty-triggering events such as childbirth or job loss. In the welfare state literature, the concept of vulnerability has been used to point to state insufficiencies in providing adequate solutions to social problems (Esping-Andersen, 2002; Safarti & Bonoli, 2002; Esping-Andersen, 2009). In sum, concepts that account for the vulnerabilities of groups and individuals are at the intersection of domains such as work and family in a dynamic way—across human lives. That is why we consider such concepts to be particularly promising for advancing life course research.

We empirically assess the thematic and methodological structure of life course studies by the use of correspondence analyses and provide an overview of topics and life stages covered and methods used in this field of research. Unlike classic literature reviews, empirical literature assessments based on correspondence analysis do not require prior interpretative techniques. This makes them a very flexible and efficient tool for assessing the semantic structure of any research domain. We also identify the locations of research on vulnerability in/across various disciplines, thus expanding upon noteworthy literature reviews that focus on one specific research area (e.g., Walsh, 1996; Paugam, 2000). We give preference to scientific material published since the year 2000, to empirical research applying longitudinal designs to study changes in human lives over a longer stretch of time or over the duration of a lifetime, or to those that focus on particular episodes (such as the transition to employment) or narrow life phases; we also include cohort studies (rather than cross-sectional designs), studies on changes of lives within or across life domains, and studies that treat life course development as an outcome of personal characteristics and institutional or structural conditions. Finally, we add studies that locate human lives in community contexts, kinship structures, or families.

This paper is organised in three sections. In the next section, we explain how we obtained our data and describe the method that we used. In the subsequent section, we provide a shorthand overview indicating how sociologists, developmental psychologists, demographers, social historians, and gerontologists have applied a life course perspective to understand changes in human lives. For this purpose, we illustrate the location of the themes covered, methods, and data in the respective semantic field space. In the remainder, we provide a first attempt, on the basis of that evidence, to address Research Aim 1, regarding thematic and methodological common ground in empirical life course studies, and Research Aim 2, which investigates the value of 'vulnerability' as a heuristic concept that can contribute to further progress in life course studies.

2. Method and data

2.1 Correspondence analysis

We use correspondence analysis, which is a multivariate technique commonly employed in sociology (Bourdieu, 1977) and used for exploring textual data (Lebart & Mirkin, 1993, Lebart, Salem, & Berry, 2010; Benzecri, 1992; for applications see, e.g., Mussino & Bernardi, 2010; Spini, Elcheroth, & Figini, 2008; Salamin & Hanappi, 2014). It is a descriptive/exploratory technique to analyse simple two-way and multi-way tables containing some measure of correspondence between the rows and columns. The results provide information that is similar to factor analysis techniques, and they allow for the exploration of the structure of categorical variables. It is a technique for describing contingency tables (or cross-tabulations) and certain binary tables (also known as presence-absence tables) (Lebart & Mirkin, 1993; Greenacre, 2010).

We apply this technique to explore the thematic and methodological structure of empirical life course studies. In our analysis of scientific article abstracts, we construct a cross-table of frequencies by using the aforementioned disciplines in columns, and themes or methods in rows. Each cross-tabulation of frequencies is first standardised so that frequencies across all cells sum to 1.0.

Subsequently, our goal is to represent the entries in the table of relative frequencies in terms of distances between individual rows and columns. The use of this technique allows for exploration of the simultaneous contribution of themes, methods, and disciplines in the structuring of the research field. The topography of the field emergent from the year 2000 and after shows each theme or method positioned with respect to all of the others (Greenacre, 2010).

2.2. Data

Our data covers journal article abstracts from longitudinal and life course research in the social sciences from several categories: first, studies with samples composed of vulnerable populations only (for migration see, e.g., Korinek, Entwisle, & Jampaklay, 2005; for depression see, e.g., Brockman, 2010; Kort-Butler, 2009; for elderly populations see, e.g., Brockmann, 2010; Ha, Carr, Utz, & Nesse, 2006; for precarious populations see, e.g., Gangl, 2002; Brady, 2006); second, studies that compare vulnerable populations with the 'average' population (e.g., Klimstra, Luyckx, Hale, Goossens, & Meeus, 2010; Agree, Meoni, & Klag, 2010); and, third, studies that identify resources, factors, and processes that cause or result from vulnerability (e.g., Hofferth & Goldcheider, 2010; Hank, 2005; Dunbar et al., 2006). In addition, some contributions include only specific sets of actors in their samples (e.g., adolescents, families, women, and workers), but focus on issues related to vulnerability (e.g., social exclusion, unemployment, and divorce) and, thus, have been included in our data (e.g., Brady, 2006; Friedman, Steinwachs, Temkin-Greener, & Mukamel, 2006; Drenteea, Clay, Roth, & Mittelman, 2006). Consistent with the life course perspective (e.g., Mayer, 2009), only articles adopting a longitudinal/dynamic approach have been included, that focus on situations and processes of vulnerable populations or of populations rendering them resilient or vulnerable.[2] Studies that mention cross-sectional designs have been excluded from this literature search.

Articles from academic and specialised journals have been considered and retrieved from two main bibliographic databases: (1) the *PsychINFO* database, which is an abstracting and indexing database with more than 3 million records devoted to peer-reviewed literature in the behavioural sciences and mental health; and (2) the *FRANCIS* database, a 2.6 million-record, bibliographic database covering humanities and social-science topics from an international perspective. The *FRANCIS* database covers also articles from the disciplinary database Sociological Abstracts, and other related areas such as education, employment, and training. The main search keys have been agreed upon by all authors in consultation with two additional experts in the field (i.e., sociology and social policy, gerontology, demography, psychology, and economics). The list of search keywords applied in our article is summarised in Table 1. The first column includes relevant themes related to vulnerability (Terms 1), while the second column lists methods or typical methodological terms indicating longitudinal designs (Terms 2).

Table 1. Summary of key search terms as they were searched in the databases

Terms 1 (themes)	**Terms 2 (methods)**
e.g. depression, satisfaction, victimisation, discrimination, burnout, violence, illness, disease, deaths, elderly, stigma, nursing, negative affect, psychic disorder, cumulative disadvantage, life sequence, work, poverty, precariety, precarious, employability, employment, job, mobility, sociability, social change, profession, career, wage, earning, labor, occupation, education, school, training, income, social class, wealth, justice, uncertainty, informal economy, migration, retirement, pension, turnover, layoff, informal sector, formal sector, shadow economy, institution, family, fertility, divorce, kinship, gender, marriage, conjugal, motherhood, father, parent, spouse, couple, partner, childcare, childbearing, childbirth, childless, widow, social participation, social network, social tie, paternity leave, maternity leave, domestic responsibility, domestic task, household responsibilities, sibling, reconciliation, work-life balance, union formation, cognitive process, learning, memory, attention, motivation, emotion, consciousness, cognitive development, gerontology, interpersonal process, group process, social perception, social representation, social cognition, psychological disorder, anxiety disorder, job performance, personnel selection, skill, race, intergenerational, daily living condition, social environment, hospitalisation, morality, ability, recreation, welfare, peer groups, longevity, deviant bevavior, equal opportunity, minority, community involvement, isolation, desaffiliation, vulnerability, aging, personality, coping …	optimal matching, sequence analysis, sequence comparison, sequential pattern, sequencing, sequence model, time series, Marcovian, Marcov chain, Markov chain, Marcov model, Marcov model, event history, history, latent growth, latent curve, growth curve, life story, life calendar, diary, biographical, narrative, sequence mining, structural equation, hazard model, survival model, survival analysis, survival data, survival tree, cox model, longitudinal, prospective, retrospective, panel, transition, lifecourse, lifecycle, lifepaths, lifepatterns, lifeskills, lifespan, lifestage, lifestory, lifestress, lifestyle, trajectory, critical episodes, critical incident, critical life event, critical life events, critical movements, critical point, critical state (not "cross-sectional") …

Note. The search syntax was generated in the PSYCHINFO database and adapted for the FRANCIS database. Double extractions of identical articles found in both databases were excluded from the data. English and American spellings were accounted for. Words were truncated in a semi-automatized procedure provided by the SPAD Program to allow for word variation from the root term.

In order to reach the maximum coverage of relevant contributions, the search and extraction of articles has gone far beyond the mere one-step keyword search. The articles retrieved in the initial keyword search have been screened to identify other potentially relevant contributions for this paper and to cover the maximum possible range of methods used to study vulnerability. The initial keyword search in the two databases has resulted in a set of 20,000 articles published in 2,233 journals from all social science fields. Contributions such as literature reviews or other meta-theoretical articles, meta-analyses, short notes, and comments have been excluded. In order to limit the analysed material, we have focused on those journals that published 50% of all articles corresponding to our search criteria. This led to a cut at 26 articles published at minimum per journal in the observation period so that data from 10,632 articles entered our textual analysis, performed with the SPAD software (Coheris, 2007; see http://www.coheris.com/produits/analytics/logiciel-data-mining/). The software generated a comprehensive vocabulary and repeated segments of words, on the basis of which, subsequent correspondence analyses were performed (Appendix A lists all journals and the number of articles published in these journals) (Morineau & Aluja-Banet, 1998). Moreover, each article was coded according to its discipline category. The main categories of the discipline variable represent sociology, psychology, demography, gerontology

and ageing, general social science (which includes specific applied studies and other multi-disciplinary journals, such as gender studies), and specialised youth studies. Indeed, the discipline variable was chosen as the main criterion to plot against the original content from the abstracts, because it appeared to be the most useful in identifying emerging disciplinary divides and directions for future research (in contrast to the year variable, which was less informative). In the next section, we present two applications of correspondence analysis: the first one shows how topics which are covered in empirical life course studies and disciplines structure the research field; the second application shows the correspondence between the used methods and the main disciplines. In both models, key terms related to the concept of vulnerability and life stages have been positioned *a posteriori* in the field space. We then interpret and discuss the results of the correspondence analysis and point to promising future directions for research.

3. Results, interpretation, and discussion

We explore key research themes of longitudinal and life course studies and show how they are associated with different disciplines and where the concept of 'vulnerability' is located within the research field. The salient themes constitute the active row variables; the disciplines presented in Appendix B form the columns of a contingency table. We opted for running the analysis with most frequent repeated segments (e.g., personality disorder) in our extracted abstracts to better capture the meaning of the compound words rather than isolated single words (see also, e.g., Lebart & Mirkin, 1993; Lebart et al., 2010).

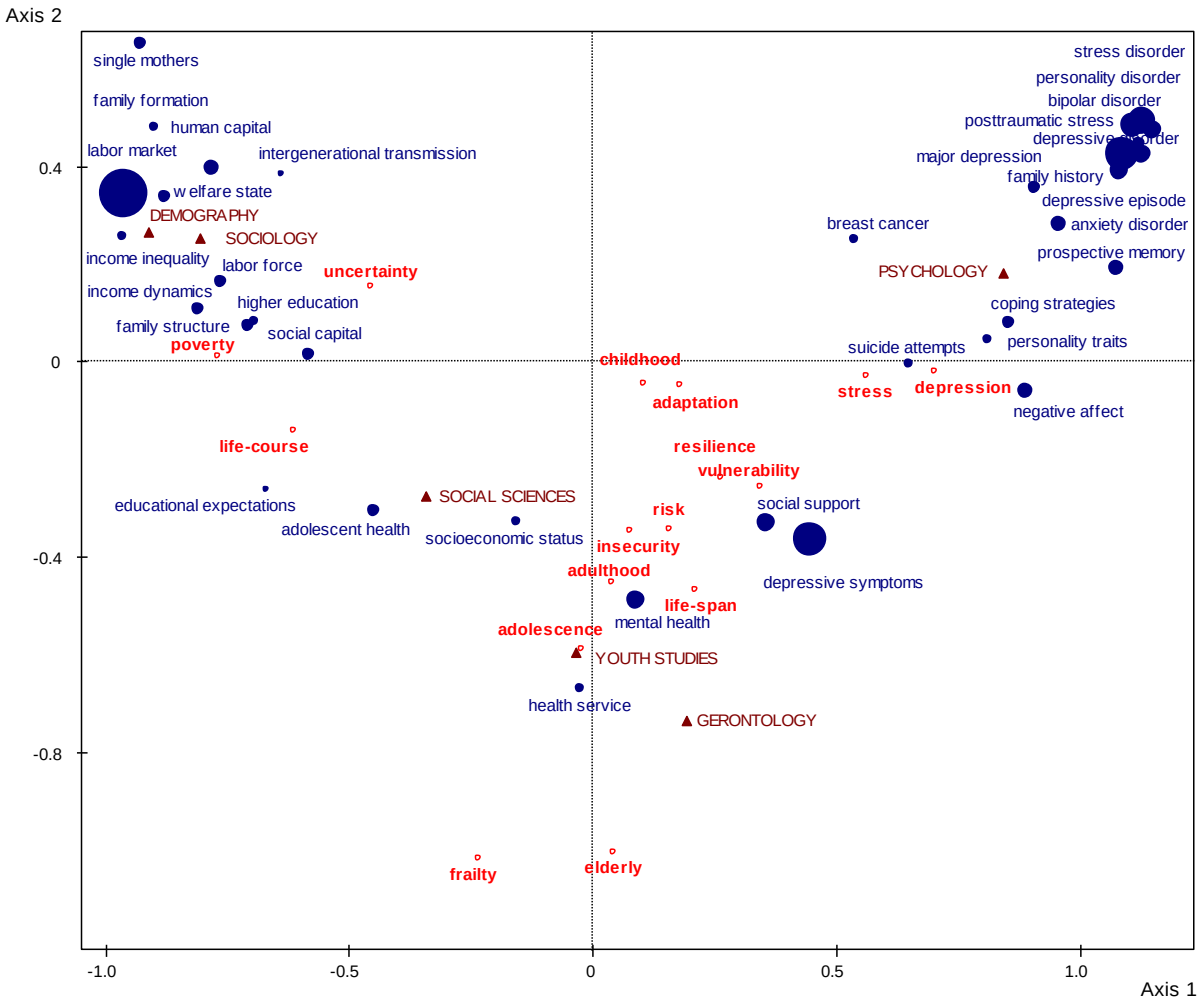
In total, 71 salient themes (i.e., repeated segments) were considered for Model 1 (Appendix B). More specifically, our analysis examines the number of times each discipline (column) coincides with particular themes (which corresponds to the value 1 for the nominal variable). It should be emphasised here that correspondence analysis, like similar methods such as principal component analysis and multi-dimensional scaling, neither generates nor requires any notion of causality between variables, instead allowing us to represent the extent to which different discipline categories "correspond" to different salient themes and the frequency of appearance of these themes in scientific abstracts. To allow for the interpretation of the detailed results, Figure 1 provides a graphical representation of the first two axes and the location of discipline categories and selected research themes in this two-dimensional space. Moreover, selected key terms (words) have been positioned *a posteriori* into the graph, depending on their potential to ease the reading of the graph; for instance, the terms childhood, adolescence, adulthood, and the elderly are indicative of the age spectrum and life course stage of the examined populations. Their computation is executed separately for each one and they do not actively construct the axes (see the boxed elements in Figure 1). Lebart (1992, p. 60) defines those variables that have only an illustrative purpose as supplementary elements.

In this first analysis, the percentages of variance of the eigenvalues were 67.5% and 15.0%, respectively, for the first two axes. Factor three carried only 9.1% of variance, followed by two additional axes with negligible inertias of 4.7% for the fourth, and 3.7% for the fifth. These results suggest a two-factor solution in which 82.5% of the overall variance of our model is explained. The overall structure of the graphical representation suggests an interpretation of the organization of the field along two main dimensions (i.e., the axes in Figure 1). We find that longitudinal and life course studies are well expressed on the first axis on a continuum from a more psychological pole to more sociological, demographic, and general social science research,[3] and youth studies. Here psychology loads positively, while all other disciplines load negatively, and gerontology and youth studies take a middle position by adopting either an interdisciplinary or disciplinary approach. It is within this distinction that the difference between themes further accentuates this disciplinary divide.

The second axis established the distinction between childhood and old age—in particular, it showed a clear succession along the axis of the different life stages, from childhood to adolescence, midlife and old age (represented here by the single term elderly)[4]. Once isolating the examined age groups of older and younger people, which are highly correlated with gerontology and youth studies, the second axis ranges from the disproportionately fast-growing epidemiological

studies that capture individual processes related to macro-structural outcomes (e.g., on mental health, health services, and social support) to individual-level research in which the standard disciplines psychology and social sciences dominate. Most interestingly, none of the salient themes (active variables) indicating the life stage of adulthood entered the most frequent words, while the opposite was true for younger and older age groups. Thus, we can assume that many abstracts deal with the life stage of adolescence, including children, or the elderly, but omit adulthood as an important stage in the life course. We briefly describe and discuss these key dimensions of longitudinal and life course research within disciplines below.

Figure 1. Simultaneous representation in correspondence analysis of disciplines (active column variables) and themes (active row variables)



Note. The size of the circles is proportional to the number of times that the specific theme appears in the dataset.

Themes in psychology

In psychology, research focused to a large extent on vulnerable individuals suffering from bipolar disorder, depressive episodes, post-traumatic stress, or personality disorder[5]. Within the discipline we can further distinguish clinical studies and social psychological studies that are closely related to life-span psychology. One can also note that the life-span psychology is closely associated with older ages, as could be expected from its historical origins.

Themes in sociology and demography

General themes in sociology and demography focused on family formation, education (human capital), the labour market, and the welfare state. The position of life course research in the vector space showed its proximity to its American roots and its disciplinary openness for social science disciplines, such as sociology and demography, and applied research, primarily labour market and youth studies (including research on childhood).

Themes in gerontology

We found that gerontological abstracts strongly determined the second axis, as expressed by a naturally clear dedication to studying people in old age. Thus, abstracts in gerontology often studied frailty in old age and health services rather than all other life stages.

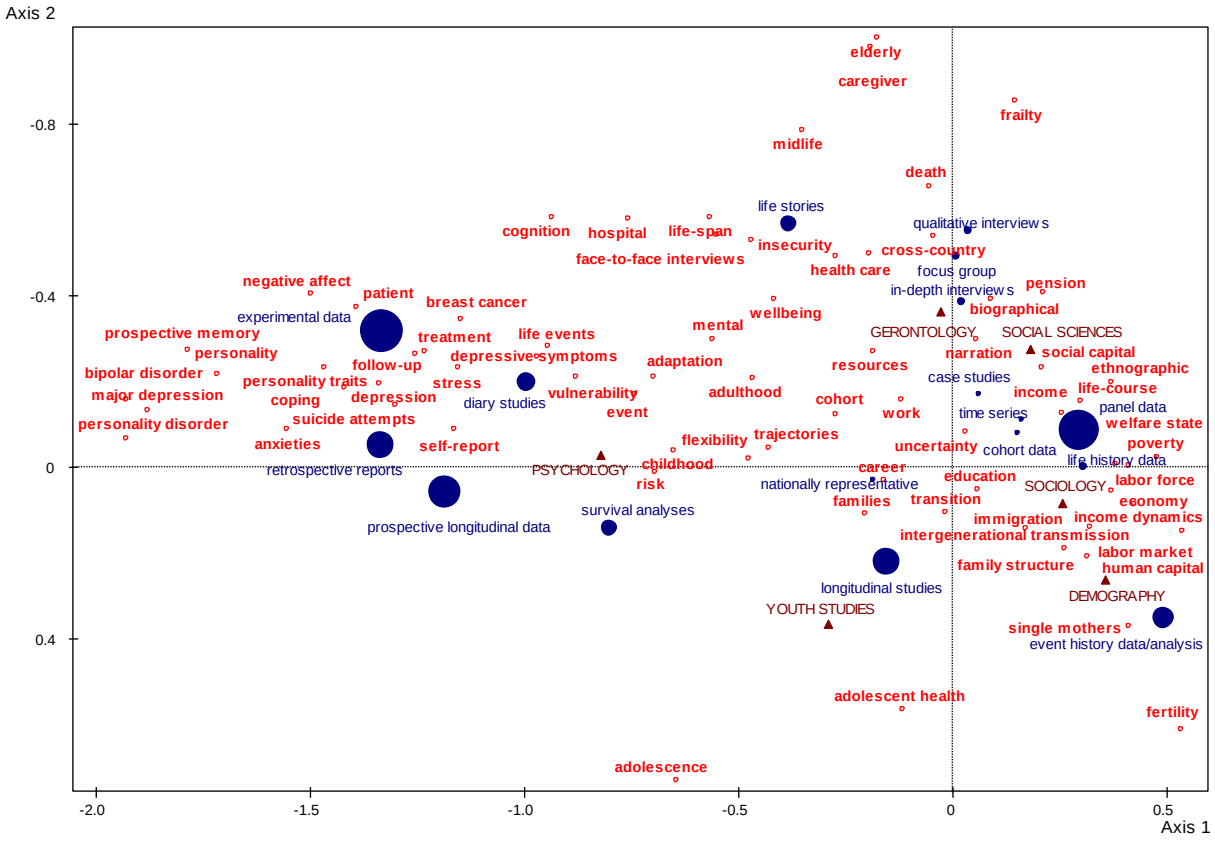
In Model 2 we explore, using the same data set, how common forms of data (active row variables) are associated with disciplines (active column variables), where the frequencies for the number of times each discipline coincides with particular forms of data (Figure 2; Appendix C). In total, 17 salient forms of data or methods entered our second model. For example, the input data would list the number of times one discipline would be related to a specific form of data, such as experimental data or panel data, and would also contain the same information for all other disciplines. For the column variables, 'psychology' determines almost 70% of the first axis, and only 0.3% of the second axis; for sociology, the corresponding values would be 15.4% and 6.0%. The second axis represents social sciences (35.9%), youth studies (27.0%), and gerontology (18.5%). For the row variables, we observe that data forms such as experimental data (indicated by the repeated segment 'control group') determine 20.8% of the first axis and only 4.3% of the second, while longitudinal data, life stories, and qualitative data mainly contribute to the second axis (the corresponding contributions are 32.1%, 17.5%, and 6.7%).

This second analysis also results in a two-factor solution: the first factor explains 65.1% of the model variance, followed by 17.9% for the second (see also Appendix C). The other three axes carry altogether less than 20% of the total variance; thus, they are dropped from the analyses and graphical representation. The overall structure of the graphical representation suggests an interpretation of the field structure along two main dimensions (i.e., axes in Figure 2). We find that the first axis spreads along a continuum that ranges from the analysis of small samples, corresponding, for instance, to experimental designs on the one end to the analyses of larger samples using panel data and event history data on the other. We observe that the disciplines of psychology and sociology explain most of the variance of the first axis, while social sciences, gerontology, and youth studies make up for most of the variance of the second axis. We recall that, in Model 1, the first axis represented the disciplinary divide. Model 2 supports the findings from Model 1 by showing that this disciplinary distinction between psychology and sociology is, to some extent, driven by the data and methods used. For example, experimental data mainly used in psychology loads negatively (in the coordinates section, column 1), while panel data and all other structural forms of data load positively. In addition, we account for the different terminology used for the same analysis techniques in various disciplines. For instance, survival analyses techniques are specifically designed to estimate risks (in the lower-left quadrant, Figure 2) and are used as a synonym for event history models that are more common in sociology (in the lower-right quadrant, Figure 2). The second axis, which explains considerably less of the model variance (17.9%), aligns research areas with the use of particular data that are used to analyse relevant phenomena in the respective fields.

Oppositions among disciplines

Figure 2 illustrates that there is a core of data that forms the characteristics of the disciplines. Not all methods or data, however, are equally important in pointing out the differences by discipline. Significantly, experimental data, prospective studies, and retrospective data determine the first axis to almost 50% with a combined absolute contribution of 49.4%. These are opposed to the set of structural and panel data[6] that also load higher on the first than on the second axis. From gerontological and life-span abstracts, we see that these make use of qualitative data (e.g., life stories, in-depth interviews, and focus groups) and, to a lesser extent, use national longitudinal data sets.

Figure 2. Simultaneous representation of correspondence analysis of disciplines (active column variables) and type of data (active row variables)



Note. The size of the circles is proportional to the number of times that the specific theme appears in the dataset.

Data used across disciplines

Longitudinal data, life history, nationally representative surveys, time series, and cohort studies in particular are more likely to be equally employed across disciplines, though their relative weight varies substantially (with the cohort data label being far more employed than the life history label). However, both models show that each discipline may be more focused on specific social phenomena and mechanisms (micro vs. macro). Model 2 also shows that only the second and less important axis differentiates very specific data formats. There is a concentration of individual-level data in the upper part of the graph, where we find diary studies and experimental data (mainly used in disciplinary sub-fields, such as life-span psychology), but also micro qualitative data such as life stories, focus groups, in-depth interviews, and case study designs (mostly in gerontology and social sciences). Towards the centre of the graph, at the crossroad of the axes, we find, instead, the data formats that are most commonly used by all disciplines, such as cohort and life history data and longitudinal data from nationally representative surveys. The proximity of terms such as retrospective and prospective datasets to psychology and of event history and survival analysis to demography, respectively, seem to reflect labelling habits for similar data formats. All in all, the field provides evidence that longitudinal data especially facilitates the use of common methods of causal modelling.

Finally, to aid interpretation, we highlighted some key concepts being illustrative variables and thus having a contribution of 0 for the construction of the vector space of model 2. This enabled us to locate the key concepts between the prior identified spectrum of disciplines. The psychology pole is characterized by four main concepts: personality, disorder, depression, and coping. This result corroborates another analysis of social psychology literature performed by Spini, Elcheroth, & Figini (2008), which showed that personality was a main field of social psychology analysing individual development. On the sociological pole,

we find other concepts like poverty, migration, the labour market, education, welfare, families, work, transition, and life course. On the top of Figure 2, we find concepts associated with the elderly: frailty, life span, health care, cognition, and pension. We clearly find here main issues related to the gerontological field and the overarching theme of frailty. The latter can be defined as a health syndrome of decreased reserves and resistance to stressors, resulting from senescence, which is associated with a lack of resilience that affects individuals' capacity to recover from loss (Spini, Ghisletta, Guilley, & Lalive d'Epinay, 2007).

The concept of vulnerability, even if it stands closer to the psychological pole, has an intermediate position between the three poles (psychology, sociology, and gerontology). It is associated with the concepts of adaptation, events, trajectories, and flexibility, and the methods of daily diaries and longitudinal studies. Concerning age stages, both childhood and adulthood are closely associated with vulnerability.

4. Summary and directions for future research

This paper has two aims. One is to report on the structure that emerges from scientific life course research and related areas. For that purpose, we have focused on scientific journal abstracts of the year 2000 and after. The other aim is to provide a sense of the disciplinary diversity of the field and to make a brief assessment of the value that the 'vulnerability' concept may have in the study of human lives.

In highlighting the structure in terms of research themes that emerge from scientific life course research, our findings corroborate the argument that psychological and sociological traditions remain separated when it comes to examining issues related to vulnerability—and this is best exemplified by scientific output in life course sociology and life-span psychology (Mayer, 2009); these disciplines structure the two poles of the main axis of the correspondence analysis. The third pole is represented by gerontology, which covers the fields of ageing studies and youth studies, drawing from all the leading disciplines of the social sciences. Among the life stages—childhood, adolescence, adulthood (including midlife), and old age—we found that adulthood was the least invested period of life, whereas younger and older ages were heavily studied. In particular, many life course sociologists and lifespan psychologists have considered early and late adulthood as marked by critical transitions and events (e.g., labour market entry, transition to marriage and parenthood, entry into retirement), but thought of middle adulthood as a less turbulent period. Yet, the 'tripartite' life course is eroding and 'adulthood' as a life stage will need to be re-defined. Lives are increasingly interwoven with one another, life course transitions get postponed, unions dissolve, migration trajectories increase, and generally—with the biographization of the life course—middle adulthood will certainly deserve more attention in the future.

In exploring the emergent structure of a discipline in terms of longitudinal data and methods, this paper observes a clear divide concerning data and methods employed according to the field of study and the discipline. Prospective longitudinal studies, experimental data, and retrospective reports are clustering around the psychological pole, while household panel data, national surveys, and event history analysis are more specific for the socio-demographic pole. Gerontology appears to be more associated with qualitative methods than other poles: life stories, focus groups, and in-depth interviews. Finally, let us note that longitudinal studies, which clearly form an overarching category, bridge the discursive and theoretical spaces between psychology, gerontology, and sociology, showing that all three disciplines are concerned with longitudinal studies. In this regard, the distinction between panel studies and prospective studies may actually denote only one type of study, that is named differently in the respective traditions.

Regarding the second aim of this review, the assessment of the conceptual value of 'vulnerability', the view is that 'vulnerability' is located in the middle between the three poles of psychology, sociology, and gerontology. According to this view, vulnerability is a major concept for interdisciplinary research and potential theory development. Not only is it not yet part of the intellectual territory of any particular discipline, but also, given its closeness to the neglected middle-adulthood life stage, it is a good concept with which to start re-thinking the adult life stage. On the basis of the evidence reviewed above, we argue that longitudinal and life course studies might gain from

orienting their empirical work towards vulnerability, for at least four key reasons.

a) First, vulnerability is a micro as well as a macro concept. We can talk about individual vulnerabilities and population vulnerabilities. It also allows us to model population behaviour as individual and group responses to structural forces (e.g., changed risk structures) and normative pressures. Central to the concept of vulnerability is the idea of how individuals, groups, and entire populations can adapt to life circumstances, overcome adversities, or recover from them by making use of resources they have or that are made accessible to them. As such, adopting the vulnerability concept can help bridge the disciplinary divide between, in particular, psychological life-span and sociological life course research, and can enhance the perspectives also of demographic researchers by providing a balanced approach integrating individual, group, and macro frames.

b) Second, vulnerability has a *static* and a *dynamic dimension* (Spini et al., 2013). Its dynamic dimension provides social scientists with a heuristic to deal with dominant claims, mainly from life course sociologists, that human lives have become de-institutionalized through the *internalization* of rules and norms of conduct and behaviour. If structural contexts (institutional conditions) are shaping individual cognitive biographical scripts that guide behaviour and that exert more and more impact within individuals as they advance in age (Kohli, 2007), the study of vulnerability allows a dynamic multi-level approach. For instance, various demographic behaviours (e.g., fertility, mortality, and migration) can be modelled by assigning time-varying, life course, and group-specific weights to individual characteristics, ideational factors, and institutional conditions.

c) Third, analysing different forms of behaviour (social, economic, and demographic) and their outcomes benefits from the increasing availability of longitudinal individual-level data covering multiple life-stages and life-domains (e.g., education, work, family, retirement, and health). Though not exhaustive, various countries provide longitudinal data for cross-national comparison, such as Great Britain (BHPS—British Household Panel), Germany (GSOEP—German Socio-economic Panel), Switzerland (SHP—Swiss Household Panel), and the United States (The Panel Study of Income Dynamics, PSID). Here, the 'vulnerability' concept may prove a useful tool for a two- to three-country comparison rather than a simplified tool often required to enable aggregating a larger number of institutional regime types. Vulnerability may be modelled to develop country-specific causal effects with the purpose to suggest preventive policy implications and recommendations.

d) Fourth, vulnerability is commonly researched across disciplines. Health topics emerged most recently, which are closely related to morbidity and mortality. Main emerging research tracks concern the relationship between early conditions and later life health and mortality, as well as the variation of health of specific sub-groups in the population, and mortality risks by social class. Integrating the concept of 'vulnerability' in such research streams seems to be more promising than following discipline-specific approaches stressing either individual factors (such as age-specific risks) or structural factors (e.g., socio-economic determinants of health inequalities) for population studies. The fact that vulnerability accumulates across generations (Spini et al., 2007) makes it valuable for research on inter-generational transfers (as well as limited transfer or lack of transfer due to geographical mobility or parents' separation). Inter-generational vulnerability hence can be analysed as an individual or group (i.e., couple, family, or ethnic minority) response to existing social structures and chances of mobility.

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Appendix A

List of journals and number of selected articles

social science and medicine	646
journal of affective disorders	332
journal of marriage and family	308
journal of youth and adolescence	208
reflections: narratives of professional helping	199
journal of adolescent health	195
developmental psychology	183
personality and individual differences	162
social indicators research	158
the journals of gerontology. series b, psychological sciences and social sciences	153
social forces	148
journal of family psychology	146
journal of family issues	143
journal of psychosomatic research	136
children and youth services review	135
social science research	127
journal of personality and social psychology	116
social science quarterly	113
qualitative inquiry	112
health psychology (hillsdale, n.j.)	112
demography	108
journal of adolescence	103
european sociological review	96
journal of applied psychology	95
journal of health and social behavior	93
journal of abnormal psychology (1965)	90
american sociological review	90
psychology and aging	89
forum qualitative sozialforschung/forum: qualitative social research	88
journal of educational psychology	88
the gerontologist	85
ageing and society	85
journal of research on adolescence	83
international journal of behavioral development (print)	76
social science and medicine (1982)	71
sociology of health and illness	71
journal of traumatic stress	70
research on aging	69
sex roles: a journal of research	69
demographic research	68
journal of social and personal relationships	67
journals of gerontology series b: psychological sciences and social sciences	67

aids care	66
journal of personality	65
american journal of community psychology	63
sociological research online	61
sociology of education	60
family relations	60
industrial and labor relations review	57
aids and behavior	57
women's studies international forum	56
american journal of sociology	54
british journal of health psychology	54
journal of social and clinical psychology	54
journal of adolescent research	53
social problems	52
journal of occupational and organizational psychology	52
sex roles	52
international journal of sociology	51
the sociological quarterly	51
labour	50
international journal of aging and human development	50
sociology	50
families in society	50
the british journal of social work	49
marriage and family review	49
british journal of educational psychology	49
journal of family and economic issues	48
the journal of development studies	47
population research and policy review	47
gender and education	47
journal of youth studies	47
kolner zeitschrift fur soziologie und sozialpsychologie	47
work and stress	46
american behavioral scientist	46
british journal of sociology of education	46
journal of biosocial science	46
journal of personality disorders	45
journal of aging and health	45
journal of counseling psychology	45
qualitative research	45
journal of applied developmental psychology	44
reflections	44
population studies	44
journal of behavioral medicine	43
family process	43
sotsiologicheskie issledovaniya	43

european journal of population/revue europeenne de demographie	42
zeitschrift fur soziologie	42
psychology, health and medicine	42
journal of ethnic and migration studies	42
women and health	41
journal of aging studies	41
quality and quantity	41
the journal of socio-economics	41
youth and society	41
world development	41
journal of family violence	41
social service review	41
social work research	40
international journal of social research methodology	39
journal of comparative family studies	39
historical social research/historische sozialforschung	39
sociological methods and research	39
journal of social history	38
journal of contemporary ethnography	38
research on social work practice	38
advances in life course research	38
social behavior and personality	37
work, employment and society	37
journal of sociology and social welfare	37
sociological perspectives	37
memory and cognition	36
race, ethnicity and education	36
qualitative social work	36
research in social stratification and mobility	35
gender, place and culture	35
social psychology quarterly	35
canadian journal on aging/la revue canadienne du vieillissement	35
british journal of clinical psychology	34
the annals of the american academy of political and social science	34
psychosomatics (washington, dc)	34
journal of anxiety disorders	34
journal of community and applied social psychology	34
industrial relations	33
journal of divorce and remarriage	33
signs	33
health	33
health and social care in the community	33
adolescence	33
international migration review	32
suicide and life-threatening behavior	32

revista espanola de investigaciones sociologicas	32
deviant behavior	32
sociological quarterly	31
sociological spectrum	31
studies in symbolic interaction	31
stress and health	31
international migration	30
longitudinal surveys of australian youth	30
international journal of intercultural relations	30
journal of health psychology	30
psychological assessment	30
journal of social policy	30
psychopathology	30
qualitative report	29
child and family social work	29
european psychologist	29
ethnography	29
sociology of sport journal	29
social identities	28
the sociological review	28
social work in health care	28
work and occupations	28
aids education and prevention	28
sociological forum	28
women's studies quarterly	27
acta sociologica	27
culture and psychology	27
schmollers jahrbuch	27
anthropology and medicine	27
women's history review	27
qualitative sociology	27
journal of aggression, maltreatment and trauma	27
international journal of social welfare	27
applied cognitive psychology	27
gender and society	27
canadian studies in population	27
european journal of social psychology	26

Appendix B

SIMPLE CORRESPONDENCE ANALYSIS

EIGENVALUES

COMPUTATIONS PRECISION SUMMARY: TRACE BEFORE DIAGONALISATION. 0.7277

SUM OF EIGENVALUES..... 0.7277

FIRST 5 EIGENVALUES

NUMBER	EIGEN-VALUE	PERCENT-AGE	CUMULATED PERCENTAGE					
1	0.4909	67.46	67.46					
2	0.1094	15.03	82.49					
3	0.066	9.08	91.57					
4	0.0343	4.71	96.28					
5	0.0271	3.72	100					
Khi-2 TEST FOR AXIS CHOICE								
(USING USUAL THRESHOLD, YOU CAN GO TO THE FIRST TEST-VALUE > 2.0)								
NUMBER OF AXES	**STAT KHI2**	**DEG. OF FREEDOM**	**PROB. X>KHI2**	**TEST VALUE**				
1	2571.61	272	0	-41.11	*			
2	1383.57	201	0	-28.22	*			
COORDINATES, CONTRIBUTIONS OF FREQUENCIES ON AXES 1 TO 2								
ACTIVE FREQUENCIES								
FREQUENCIES			**COORDINATES**		**CONTRIBU-TIONS**		**SQUARED COSINES**	
IDEN - SHORT LABEL	**REL.WT**	**DISTO**	**1**	**2**	**1**	**2**	**1**	**2**
m1 - 1	36.45	0.74	0.84	0.18	52.60	10.90	0.96	0.04
m2 - 2	27.20	0.75	-0.81	0.25	36.00	15.90	0.87	0.09
m3 - 3	17.80	0.33	-0.34	-0.27	4.30	12.30	0.35	0.23
m4 - 4	3.90	1.78	-0.91	0.27	6.60	2.50	0.47	0.04
m5 - 5	6.43	0.91	0.19	-0.74	0.50	31.90	0.04	0.60
m7 - 7	8.22	0.82	-0.04	-0.59	0.00	26.50	0.00	0.43
SUPPLEMENTARY FREQUENCIES								
FREQUENCIES			**COORDINATES**		**CONTRIBU-TIONS**		**SQUARED COSINES**	
IDEN - SHORT LABEL	**REL.WT**	**DISTO**	**1**	**2**	**1**	**2**	**1**	**2**
m1 - 2000	3.32	0.89	-0.49	-0.07	0.00	0.00	0.27	0.01
m2 - 2001	7.03	0.34	0.00	0.14	0.00	0.00	0.00	0.06
m3 - 2002	6.76	0.22	-0.05	-0.05	0.00	0.00	0.01	0.01
m4 - 2003	7.25	0.26	-0.12	0.05	0.00	0.00	0.05	0.01

m5 - 2004	8.74	0.16	0.05	-0.02	0.00	0.00	0.02	0.00
m6 - 2005	9.73	0.12	0.05	-0.04	0.00	0.00	0.02	0.02
m7 - 2006	11.47	0.16	-0.03	-0.04	0.00	0.00	0.01	0.01
m8 - 2007	12.15	0.11	0.02	-0.01	0.00	0.00	0.00	0.00
m9 - 2008	12.92	0.16	0.11	0.02	0.00	0.00	0.07	0.00
m10 - 2009	9.82	0.30	-0.31	-0.17	0.00	0.00	0.31	0.10
m11 - 2010	13.21	0.23	0.23	0.01	0.00	0.00	0.24	0.00
m6 - 6	2.41	5.43	-0.21	-0.70	0.00	0.00	0.01	0.09
COORDINATES, CONTRIBUTIONS AND SQUARED COSINES OF CASES								
ACTIVE CASES (AXES 1 TO 2)								
CASES			**COORDINATES**		**CONTRIBUTIONS**		**SQUARED COSINES**	
IDENTIFIER	**REL.WT.**	**DISTO**	**1**	**2**	**1**	**2**	**1**	**2**
adolescent health	3.47	1.01	-0.45	-0.31	1.40	3.00	0.20	0.09
anxiety disorder	1.29	1.04	0.96	0.28	2.40	0.90	0.88	0.08
bipolar disorder	1.72	1.52	1.13	0.49	4.50	3.80	0.84	0.16
black women	0.52	1.19	-0.91	0.47	0.90	1.00	0.70	0.19
breast cancer	1.30	0.52	0.54	0.25	0.80	0.70	0.55	0.12
coping strategies	1.20	0.74	0.85	0.08	1.80	0.10	0.98	0.01
depressive disorder	0.99	1.47	1.13	0.42	2.50	1.60	0.86	0.12
depressive episode	1.21	1.36	1.08	0.39	2.90	1.70	0.86	0.11
depressive symptoms	9.87	0.36	0.45	-0.37	4.00	12.10	0.56	0.38
economic resources	0.48	0.79	-0.83	0.21	0.70	0.20	0.88	0.06
education longitudinal	0.55	0.76	-0.76	0.19	0.70	0.20	0.76	0.05
educational attainment	2.53	0.23	-0.45	0.09	1.10	0.20	0.90	0.04
educational expectations	0.50	1.99	-0.67	-0.26	0.50	0.30	0.23	0.04
european community	0.62	1.27	-1.00	0.37	1.30	0.80	0.79	0.11
european countries	0.46	0.91	-0.82	0.29	0.60	0.40	0.74	0.09
family background	0.62	0.54	-0.71	0.09	0.60	0.10	0.92	0.02
family formation	0.54	1.15	-0.90	0.48	0.90	1.10	0.70	0.20
family history	0.77	0.95	0.91	0.36	1.30	0.90	0.86	0.13
family life	0.64	0.34	-0.54	0.02	0.40	0.00	0.85	0.00
family structure	1.92	0.55	-0.71	0.07	2.00	0.10	0.91	0.01
force participation	0.72	1.19	-0.96	0.49	1.40	1.60	0.78	0.20
health service	1.18	0.69	-0.03	-0.67	0.00	4.80	0.00	0.65
higher education	1.34	0.65	-0.69	0.08	1.30	0.10	0.74	0.01
household income	0.69	0.63	-0.75	0.07	0.80	0.00	0.89	0.01
human capital	1.61	0.79	-0.78	0.39	2.00	2.30	0.77	0.20

income dynamics	1.59	0.78	-0.81	0.11	2.10	0.20	0.84	0.01
income inequality	0.60	1.27	-0.96	0.26	1.10	0.40	0.73	0.05
intergenerational transmiss.	0.56	0.68	-0.64	0.38	0.50	0.70	0.60	0.22
job demands	0.50	1.46	1.12	0.44	1.30	0.90	0.86	0.14
labor force	1.56	0.73	-0.76	0.16	1.80	0.40	0.80	0.04
labor market	4.81	1.08	-0.96	0.34	9.00	5.20	0.86	0.11
life expectancy	0.48	2.35	-0.61	-0.39	0.40	0.60	0.16	0.06
living arrangements	0.72	1.09	-0.66	-0.41	0.60	1.10	0.40	0.15
major depression	2.38	1.37	1.09	0.43	5.70	3.90	0.86	0.13
married women	0.66	0.67	-0.72	0.22	0.70	0.30	0.76	0.08
mean age	1.55	0.73	0.58	-0.38	1.00	2.10	0.46	0.20
mental health	6.87	0.26	0.09	-0.49	0.10	15.10	0.03	0.93
mental illness	0.69	0.36	-0.32	0.01	0.10	0.00	0.28	0.00
middle class	1.13	0.76	-0.70	0.18	1.10	0.30	0.64	0.04
negative affect	1.79	0.93	0.89	-0.06	2.90	0.10	0.85	0.00
negative effect	1.68	0.25	-0.40	0.22	0.60	0.80	0.66	0.21
outcome measures	0.85	0.91	0.91	0.25	1.40	0.50	0.91	0.07
parental divorce	0.54	0.66	-0.63	0.07	0.40	0.00	0.61	0.01
partially mediated	0.85	0.67	0.75	0.01	1.00	0.00	0.85	0.00
personality disorder	1.55	1.47	1.11	0.48	3.90	3.30	0.83	0.16
personality traits	1.04	0.67	0.81	0.04	1.40	0.00	0.97	0.00
positive effect	1.57	0.24	-0.40	0.19	0.50	0.50	0.65	0.15
posttraumatic stress	0.95	1.54	1.15	0.47	2.50	1.90	0.85	0.14
prospective memory	0.91	1.27	1.07	0.19	2.10	0.30	0.91	0.03
psychological association	0.79	1.74	1.20	0.55	2.30	2.20	0.83	0.17
rating scale	0.58	1.43	1.12	0.42	1.50	0.90	0.88	0.12
rural areas	0.43	1.23	-0.60	-0.24	0.30	0.20	0.29	0.05
single mothers	0.67	1.44	-0.93	0.65	1.20	2.60	0.60	0.29
social assistance	0.42	1.55	-1.01	0.43	0.90	0.70	0.66	0.12
social capital	2.64	0.52	-0.58	0.01	1.80	0.00	0.65	0.00
social change	0.61	0.58	-0.59	0.17	0.40	0.20	0.60	0.05
social class	1.35	0.36	-0.40	-0.14	0.40	0.20	0.44	0.05
social networks	2.04	0.21	-0.32	-0.23	0.40	1.00	0.50	0.26
social services	0.24	0.97	-0.45	-0.67	0.10	1.00	0.21	0.46
social support	6.65	0.33	0.36	-0.33	1.70	6.60	0.38	0.33
socioeconomic status	2.70	0.16	-0.16	-0.33	0.10	2.70	0.15	0.67
stress disorder	0.91	1.53	1.13	0.50	2.40	2.10	0.83	0.16
suicidal behavior	0.55	1.11	0.93	0.20	1.00	0.20	0.79	0.04

suicide attempts	1.11	0.57	0.65	0.00	1.00	0.00	0.73	0.00
symptom severity	0.48	1.46	1.10	0.47	1.20	1.00	0.84	0.15
united states	2.77	0.31	-0.49	-0.12	1.30	0.40	0.77	0.05
welfare recipients	0.35	0.55	-0.62	0.17	0.30	0.10	0.70	0.05
welfare state	0.84	0.98	-0.88	0.34	1.30	0.90	0.79	0.12
west germany	0.56	2.55	-0.85	0.30	0.80	0.50	0.29	0.04
young men	0.75	0.52	-0.62	-0.10	0.60	0.10	0.75	0.02
SUPPLEMENTARY CASES (AXES 1 TO 2)								
CASES			**COORDINATES**		**CONTRIBUTIONS**		**SQUARED COSINES**	
IDENTIFIER	**REL.WT.**	**DISTO**	**1**	**2**	**1**	**2**	**1**	**2**
adaptation	3.04	0.05	0.18	-0.05	0.00	0.00	0.69	0.05
adolescence	44.33	1.86	-0.02	-0.59	0.00	0.00	0.00	0.19
adult	27.77	0.31	0.04	-0.45	0.00	0.00	0.01	0.65
anxieties	9.25	0.74	0.84	0.15	0.00	0.00	0.95	0.03
biographical	5.36	0.45	-0.44	-0.08	0.00	0.00	0.44	0.01
care	19.17	0.77	-0.10	-0.75	0.00	0.00	0.01	0.74
career	5.52	0.21	-0.35	0.23	0.00	0.00	0.58	0.26
caregiver	7.48	3.15	0.06	-1.10	0.00	0.00	0.00	0.38
childhood	9.16	0.06	0.10	-0.05	0.00	0.00	0.18	0.03
clinical	9.72	0.55	0.70	0.13	0.00	0.00	0.89	0.03
cognition	11.17	1.28	0.53	-0.54	0.00	0.00	0.22	0.23
cohort	9.95	0.11	-0.16	-0.24	0.00	0.00	0.24	0.52
coping	9.01	0.58	0.76	0.07	0.00	0.00	0.99	0.01
cross-country	0.64	0.41	-0.26	-0.30	0.00	0.00	0.17	0.22
cross-cultural	0.44	0.36	0.50	0.21	0.00	0.00	0.68	0.13
cross-section	1.25	0.09	0.26	0.05	0.00	0.00	0.76	0.02
death	4.32	0.80	-0.19	-0.51	0.00	0.00	0.05	0.33
demographic	5.29	0.51	-0.13	-0.12	0.00	0.00	0.04	0.03
depression	40.75	0.49	0.70	-0.02	0.00	0.00	1.00	0.00
disorder	15.92	1.09	0.98	0.32	0.00	0.00	0.88	0.10
divorce	6.99	0.51	-0.63	0.31	0.00	0.00	0.78	0.19
economy	14.04	0.68	-0.78	0.23	0.00	0.00	0.89	0.08
education	27.88	0.26	-0.50	-0.03	0.00	0.00	0.97	0.00
ehist	2.10	1.60	-0.93	0.40	0.00	0.00	0.54	0.10
elderly	4.01	2.93	0.04	-1.01	0.00	0.00	0.00	0.35
episode	4.92	0.74	0.84	0.17	0.00	0.00	0.96	0.04
ethnographic	2.31	0.84	-0.75	0.16	0.00	0.00	0.67	0.03
event	10.52	0.05	0.20	0.03	0.00	0.00	0.83	0.02
face-to-face	0.47	1.06	0.21	-0.66	0.00	0.00	0.04	0.41
families	46.34	0.12	-0.30	-0.01	0.00	0.00	0.74	0.00
fatherhood	1.05	0.77	-0.65	0.50	0.00	0.00	0.54	0.32

fertility	4.19	7.89	-0.95	0.54	0.00	0.00	0.12	0.04
flexibility	1.22	0.11	-0.08	0.30	0.00	0.00	0.06	0.80
follow-up	6.62	0.45	0.66	-0.12	0.00	0.00	0.96	0.03
frail	0.87	3.41	-0.24	-1.02	0.00	0.00	0.02	0.30
graduate	1.39	0.40	-0.45	0.26	0.00	0.00	0.50	0.18
health	57.61	0.41	-0.06	-0.55	0.00	0.00	0.01	0.74
hiv-related	1.69	0.82	0.14	-0.33	0.00	0.00	0.02	0.14
hospital	4.59	0.42	0.34	-0.40	0.00	0.00	0.27	0.39
household	10.95	0.60	-0.67	0.00	0.00	0.00	0.74	0.00
immigration	8.87	1.27	-0.72	0.14	0.00	0.00	0.41	0.01
income	13.20	0.51	-0.65	-0.03	0.00	0.00	0.82	0.00
individual-level	1.08	0.33	-0.44	-0.16	0.00	0.00	0.58	0.08
labor	11.72	1.03	-0.91	0.41	0.00	0.00	0.80	0.16
lifco	4.99	0.41	-0.61	-0.14	0.00	0.00	0.91	0.05
lifsp	0.79	0.63	0.21	-0.47	0.00	0.00	0.07	0.35
lihist	2.22	0.50	-0.69	0.01	0.00	0.00	0.96	0.00
listo	1.22	0.37	0.03	-0.45	0.00	0.00	0.00	0.55
manic	1.88	1.74	1.20	0.55	0.00	0.00	0.83	0.17
market	7.03	1.05	-0.95	0.36	0.00	0.00	0.86	0.12
marriage	15.29	0.58	-0.60	0.32	0.00	0.00	0.62	0.18
mental	10.69	0.17	0.11	-0.37	0.00	0.00	0.07	0.81
midlife	1.35	1.14	0.09	-0.60	0.00	0.00	0.01	0.32
migration	9.74	2.49	-0.93	0.33	0.00	0.00	0.35	0.04
narration	24.76	0.36	-0.44	-0.05	0.00	0.00	0.54	0.01
partnership	12.07	0.05	0.08	-0.06	0.00	0.00	0.15	0.07
patient	20.78	0.68	0.76	0.12	0.00	0.00	0.86	0.02
pension	0.73	1.47	-0.47	-0.36	0.00	0.00	0.15	0.09
personality	8.77	1.07	0.99	0.28	0.00	0.00	0.92	0.07
poverty	5.86	0.88	-0.77	0.01	0.00	0.00	0.67	0.00
professionals	5.30	0.29	-0.31	-0.34	0.00	0.00	0.33	0.39
reports	24.18	0.26	0.26	-0.31	0.00	0.00	0.26	0.38
self-report	5.73	0.38	0.55	-0.19	0.00	0.00	0.80	0.10
services	9.50	0.61	-0.15	-0.70	0.00	0.00	0.04	0.82
sociological	4.86	1.35	-0.93	0.42	0.00	0.00	0.64	0.13
stress	16.65	0.34	0.56	-0.03	0.00	0.00	0.92	0.00
survey	19.62	0.27	-0.40	-0.13	0.00	0.00	0.61	0.06
trajectories	7.06	0.16	-0.05	-0.34	0.00	0.00	0.01	0.70
transition	11.12	0.26	-0.44	-0.07	0.00	0.00	0.74	0.02
treatment	13.85	0.45	0.61	0.11	0.00	0.00	0.83	0.02
uncertain	1.29	0.40	-0.46	0.15	0.00	0.00	0.52	0.06
vulnerability	3.61	0.22	0.35	-0.26	0.00	0.00	0.55	0.31
wages	3.75	1.43	-1.03	0.53	0.00	0.00	0.74	0.20

CASES			COORDINATES		CONTRIBUTIONS		SQUARED COSINES	
IDENTIFIER	**REL.WT.**	**DISTO**	**1**	**2**	**1**	**2**	**1**	**2**
welfare	7.13	0.62	-0.66	-0.04	0.00	0.00	0.69	0.00
work	42.69	0.16	-0.33	0.05	0.00	0.00	0.68	0.02
birth cohort	0.85	0.36	-0.53	-0.12	0.00	0.00	0.80	0.04
case studies	0.41	0.30	-0.47	0.00	0.00	0.00	0.71	0.00
control group	0.95	0.59	0.73	0.00	0.00	0.00	0.89	0.00
daily diary	0.64	0.20	0.41	0.05	0.00	0.00	0.85	0.01
first birth	0.55	6.21	-0.86	0.44	0.00	0.00	0.12	0.03
focus group	0.99	0.58	-0.32	-0.44	0.00	0.00	0.18	0.33
household panel	1.66	0.84	-0.87	0.12	0.00	0.00	0.91	0.02
in-depth interviews	1.07	0.35	-0.38	-0.18	0.00	0.00	0.40	0.09
later life	0.99	4.68	0.08	-1.18	0.00	0.00	0.00	0.30
life events	2.39	0.20	0.40	-0.13	0.00	0.00	0.83	0.09
logistic regression	2.75	0.52	0.05	-0.63	0.00	0.00	0.01	0.76
longitudinal studies	7.80	0.08	-0.17	-0.02	0.00	0.00	0.39	0.00
multiple regression	0.89	0.27	0.46	-0.24	0.00	0.00	0.77	0.22
national longitudinal	6.75	0.55	-0.58	-0.04	0.00	0.00	0.60	0.00
national survey	0.86	0.60	-0.69	0.09	0.00	0.00	0.80	0.01
panel survey	1.49	0.60	-0.64	-0.18	0.00	0.00	0.68	0.05
prospective cohort	0.68	0.43	0.42	-0.27	0.00	0.00	0.42	0.17
prospective longitudinal	0.90	0.39	0.53	-0.06	0.00	0.00	0.71	0.01
prospective studies	0.49	1.04	0.96	0.32	0.00	0.00	0.89	0.10
qualitative interviews	0.50	0.66	-0.33	-0.47	0.00	0.00	0.16	0.33
regression analyses	2.08	0.30	0.33	-0.31	0.00	0.00	0.36	0.33
retrospective reports	0.59	0.53	0.64	0.28	0.00	0.00	0.77	0.15
social work	1.14	0.67	-0.69	-0.01	0.00	0.00	0.70	0.00
socio-economic panel	1.05	1.03	-0.85	0.06	0.00	0.00	0.70	0.00
time series	1.92	0.47	-0.57	0.17	0.00	0.00	0.68	0.06
young adulthood	2.03	1.64	-0.04	-0.57	0.00	0.00	0.00	0.19
young people	3.43	1.55	-0.39	-0.50	0.00	0.00	0.10	0.16
young women	1.71	0.51	-0.47	-0.13	0.00	0.00	0.44	0.03

Appendix C

SIMPLE CORRESPONDENCE ANALYSIS

EIGEN-VALUES

COMPUTATIONS PRECISION SUMMARY: TRACE BEFORE DIAGONALISATION..
0.2511
SUM OF EIGENVALUES..... 0.2511

HISTOGRAM OF THE FIRST 5 EIGENVALUES								
NUMBER	**EIGEN-VALUE**	**PERCENT-AGE**	**CUMUL-ATED PERCENT-AGE**					
1	0.1636	65.14	65.14					
2	0.045	17.93	83.07					
3	0.0282	11.25	94.32					
4	0.0075	2.99	97.31					
5	0.0067	2.69	100					
Khi-2 TEST FOR AXIS CHOICE								
(USING USUAL THRESHOLD, YOU CAN GO TO THE FIRST TEST-VALUE > 2.0)								
NUMBER	**STAT**	**DEG. OF**	**PROB.**	**TEST**				
OF AXIS	**KHI2**	**FREEDOM**	**X>KHI2**	**VALUE**				
1	471.61	60	0	-17.01	*			
COORDINATES, CONTRIBUTIONS OF FREQUENCIES ON AXES 1 TO 2								
FREQUENCIES			**COORDINATES**		**CONTRIBU-TIONS**		**SQUARED COSINES**	
IDEN - SHORT LABEL	**REL.WT**	**DISTO**	**1**	**2**	**1**	**2**	**1**	**2**
m1 - 1	16.76	0.70	-0.82	-0.03	69.10	0.30	0.97	0.00
m2 - 2	38.16	0.08	0.26	0.08	15.40	6.00	0.81	0.09
m3 - 3	21.55	0.13	0.18	-0.27	4.30	35.90	0.26	0.59
m4 - 4	8.07	0.33	0.36	0.26	6.30	12.40	0.39	0.21
m5 - 5	6.33	0.22	-0.03	-0.36	0.00	18.50	0.00	0.60
m7 - 7	9.13	0.39	-0.29	0.36	4.70	27.00	0.22	0.34

SUPPLEMENTARY FREQUENCIES								
FREQUENCIES			**COORDINATES**		**CONTRIBU-TIONS**		**SQUARED COSINES**	
IDEN - SHORT LABEL	**REL.WT**	**DISTO**	**1**	**2**	**1**	**2**	**1**	**2**
m1 - 2000	4.77	0.11	0.18	0.10	0.00	0.00	0.31	0.10
m2 - 2001	6.31	0.05	0.03	0.01	0.00	0.00	0.01	0.00
m3 - 2002	7.16	0.08	0.03	0.02	0.00	0.00	0.02	0.00

m4 - 2003	7.70	0.08	-0.05	0.03	0.00	0.00	0.03	0.01
m5 - 2004	8.05	0.07	-0.04	-0.09	0.00	0.00	0.03	0.12
m6 - 2005	9.37	0.06	0.06	-0.10	0.00	0.00	0.05	0.16
m7 - 2006	10.49	0.07	-0.07	0.07	0.00	0.00	0.07	0.07
m8 - 2007	12.23	0.03	-0.06	0.05	0.00	0.00	0.13	0.09
m9 - 2008	12.01	0.06	0.00	-0.01	0.00	0.00	0.00	0.00
m10 - 2009	11.34	0.05	0.05	-0.03	0.00	0.00	0.05	0.02
m11 - 2010	12.75	0.04	-0.04	0.00	0.00	0.00	0.04	0.00
m6 - 6	2.19	0.39	-0.17	0.09	0.00	0.00	0.07	0.02
COORDINATES, CONTRIBUTIONS AND SQUARED COSINES OF CASES								
ACTIVE CASES (AXES 1 TO 2)								
CASES			**COORDINATES**		**CONTRIBUTIONS**		**SQUARED COSINES**	
IDENTIFIER	**REL.WT.**	**DISTO**	**1**	**2**	**1**	**2**	**1**	**2**
event history	4.23	0.55	0.49	0.35	6.30	11.70	0.44	0.23
life history	4.47	0.11	0.31	0.00	2.50	0.00	0.83	0.00
life story	2.47	0.50	-0.38	-0.57	2.20	17.50	0.29	0.64
panel data	35.91	0.10	0.30	-0.09	19.30	5.90	0.89	0.08
survival analyses	1.67	0.87	-0.80	0.14	6.60	0.80	0.74	0.02
birth cohort	1.71	0.05	0.15	-0.08	0.20	0.20	0.50	0.13
case studies	0.84	0.10	0.06	-0.17	0.00	0.50	0.04	0.30
control gr. (experiments)	1.91	2.07	-1.33	-0.32	20.80	4.30	0.86	0.05
daily diary	1.28	1.12	-0.99	-0.20	7.70	1.10	0.88	0.03
focus group	2.00	0.38	0.01	-0.49	0.00	10.80	0.00	0.63
in-depth interviews	2.15	0.18	0.02	-0.39	0.00	7.10	0.00	0.81
longitudinal studies	29.32	0.09	-0.15	0.22	4.30	32.10	0.28	0.57
nationally representative	4.16	0.19	-0.19	0.03	0.90	0.10	0.18	0.00
prospective longitudinal	1.82	1.44	-1.19	0.06	15.60	0.10	0.98	0.00
qualitative interviews	1.00	0.44	0.04	-0.55	0.00	6.70	0.00	0.68
retrospective reports	1.19	2.08	-1.34	-0.05	13.00	0.10	0.86	0.00
time series	3.86	0.13	0.16	-0.11	0.60	1.00	0.21	0.09

SUPPLEMENTARY CASES (AXES 1 TO 2)								
CASES			COORDINATES		CONTRIBU-TIONS		SQUARED COSINES	
IDENTIFIER	REL.WT.	DISTO	1	2	1	2	1	2
adaptation	6.12	0.56	-0.70	-0.21	0.00	0.00	0.87	0.08
adolescence	89.35	1.75	-0.64	0.73	0.00	0.00	0.24	0.31
adult	55.98	0.49	-0.47	-0.21	0.00	0.00	0.45	0.09
anxieties	18.65	2.60	-1.55	-0.09	0.00	0.00	0.93	0.00
biographical	10.80	0.23	0.09	-0.39	0.00	0.00	0.04	0.66
care	38.64	0.75	-0.19	-0.50	0.00	0.00	0.05	0.33
career	11.12	0.14	-0.16	0.03	0.00	0.00	0.18	0.01
caregiver	15.07	3.23	-0.19	-0.98	0.00	0.00	0.01	0.30
childhood	18.47	0.46	-0.65	-0.04	0.00	0.00	0.92	0.00
clinical	19.60	2.10	-1.34	-0.28	0.00	0.00	0.86	0.04
cognition	22.51	2.02	-0.94	-0.58	0.00	0.00	0.43	0.17
cohort	20.06	0.12	-0.27	-0.12	0.00	0.00	0.61	0.12
coping	18.15	2.18	-1.42	-0.18	0.00	0.00	0.92	0.02
cross-country	1.28	0.31	-0.04	-0.54	0.00	0.00	0.01	0.94
cross-cultural	0.89	1.56	-1.11	-0.27	0.00	0.00	0.79	0.05
cross-section	2.52	0.77	-0.82	-0.16	0.00	0.00	0.87	0.03
death	8.70	0.69	-0.05	-0.65	0.00	0.00	0.00	0.62
demographic	10.65	0.34	-0.35	0.12	0.00	0.00	0.37	0.04
depression	82.13	1.90	-1.34	-0.19	0.00	0.00	0.94	0.02
disorder	32.09	3.47	-1.75	-0.09	0.00	0.00	0.88	0.00
divorce	14.09	0.16	0.18	0.02	0.00	0.00	0.21	0.00
economy	28.30	0.19	0.37	0.06	0.00	0.00	0.72	0.02
education	56.20	0.02	0.06	0.05	0.00	0.00	0.21	0.18
elderly	8.07	3.01	-0.17	-1.00	0.00	0.00	0.01	0.33
ethnographic	4.66	0.40	0.37	-0.20	0.00	0.00	0.35	0.10
event	21.20	0.63	-0.74	-0.17	0.00	0.00	0.87	0.04
face-to-face	0.95	1.35	-0.55	-0.54	0.00	0.00	0.22	0.22
families	93.41	0.06	-0.20	0.11	0.00	0.00	0.70	0.20
fatherhood	2.12	0.37	0.12	0.24	0.00	0.00	0.04	0.15
fertility	8.44	3.40	0.53	0.61	0.00	0.00	0.08	0.11
flexibility	2.45	0.40	-0.48	-0.02	0.00	0.00	0.56	0.00
follow-up	13.34	1.69	-1.25	-0.26	0.00	0.00	0.93	0.04
frail	1.74	3.29	0.15	-0.85	0.00	0.00	0.01	0.22
graduate	2.80	0.22	-0.10	0.23	0.00	0.00	0.05	0.25
health	116.11	0.44	-0.27	-0.49	0.00	0.00	0.17	0.55
hospital	9.24	0.93	-0.76	-0.58	0.00	0.00	0.61	0.36
household	22.07	0.15	0.32	-0.15	0.00	0.00	0.67	0.15
immigration	17.87	0.38	0.32	0.14	0.00	0.00	0.27	0.05
income	26.61	0.12	0.30	-0.15	0.00	0.00	0.72	0.18

individual-level	2.17	0.12	0.01	-0.05	0.00	0.00	0.00	0.02
insecure	2.73	0.62	-0.47	-0.53	0.00	0.00	0.36	0.45
labor	23.63	0.43	0.47	0.18	0.00	0.00	0.51	0.08
lifco	10.06	0.10	0.26	-0.13	0.00	0.00	0.66	0.16
lifsp	1.60	0.95	-0.57	-0.58	0.00	0.00	0.34	0.35
manic	3.79	4.97	-2.03	-0.13	0.00	0.00	0.83	0.00
market	14.16	0.45	0.53	0.15	0.00	0.00	0.62	0.05
marriage	30.83	0.15	0.14	0.11	0.00	0.00	0.13	0.09
mental	21.55	0.43	-0.56	-0.30	0.00	0.00	0.73	0.20
midlife	2.73	1.32	-0.35	-0.78	0.00	0.00	0.09	0.47
migration	19.64	0.93	0.56	0.23	0.00	0.00	0.34	0.06
narration	49.91	0.16	0.06	-0.30	0.00	0.00	0.02	0.57
partnership	24.33	0.42	-0.63	0.00	0.00	0.00	0.96	0.00
patient	41.89	2.33	-1.39	-0.37	0.00	0.00	0.83	0.06
pension	1.47	1.22	0.21	-0.41	0.00	0.00	0.04	0.14
personality	17.67	3.40	-1.72	-0.22	0.00	0.00	0.87	0.01
poverty	11.80	0.27	0.41	0.00	0.00	0.00	0.63	0.00
professionals	10.69	0.16	-0.13	-0.02	0.00	0.00	0.11	0.00
resources	17.20	0.16	-0.19	-0.27	0.00	0.00	0.22	0.46
risk	67.97	0.57	-0.69	0.01	0.00	0.00	0.85	0.00
self-report	11.54	1.37	-1.16	-0.09	0.00	0.00	0.99	0.01
services	19.15	0.51	-0.27	-0.03	0.00	0.00	0.15	0.00
sociological	9.80	0.70	0.49	0.09	0.00	0.00	0.35	0.01
stress	33.56	1.48	-1.15	-0.23	0.00	0.00	0.90	0.04
survey	39.55	0.03	0.00	-0.06	0.00	0.00	0.00	0.11
trajectories	14.24	0.28	-0.43	-0.04	0.00	0.00	0.66	0.01
transition	22.42	0.03	-0.02	0.11	0.00	0.00	0.01	0.43
treatment	27.91	1.79	-1.23	-0.27	0.00	0.00	0.85	0.04
uncertain	2.60	0.11	0.03	-0.08	0.00	0.00	0.01	0.06
vulnerability	7.28	0.84	-0.88	-0.21	0.00	0.00	0.92	0.05
wages	7.55	0.71	0.57	0.24	0.00	0.00	0.46	0.08
welfare	14.37	0.22	0.18	0.35	0.00	0.00	0.14	0.58
wellbeing	24.42	0.49	-0.42	-0.39	0.00	0.00	0.36	0.31
work	86.04	0.09	-0.12	-0.16	0.00	0.00	0.16	0.28

CASES			**COORDINATES**		**CONTRIBU-TIONS**		**SQUARED COSINES**	
IDENTIFIER	**REL.WT.**	**DISTO**	**1**	**2**	**1**	**2**	**1**	**2**
adolescent health	7.00	0.72	-0.12	0.56	0.00	0.00	0.02	0.44
bipolar disorder	3.47	4.47	-1.93	-0.16	0.00	0.00	0.83	0.01
breast cancer	2.62	1.83	-1.15	-0.34	0.00	0.00	0.72	0.06
depressive	19.90	1.07	-0.97	-0.26	0.00	0.00	0.88	0.06

symptoms								
educational attainment	5.10	0.04	-0.02	0.05	0.00	0.00	0.01	0.05
family structure	3.88	0.14	0.26	0.19	0.00	0.00	0.51	0.27
human capital	3.25	0.25	0.31	0.21	0.00	0.00	0.39	0.17
income dynamics	3.21	0.20	0.42	0.09	0.00	0.00	0.89	0.04
intergenerational transm	1.13	0.20	0.17	0.14	0.00	0.00	0.15	0.11
labor force	3.14	0.25	0.38	-0.01	0.00	0.00	0.59	0.00
labor market	9.69	0.48	0.54	0.15	0.00	0.00	0.60	0.05
life events	4.83	0.99	-0.94	-0.28	0.00	0.00	0.90	0.08
major depression	4.79	4.14	-1.88	-0.13	0.00	0.00	0.85	0.00
negative affect	3.60	2.68	-1.50	-0.40	0.00	0.00	0.84	0.06
personality disorder	3.12	4.36	-1.93	-0.07	0.00	0.00	0.85	0.00
personality traits	2.10	2.36	-1.47	-0.23	0.00	0.00	0.91	0.02
prospective memory	1.84	3.70	-1.79	-0.27	0.00	0.00	0.86	0.02
single mothers	1.35	0.73	0.41	0.37	0.00	0.00	0.23	0.19
social capital	5.33	0.22	0.21	-0.23	0.00	0.00	0.20	0.24
suicide attempts	2.25	1.89	-1.30	-0.14	0.00	0.00	0.90	0.01
welfare state	1.69	0.45	0.48	-0.02	0.00	0.00	0.51	0.00

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Endnotes

[1] Note that excluding the medical and epidemiological studies is a thematic choice for assessing vulnerability as an interdisciplinary heuristic in the social sciences. Unlike including the vast amount of medical and epidemiological research, concentrating on sub-disciplines within our primary field of interest—the social sciences—allows us to better distinguish diverse themes covered and methods used in the field of interest.

[2] For each row entry (article), each term from the first column was combined with terms from the second or third column using the "AND" operator. Terms within the same columns were searched by using the "OR" operator. The key search terms were searched in the abstracts of each row entry.

[3] General social science journals include multidisciplinary and applied sciences journal abstracts.

[4] Note that life stages are plotted into the graphical representation as supplementary variables, thus having contributions of zero.

[5] Terms such as 'bipolar disorder' or 'labour market' in bold refer to terms represented in the two-dimensional display generated by correspondence analysis (see Figure 1).

[6] The term 'panel data' is primarily used in sociological, demographic, and socio-economic journal publications, while the term 'longitudinal studies' is often used synonymously in psychology and the social sciences.

The life course determinants of vulnerability in late careers

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Abstract

Late career is often seen as a more vulnerable life-stage in the labour market, in which workers may experience a deterioration in job quality. Using a life course perspective and longitudinal data, this article analyses the vulnerability associated with late career by focusing on four occupational dimensions: working-time, career continuity, retirement timing and income change. The research is carried out using data from Switzerland, a country where the age profile of the labour force is an increasing issue. The paper also adopts a cumulative disadvantage perspective to examine the impact of previous work and family life experiences on work life vulnerability at older age. Our data come from the Survey of Health, Ageing and Retirement in Europe (SHARELIFE). The paper uses cluster analysis, sequence analysis and ordered logistic regression. Results show that women with previous family responsibilities resulting in long-term unemployment or caring, often with health complications, are more likely to be vulnerable to deterioration in job quality in late career. This suggests that experiences in the last period of the working life may be just as gendered as earlier periods.

Keywords: late careers; vulnerability; cumulative disadvantages; SHARELIFE data; sequence analysis

Introduction

The labour market is a core focus of life course research. Scholars in the social sciences have particularly focused on the increasing variation in career patterns among individuals. Some examples of career variability include the growth of the female workforce in recent decades associated with part-time working, the rise of flexible contracts, the systematic development of the tertiary sector of the economy and variation in the timing of retirement (Kohli, Rein, Guillemard, & Van Gunsteren, 1991; Levy, Joye, Guye, & Kaufmann, 1997).

Life course sociologists often link the analysis of two dimensions of research: the study of the determinants of varying occupational trajectories and the analysis of how such variation leads some individuals to experience more labour market vulnerability in their career. In regard to the first dimension, life course scholars usually focus on factors such as institutional policies in the labour market, interdependence between career and other life domains, and the socially structured timing of work transitions (Levy et al., 1997).

In terms of the second dimension of research, studies often analyse how individual variation in career trajectory benefits some people but harms others. When the consequences are harmful, life course sociologists tend to focus on the notion of social vulnerability. Here, different notions and principles of vulnerability have been proposed (Spini, Hanappi, Bernardi, Oris, & Bickel, 2013). However, in this paper, we use Castel's notion of vulnerability, which focuses on vulnerability in social integration, particularly in the work sphere (Castel, 2000, 2003, 2009).

Both research dimensions, i.e., the study of vulnerability in occupational life and the analysis of the determinants of varying labour trajectories, have been integrated into international life course research in different career phases (Kohli et al., 1991). In Switzerland, however, life course research has mainly focused on early or middle career (Le Goff, Sapin, & Camenisch, 2011; Levy, Gauthier, & Widmer, 2006). Yet in socio-political contexts such as Switzerland, which is characterized by a high rate of participation among older workers (OECD, 2012) and by continuous political reforms aiming to foster an active ageing lifestyle (OFS, 2012a), the issue of

late career —i.e., having an occupation after age 50 — and specifically, the vulnerability faced in the labour market, are becoming increasingly important.

This paper aims to offer new insights on the study of vulnerability in late career in Switzerland through the lens of Castel's notion of vulnerability. Moreover, in order to measure vulnerability in late career, four occupational dimensions are considered: working-time, career continuity, retirement timing, and income change. More specifically, the aim is to classify vulnerability in each of these dimensions, using both theoretical expectations and empirical classification based on cluster analysis.

Another objective of the paper is the analysis of the determinants of these patterns of vulnerability in late career. Two groups of determinants are studied: life experiences in social domains and what we term 'positional factors' (Levy et al., 1997). The selection of determinants is guided by the theory of cumulative disadvantage in the labour market. This theory proposes that during the life course, cumulative familial and occupational experiences, as well as positional characteristics have consequences in later life (Dannefer, 2003; Sapin, Spini, & Widmer, 2007).

We use retrospective data from the Survey of Health, Ageing and Retirement in Europe (SHARELIFE) for the analyses. These data permit the application of longitudinal quantitative techniques, such as sequence analysis, to build typical familial and occupational trajectories. We also use ordinal logistic models to analyse the determinants of vulnerability in the labour market in later life.

The paper is organized into five sections. First, Castel's conception of vulnerability is presented and then used to classify vulnerability in late career. Second, a review of the international literature illustrates the impact of risk factors for social vulnerability in the labour market at older age. The third section presents the data, variables and methods used in the paper. In the fourth section, the results of the cluster analyses — which provide an empirical classification of vulnerability in late careers — as well as the sequence analyses and ordinal logistic analyses are presented. The final section offers a discussion of the main findings and prospective research questions.

1. Castel's notion of vulnerability

Individual variation in life trajectory often has consequences for social vulnerability (Spini et al., 2013). Castel's notion of vulnerability provides a framework through which to understand these vulnerabilities, that will be applied in this research.

Castel understands vulnerability as a social status which influences the person's integration into society as a function of experiences in two domains: labour market and personal relationships (Castel, 2000). Concretely, a vulnerable status is characterized by insecure employment and fragile social and family networks. Moreover, being defined as vulnerable indicates low social cohesion between the individual and society (Castel, 2003).

The pertinence of Castel's perspective to the life course approach comes from three main points. First, from his comprehensive framework of vulnerability as a status related to social difficulties in gaining access to central institutions of modern society, such as family and work. Secondly, from his understanding of vulnerability not as a status that people experience when they are disaffiliated from social institutions, but rather as a risk for lack of integration into social institutions (Castel, 2000, 2003, 2009). Finally, Castel conceives vulnerability as a contingent status, i.e., as a status that can change over the life course. Indeed, Castel talks about four zones of social life: the integration zone, the vulnerability zone, the assistance zone and the disaffiliation zone. They are defined according to the extent to which people are integrated into the work and relationship domains (Castel, 2000). This schema makes it possible to see vulnerability not necessarily as fixed, but rather as a conditional status. This is why, in this research, vulnerability will be also considered in terms of two other statuses: non-vulnerable and partially vulnerable. Whereas the non-vulnerable status will refer to an individual with good working conditions; partial vulnerability will consider individuals having both good and precarious job conditions.

Using Castel's notion of vulnerability in late careers

Understanding vulnerability according to Castel's perspective — i.e. as precarious integration into institutions like the labour market – is intrinsically linked to vulnerability in late career.

The low employment rates of workers aged 50 and older are an illustrative example of variation in

work status during older age. Calculations based on OECD country data (OECD, 2012) reveal that between 1991 and 2012, workers aged 25 to 49 had a labour force participation rate of 81.2% compared to 59.9% among workers aged 50 to 64. New technological demands at work, economic recession, attractive financial incentives for early retirement and firms preferences for hiring younger workers all contribute to the lower employment rates among older workers (Dorn & Sousa-Poza, 2010; Fischer & Sousa-Poza, 2006).

We are now also witnessing an increasing proportion of older workers in part-time or temporary jobs which are often associated with lower wages and employment instability (Chan & Stevens, 2001; Hirsch, Macpherson & Hardy, 2000). On the one hand, as Feldman (1994) has proposed, these precarious or risky labour conditions for older workers could be part of *bridge to retirement* in which individuals accept having part-time or provisional jobs before permanently retiring. On the other hand, given that labour markets are usually socially stratified scenarios — often along gendered lines (Meyer & Pfau-Effinger, 2006) — it is possible that these precarious conditions are more likely to affect more disadvantaged groups, rather than being a phase through which all groups pass.

Bearing in mind these current employment trends, late career is here understood to entail more than the presence or absence of employment. Four occupational dimensions are used to evaluate this career period: working-time, career continuity, retirement timing, and income change. Vulnerability in late careers will be analysed according to these four occupational dimensions. Based on previous research, the following paragraphs provide a number of hypotheses for understanding vulnerability in each of these dimensions.

Working-time. As some research indicates, full-time jobs in the primary labour market are the main contributors to work integration (Hansen, Hespanha, Machado, & van Berkel, 2002). However, other studies also suggest that part-time jobs can be considered as alternative sources of integration into the labour market, which, depending on the institutional setting, *may* be associated with a precarious work situation (O'Reilly & Fagan, 1998). Given this we hypothesize that partial vulnerability could be linked to both full-time and part-time jobs during the late careers, but define part-time jobs as vulnerable.

*Career continuity***.** As García and Schampheleire (2002) point out, the decreasing amount of formal work during the 1980s and the 1990s generated, in most Western countries, provisional or temporary jobs characterized by flexible occupational status and the reduction of lifelong careers. Consequently, we assume that while non-vulnerable status might refer to a continuous career, partial vulnerability and vulnerability could rather be associated with interrupted careers.

*Retirement timing***.** The literature shows that whereas early retirement is mostly linked to individuals with more advantaged social and economic positions, late retirement is normally a consequence of an interrupted career and is more likely to affect women and employees with low qualifications (Bütler, Huguenin, & Teppa, 2004; Radl, 2013). Here we hypothesize that while early retirement could reflect a non-vulnerable status, 'on-time' retirement indicates partial vulnerability and late retirement is evidence of a vulnerable status.

Income changes. Taking into consideration the importance of income entitlement for personal autonomy, empowerment, and participation during the occupational career (van Berkel, Hornemann, & Williams, 2002), it is hypothesized that increases in income indicate a non-vulnerable status in the labour market, while stable income represents partial vulnerability and decreasing income a vulnerable status. Table 1 summarizes the suggested classification of the 'non-vulnerable', 'partially vulnerable', and 'vulnerable' across our four occupational dimensions.

Table 1. Vulnerability in four occupational dimensions (hypothetical classification)

Occupational Dimension	Non-Vulnerable	Partially Vulnerable	Vulnerable
Working-Time	Full-time job	Changing-time job	Part-time job
Career Continuity	Continuous career	Interrupted career	Interrupted career
Retirement Timings	Early retirement	On-Time retirement	Late Retirement
Income Changes	Upward Income Changes	Null Income changes	Downward Income Changes

The different occupational dimensions are classified according to level of vulnerability. The question of how these dimensions are associated with one another will be addressed using a cluster analysis model that will be presented in the results section.

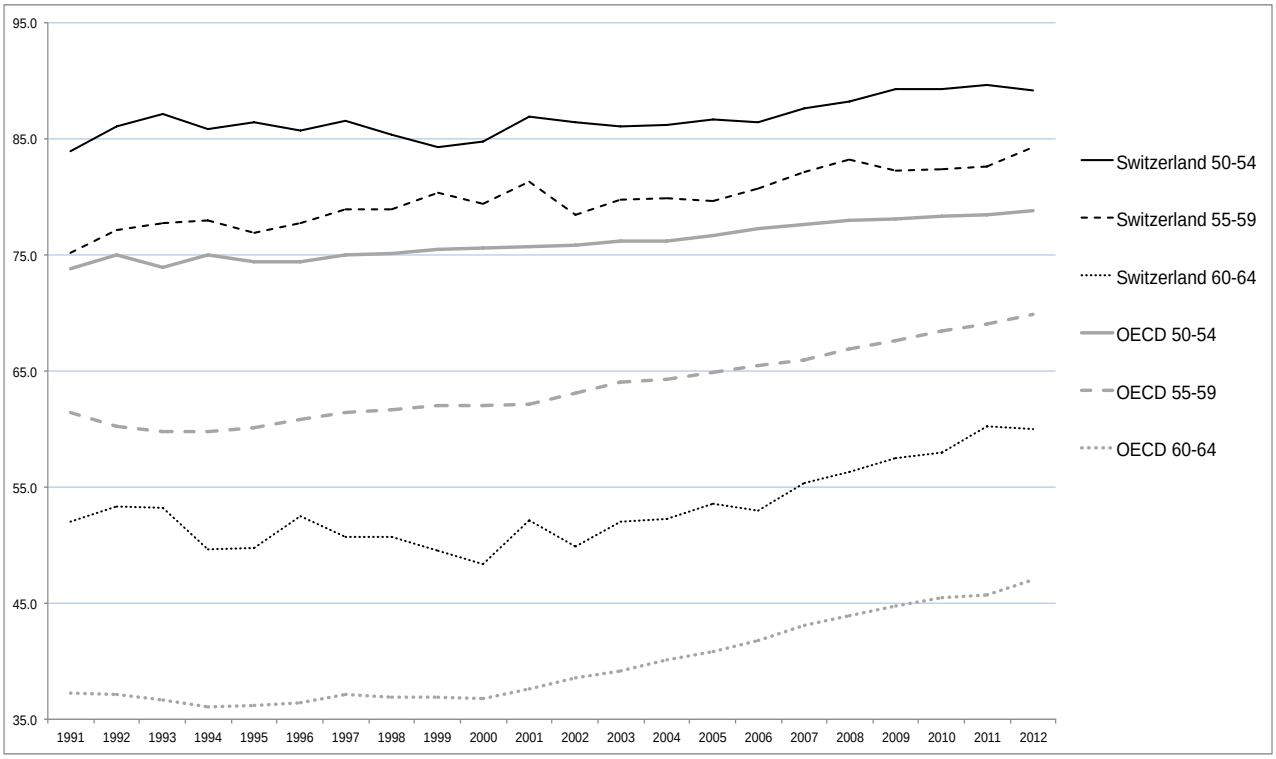
Switzerland as a research case for the study of late careers

Switzerland is an ideal research case for this paper since it has a number of institutional mechanisms promoting the extended work life or, as it is formally called, 'active ageing' (OFS, 2012b). This refers to various public policies and market incentives aimed at discouraging early withdrawal from the labour market and also fostering career continuity after the state pension age. As in other European countries, in Switzerland the policies are a result of a declining birth rate and increasing average age, combined with growing financial instability of public spending and private pension funds (Hanel, 2010).

Specifically in Switzerland, the *active ageing* mechanisms include: the current option of accumulating public pension funds beyond the state pension age (till age 69 for women and 70 for men), financial benefits in the context of occupational pension funds in the event of late withdrawal, financial penalties for early retirement and financial exemptions for late retirement provided by the public pension fund. Finally, training policies in various sectors of the Swiss economy aim to improve the labour skills of older workers (OFS, 2012b, 2012c, 2012d).

From an international point of view, Switzerland is a country with a large proportion of older workers. As Figure 1 shows, in comparison with other OECD countries, Switzerland has a high rate of active workers aged 50 to 64. Figure 1 also indicates that within the 5-year divisions of that age range (e.g. 50-54, 55-59 or 60-64), the larger proportion of older workers in Switzerland than in the rest of the OECD, has remained consistent for more than 20 years. Yet, in the age category 60–64 the participation rate in the Swiss labour market fluctuates around 55%, which prompted the development of incentives for active ageing.

Figure 1. Labour participation rate by age class in Switzerland and OECD countries between years 1991 and 2012



Source: Author calculations based on data from OECD (OECD, 2012)

Both the large number of older workers and the institutional aim of fostering the career continuity of older workers have caused the recent occupational period in Switzerland to be a topic of increasing importance for research. This is not only because it provides an opportunity to extend the vast literature on early and middle adulthood careers but also because it provides an opportunity to gain insight into the particular dynamics of vulnerability at older age.

2. Life course determinants of vulnerability in late careers

As well as studying the distribution of vulnerability in late career, another aim of this research is to explore the determinants of vulnerability at older age. As mentioned, the cumulative disadvantage perspective theoretically supports the choice of considering particular life course determinants of vulnerability.

This theoretical approach assumes that social differences among people were not imposed at birth, but that they progressively developed during the life course through a cumulative process and then contribute to the likelihood of later life transitions (Dannefer, 2003). Put descriptively, small inequalities in health, social networks, family duties, socio-cultural backgrounds, and professional status, when accumulated and combined, could produce socially differentiated trajectories across the life-course (Sapin et al., 2007).

In this paper, the selected life course factors are *life experiences in social domains* and *positional factors.* The first refers to those individual events, transitions or trajectories that people experience in domains such as education, family, occupation, or political spheres (Levy et al., 1997). The second, positional factors, should be understood as those determinants that comprise an individual's position in dimensions of social stratification (Blau, 1977). These include positional or stratifying characteristics such as birth cohort, gender, ethnicity, cultural background, or socio-economic conditions, which, when taken together, provide a more or less privileged position for each individual in society.

We now review the international literature on the impact of life course determinants on vulnerability in late career. This review considers the occupational dimensions *working-time*, *career continuity*, *retirement timing*, and *income changes*.

Influence of life experiences in social domains on vulnerability in late careers

Research on the life course suggests that particular life experiences can have a large impact on later employment experience (Hyde, Ferrie, Higgs, Mein, & Nazroo, 2004). This research specifically focuses on two dimensions of life experience. The first is financial well-being: pension contributions, periods of financial hardship and periods of ill-health. The second focuses on familial and occupational experiences before older age. The first dimension we label *financial well-being indicators*, and the second *familial and occupational trajectories*.

In terms of financial indicators, the literature suggests that beneficial conditions such as progressive access to pension plans and the absence of periods of financial hardship are associated with a later career characterized by full-time employment and early retirement (Gowan, 1998; Radl, 2013). Periods of ill-health may be an important factor here. Research suggests that although there is some variation according to the economic sector, in the majority of occupations, workers with health disabilities are more likely to retire early and also to interrupt their careers due to physical disability (Dorn & Sousa-Poza, 2004a).

With regard to the family and labour market determinants of vulnerability, some studies indicate that for women, a familial trajectory marked by marriage and parenthood generates later career patterns, with part-time jobs, an interrupted career and 'on-time' or late retirement (Hirsch et al., 2000; Hyde et al., 2004; O'Rand & Henretta, 1982). Additionally, occupational trajectories characterized by long-term employment, working continuously as a civil servant or in occupations with higher occupational prestige such as professional jobs, are associated with early retirement, continuous careers, and full-time jobs in the last occupational period (Dorn & Sousa-Poza, 2004b; Madero-Cabib, Gauthier, & Le Goff, 2013).

Influence of positional factors on vulnerability in late careers

Studies of older people in the labour market have shown that men are more likely than women to occupy advantaged labour positions and to experience increasing income and continuous careers (Han & Moen, 1999; Riley, 1986). Similarly, native citizenship versus being a non-national is usually linked to the experience of a continuous career development with an upward income trajectory (Madero-Cabib & Mora, 2011).

Research also indicates that people occupying higher social class positions are more likely to have later careers, characterized by advantaged working conditions including full-time jobs, continuous careers, and upward changes of income (Bukodi & Goldthorpe, 2011; Radl, 2013).

Finally, studies focused on the impact of different birth cohorts on careers, demonstrate that people belonging to older birth cohorts (1920–1940) were more likely to experience the economic and structural opportunities associated with the 'thirty glorious years' between 1945 and 1975 (Chauvel, 1998). This may have made them more likely to enjoy an uninterrupted career in their later work life, involving upward income changes and early retirement.

3. Data, variables, and methods

Data

The data used for the current study come from the Survey of Health, Ageing, and Retirement in Europe (SHARE), and specifically from the third wave named SHARELIFE, which has a retrospective design and was carried out in 2008–2009. The SHARELIFE survey collected information on individuals aged 50+ and collected information on different dimensions over the course of their lives including family composition, occupation characteristics, health care, retirement, and other life aspects (Schröder, 2011). Data collection for SHARELIFE was based on probabilistic sampling and face-to-face interviews using life history calendars. These helped respondents to remember, and chronologically organize, the various episodes of their lives, given people's usual difficulty in accurately remembering early life events (Schröder, 2011).

The Swiss sample of SHARELIFE is composed of 1,296 individuals. The specific sample used in this study consisted of people who effectively worked in Switzerland in an occupation after age 50 and who also fitted the substantive criteria concerning the four occupational dimensions under investigation. This means that the population of interest of this study is people who worked in a full-time or part-time position (*working-time*), who had continuous or interrupted careers (*career continuity*), who retired early, 'on-time' or late (*retirement timing*),

and who did or did not experience variations in their incomes (*income changes*). Consequently, the study sample consists of 451 individuals. As Appendix 1 indicates, the study sample and the Swiss sample of SHARELIFE are very similar, considering the different financial and positional characteristics. The observed differences in the proportions of birth cohorts between both samples arise because in the study sample only retired people were included, while the Swiss sample of SHARELIFE includes individuals aged 50 and older. The study sample represents 97% of retirees included in the Swiss data of SHARELIFE.

However, Appendix 1 shows a notable difference between the two samples in terms of gender proportions: whereas in the study sample 60.3% are men and 39.7% women, in the Swiss sample of SHARELIFE 45.9% are men and 54.1% women. This gender distribution is probably due to the strong male breadwinner model in Switzerland, which usually entails low female participation in the labour market, especially during the life courses of the cohorts under study (Le Feuvre, Kuehni, Rosende, & Schoeni, 2014; Kuehni, Rosende, & Schoeni, 2013; Rosende & Schoeni, 2012).

In other words, a considerable proportion of the women included in the Swiss sample of SHARELIFE probably followed a traditional family trajectory, e.g. marriage and children's births, which meant they experienced either extended periods out of the labour force or left the labour market early in life. Hence, given that the research focus is on active people after age 50, women who withdrew from the labour market due to family responsibilities or other issues before that age are excluded from the analysis.

In order to avoid potential selection bias caused by differential non-response, that could lead to erroneous or non-representative results, this sample was weighted according to the strategy recommended by SHARE, namely using calibrated weights (Deville & Särndal, 1992). As mentioned in the SHARE 2.5.0 guide, calibrated weights provide weights that are as close as possible to the original sampling design weights, while also respecting a set of known population totals. However, given the large debate in the scientific literature about the effectiveness of weighting in regression analysis (see for example Solon, Haider & Wooldrige, 2013) it should be noted that this is a measure that only partially reduces non-response biases.

Variables

Dependent variable. The dependent variable in this study is an ordinal variable with three levels: 1=*non-vulnerable*, 2=*partially vulnerable*, and 3=*vulnerable* in late career. Each level of this variable corresponds to a cluster resulting from the construction of a three-cluster analysis, which is explained in depth in the Methods section below.

Covariates. In accordance with the international literature review and the cumulative disadvantage perspective, the covariates for the study correspond to three life course factors: financial well-being indicators, familial and occupational trajectories, and positional factors. As shown in Table 2, specific variables operate as proxies for the three covariates mentioned. The first covariate concerns contribution to pension funds, periods of financial hardship and periods of ill-health. The second covariate brings together familial and occupational trajectories — which are described in the Results section — and the third covariate groups together the stratification variables.

In Table 2, the choice of contributions to pension funds as a proxy of financial status is based on the evidence that in Switzerland the possibility of having access to the three types of pension funds is strongly associated with the financial status of each individual. The public pension system is mandatory for every individual living in Switzerland but those with very low incomes often do not contribute (OFS, 2012a). The occupational pension fund is available only to employees and civil servants with annual salaries higher than 20,880 Swiss Francs (i.e. $22,854 or €16,920). Finally, private pension funds are often used by the self-employed or by employees and civil servants with enough income to invest. Moreover, because the sample is composed of already-retired individuals, these are pension investments made during their late careers.

Table 2. Covariates

Covariate	Proxy Covariates	Operationalization and Weighted Frequencies
Financial and Well-Being Indicators	Contribution to public pension fund	1: More than half of late careers (94.5%), 0: Less than half of late careers (5.5%)
	Contribution to occupational pension fund	1: More than half of late careers (54.1%), 0: Less than half of late careers (45.9%)
	Contribution to private pension fund	1: More than half of late careers (8.2%), 0: Less than half of late careers (91.8%)
	Ill-health periods	0: No (89.8%), 1: Yes (10.2%)
	Financial hardship periods	0: No (69.3%); 1: Yes (30.7%)
Familial and Occupational Trajectories	Marriage & One Child	1: Belonging (12%), 0: Not belonging (88%)
	Marriage & Two Children	1: Belonging (31.2%), 0: Not belonging (68.8%)
	Marriage & Three or More Children	1: Belonging (31.1%), 0: Not belonging (68.9%)
	Solo Living	1: Belonging (9.3%), 0: Not belonging (90.7%)
	Marriage & Divorce	1: Belonging (12.5%), 0: Not belonging (87.5%)
	Late Marriage	1: Belonging (3.8%), 0: Not belonging (96.2%)
	Service Employee Careers	1: Belonging (21.8%), 0: Not belonging (78.2%)
	Technician Employee Careers	1: Belonging (35.9%), 0: Not belonging (64.1%)
	Professional Employee Careers	1: Belonging (9.1%), 0: Not belonging (90.9%)
	Interrupted Careers & Non-Careers	1: Belonging (14.9%), 0: Not belonging (85.1%)
	From Employee to Self-Employed	1: Belonging (8.1%), 0: Not belonging (91.9%)
	Technician Civil-Servant Careers	1: Belonging (5.9%), 0: Not belonging (94.1%)
	Professional Civil-Servant Careers	1: Belonging (4.3%), 0: Not belonging (95.7%)
Positional Factors	Gender	1: Men (60.3%), 0: Women (39.7%)
	Sociocultural Background: Educational position relative to others in maths during childhood	1: Better or Much Better (88.8%), 0: Much worse, Worse or About the same (11.2%)
	Sociocultural Background: Educational position relative to others in language during childhood	1: Better or Much Better (86.4%), 0: Much worse, Worse or About the same (13.6%)
	Sociocultural Background: Number of books in home in childhood	1: 26 books or more (83.1%), 0: Fewer than 26 books (16.9%)
	Birth Cohort	1: Before 1930 (27.4%), 2:1931-1936 (23.4%), 3:1936-1942 (29.8%), 4: After 1942 (19.3%)

Methods

Three different research methods were applied: first, cluster analysis was used to build the dependent variable. Second, sequence analysis was used to construct familial and occupational trajectories. Third, ordered logistic regression was used to estimate the effects of covariates on the dependent variable.

The statistical association between work-time basis, career continuity, retirement timing, and income changes was measured using cluster analysis. However, before applying the cluster analysis, it was necessary to analyse each occupational dimension throughout the later career. Working-time, career continuity and income changes are dimensions built from the examination of variation among different jobs during the later work career. To this end, a longitudinal database with annual workers' occupational information from age 51 up to retirement was constructed. To measure income variation among jobs the first monthly income in the job was considered. Retirement timing was coded into three different categories: 'early', 'on-time', and 'late' retirement. These categories were built, taking into consideration the fact that the legal age of retirement in Switzerland is different for women and men, and that this difference has changed over time (Candolfi & Chaze, 2008).

Once the information for the four occupational dimensions for the career period was obtained, the indicators for these dimensions were converted into different dichotomous variables, which were introduced into the cluster model. A k-means clustering method was used. The cluster analysis then allowed three clusters to be identified, which were associated with the statuses non-vulnerable, partially vulnerable, and vulnerable.

The second method used in this research is sequence analysis. This technique creates

typologies of longitudinal patterns from sequences of life-course events in domains such as family, education, political and occupation. The method creates types of individual trajectories in a certain domain by comparing them according to their similarity or dissimilarity across individuals. In technical terms, sequence analysis works by creating matrices of individual sequences composed of different social statuses, and measuring the distance between all pairs of individual sequences. The method used to measure these distances is optimal matching analysis (OMA). In order to calculate those distances we used specifically the constant substitution costs of 2 and indel costs of 1 to balance the importance of the order of statuses and the timing of changes between statuses in each kind of sequence (Blanchard, Bühlmann, & Gauthier, 2014). It is possible to perform a cluster analysis on the resulting distance matrix, which allows homogeneous groups of sequences to be created, which, taken together, represent types of trajectories (Blanchard et al., 2014). The clustering method used to agglomerate trajectory types was 'Ward' (Ward, 1963), and the average silhouette width higher than 0.5 as the cut-off criterion of trajectory types was used (Kaufman & Rousseeuw, 1990).

In the study presented here, types of familial and occupational trajectories from age 20 to 49 were constructed. The events or statuses for building these trajectories were chosen based on the family and work determinants of vulnerability in late career, highlighted in the literature. Familial trajectories were built according to five indicators: 1) marriage, 2) divorce, 3) children, 4) cohabitating partners, and 5) non-cohabitating partners. Meanwhile, occupational trajectories were built based on three indicators: 1) out of the labour market, e.g. housework or unemployment, 2) employment status, e.g., employee, civil servant, and self-employed, and 3) type of occupation, e.g., professionals (legislator, senior official or manager, professional), technicians (technician or associated professional, clerk, armed forces, skilled agricultural or fishery worker, craft or related trades worker), and service occupations (service, shop or market sales worker, plant/machine operator or assembler, elementary occupation). Both in the case of familial and occupational trajectories, in order to construct individual sequences according to the indicators mentioned, each individual was measured according to age at beginning, age at end, and status in every indicator.

The third method used in this study is ordered logistic regression. As Long (1997) has pointed out, one of the main reasons to use this technique is the opportunity to examine how different covariates impact on an ordinal variable taking into account all its values simultaneously. In the present research, since a higher value (value 3) relates to a vulnerable status, results will be interpreted as the likelihood of experiencing that status given the other two, i.e., non-vulnerable and partially vulnerable. One crucial assumption made is the *proportional odds* associated with any independent predictor are assumed to be the same over all levels of the dependent variable (Long, 1997). This means, for instance, that the regression estimate of any covariate on the odds of being *non-vulnerable or partially vulnerable* will be identical.

In this research, those predictor variables that did not have valid values for the entire range of the dependent variable were automatically removed from the ordered regression models as the proportional odds assumption could not be tested. This was the case for the familial type 'solo living', the occupational type 'service employee careers' and 'professional and technician civil-servant careers'. As well as considering the common difficulty of implementing the proportional odds assumption (see for instance Peterson & Harrell, 1990), covariates showing a difference of regression estimates at most 2.2 on the pairs of values of the dependent variable were tolerated. By using the Phi coefficient, the correlation between covariates was controlled, and only one covariate ('birth cohort 1936-1942') was removed from the regression model due to a moderate-positive association with two other covariates, i.e. equal to or higher than 0.4 (Dancey & Reidy, 2004). Finally, covariates with many missing values such as social class, educational level and ethnicity, were not included in the regression models of this study.

All computations presented here are made using the R statistical software (R Core Team, 2012) together with the libraries *svytable*—for calculating weighted univariate frequencies—*Cluster*—for performing cluster analysis—*TraMineR*—for carrying out sequence analysis (Gabadinho, Ritschard, Müller, & Studer 2011)—and *svyolr*—for estimating weighted ordinal logistic regressions.

4. Results

Cluster analysis of vulnerability in late careers

Table 3 presents different criteria according to which the three-cluster solution performed better than, or similarly to, the cluster solutions with two, four and five conglomerates. It indicates that after three clusters, the criteria to measure robustness of cluster solutions only marginally improved. Thus, three groups appeared to be an acceptable solution for the patterning among the four occupational dimensions of later career.

Table 3. Comparison of different cluster solutions

Criterium	2 Clusters	3 Clusters	4 Clusters	5 Clusters
Average distance between clusters	8.93	5.10	5.95	5.99
Average distance within clusters	3.36	2.71	2.25	2.43
Average silhouette	0.61	0.41	0.45	0.45
Entropy	0.18	0.77	0.84	0.82

Table 4 shows the cluster analysis with three conglomerates. As observed, a first conglomerate groups those individuals with upward income changes, full-time jobs, continuous careers, and 'on-time' retirement. This cluster was called *non-vulnerable.* A second conglomerate, entitled *partially vulnerable,* comprised those with null income changes, full-time jobs, continuous careers, and early retirement. A third conglomerate, named *vulnerable*, groups people with downward income changes, changing-time jobs, interrupted careers, and late retirement.

Table 4. Contribution of indicators of four occupational dimensions to each cluster

Cluster	Upward Income Changes	Null Income Changes	Downward Income Changes	Full-Time Job	Part-Time Job	Changing-Time Job
1. Not-Vulnerable	0.058	-0.048	-0.009	0.089	-0.082	-0.028
2. Partially Vulnerable	-0.062	0.080	-0.050	0.047	-0.021	-0.048
3. Vulnerable	0.553	-0.890	0.813	-1.284	0.844	0.913

Cluster	Interrupted Career	Continuous Career	Early Retirement	"On-Time" Retirement	Late Retirement
1. Not-Vulnerable	-0.215	0.215	-1.080	1.512	-0.432
2. Partially Vulnerable	-0.215	0.215	0.511	-0.660	0.133
3. Vulnerable	4.637	-4.637	-0.679	0.100	0.802

Note. Indicators of occupational dimensions with the higher contribution in each cluster are highlighted in grey.

There is a satisfactory association between the hypothetical classification of the four occupational dimensions of vulnerability (Table 1) and the empirical results of the cluster analysis. Thus the idea of studying late careers by distinguishing three different levels of vulnerability within the labour market continues to be valuable. It is noteworthy that the status *vulnerable* still represents those people who are in precarious work conditions, while *non-vulnerable* is associated with good labour status, and *partially vulnerable* presents good but not necessarily excellent job characteristics such as null income changes.

Familial and occupational trajectories

In this subsection, tables with summary information about familial and occupational trajectories are displayed. However, Appendices 2 and 3 present graphics of both familial and occupational trajectories, that provide more details of the longitudinal paths.

Types of familial trajectories. As Table 5 indicates, six familial types are specifically constructed. *A*

priori, the majority of familial trajectories appear to be associated with marriage and parenthood. Indeed, Type I, named *Marriage & One Child* (share=12.0%), Type II, named *Marriage & Two Children* (share=31.2%), and Type III, *Marriage & Three or More Children* (share=31.1%) show people who are married and the parent, respectively, of one child (Type I), two children (Type II), and three or more children (Type III) from age 26 on average. Table 5 also shows that there are more men than women in these three familial types, which could be linked to the gender proportions in the study sample.

Table 5. Types of familial trajectories in Switzerland between ages 20 and 49

Familial Type	Weighted Share (%)	Women (%)	Men (%)
I. Marriage & One Child	12.0	43.3	56.7
II. Marriage & Two Children	31.2	33.3	66.7
III. Marriage & Three or More Children	31.1	35.8	64.2
IV. Solo Living	9.3	51.4	48.6
V. Marriage & Divorce	12.5	42.2	57.8
VI. Late Marriage	3.8	76.6	23.4

Moreover, Type IV (share=9.3%) was called *Solo Living* since it corresponds to the type gathered over the entire period of a sizeable proportion of individuals living alone. Type V, named *Marriage & Divorce* (share=12.5%) indicates those persons being married and beginning to be divorced from age 35. Finally, Type VI, entitled *Late Marriage* (share=3.8%) groups individuals following what could be called a 'non-traditional' relationship, i.e., having cohabitation or non-cohabitation partners and then marrying but later than people in the previous types. As Table 5 reveals, only the last familial type shows a clear gender division, with women representing more than three quarters of the type.

Types of occupational trajectories. Table 6 shows that are seven types of occupational trajectories. At first sight, large numbers of employees and low rates of unemployment characterize most occupational trajectories. For instance, Type I, called *Service Employee Careers* (share=21.8%), Type II, called *Technician Employee Careers* (share=35.9%), and Type III, called *Professional Employee Careers* (share=9.1%), show that many people start their careers working as service, technician and professional employees and remain in those statuses until the end of the time period considered. In terms of gender differentiation, the second and third occupational types show a higher presence of men than women.

Table 6. Types of occupational trajectories in Switzerland between ages 20 and 49

Occupational Type	Weighted Share (%)	Women (%)	Men (%)
I. Service Employee Careers	21.8	50.5	49.5
II. Technician Employee Careers	35.9	25.2	74.8
III. Professional Employee Careers	9.1	23.4	76.6
IV. Interrupted Careers & Non-Careers	14.9	79.3	20.7
V. From Employee to Self-Employed	8.1	44.7	55.3
VI. Professional Civil-Servant Careers	4.3	24.5	75.5
VII. Technician Civil-Servant Careers	5.9	17.5	82.5

Moreover, Type IV, entitled *Interrupted Careers & Non-Careers* (share=14.9%) is the only cluster containing a considerable proportion of individuals either being permanently outside the labour market or interrupting their careers notably between ages 25 and 40. This is the only occupational type in which women are in a clear majority. Type V, called *From Employee to Self-Employed* (share=8.1%), groups those self-employed workers who started their careers as employees. Finally, Types VI and VII, entitled respectively *Professional Civil-Servant Careers* (share=4.3%) and *Technician Civil-Servant Careers* (share=5.9%), refer to those individuals continuously working as civil servants during the period considered. Table 6 indicates that it is largely men who constitute these two last occupational types.

Ordinal logistic models of vulnerability in late careers

The effects of the covariates on the ordinal dependent variable are estimated through ordered logistic modelling. Given the gender differentiation of familial and occupational trajectory types, gender interaction effects with different trajectories are tested within the models. Our analyses begin by measuring the impact of familial and occupational trajectories along with gender interaction effects, followed by the effects of financial, well-being and positional factors in additional models.

Considering Model 3 of Table 7, what can be observed first is that those individuals grouped in the familial type *Marriage & Divorce* and in the occupational types *Interrupted Careers & Non-Careers* and *Professional Employee Careers* are clearly more likely to experience vulnerable statuses in late career. However, gender interaction effects show that the positive influence of types *Marriage & Divorce* and *Professional Employee Careers* on vulnerability is significantly stronger in the case of women. Equally, gender interaction effects reveal that women in the occupational type *From Employee to Self-Employed* also tend to be more vulnerable in late career. Furthermore, it is important to note that women largely constitute the occupational type *Interrupted Careers & Non-Careers*.

These first results suggest that those women who worked mostly as an employee, who experienced divorce and/or unemployment or periods working in the home, have a higher likelihood of experiencing a downward income trajectory, career interruption, late retirement, and part-time work during their later work life. Based on previous Swiss research, this evidence can be preliminarily explained by the current sexual division of the Swiss labour market. This division creates the condition in which women with family obligations are more likely to have an interrupted career and part-time jobs, and conversely, assures a stable occupational status, i.e., full-time jobs, wage increases and continuous careers, for men (Le Feuvre et al., 2014; Kuehni et al., 2013; Rosende & Schoeni, 2012).

Going further, men are much less likely to experience career interruption due to birth or family life events (Le Goff et al., 2011). Being male is also associated with better occupational conditions in terms of continuity of contribution to public, occupational, and private pension funds, which then allows earlier retirement (Rosende & Schoeni, 2012).

Model 3 of Table 7 suggests that individuals with at least one period of ill-health in their life are more likely to experience a period of vulnerability in late career. This effect could be explained by personal necessity and the institutional context that fosters career interruptions and downward income changes for those individuals who are affected by health problems (Dorn & Sousa-Poza, 2004a).

Finally, Model 3 of Table 7 indicates that people born before 1930 are less likely to experience vulnerability in late career. This result is congruent with the above-mentioned economic and structural opportunities of the 'thirty glorious years' experienced by those who started work between 1945 and 1975 (Chauvel, 1998). Such opportunities meant that these individuals faced more benign labour market conditions in the later career.

Table 7. Ordinal logistic regression of vulnerability in late careers (Dependent variable: 1) Non-Vulnerable, 2) Partially Vulnerable 3) Vulnerable. Coefficients in odds ratios)

Covariates	Model 1	Model 2	Model 3
Familial Trajectory Types (Reference: Marriage & Two Children)			
Marriage & One Child	2.89(0.75)	-	2.88(0.74)
Marriage & Three or More Children	1.18(0.51)	-	1.26(0.53)
Late Marriage	2.64(0.68)	-	2.91(0.78)
Marriage & Divorce	3.46(0.61)*	-	3.14(0.60)+
Occupational Trajectory Types (Reference: Technician Employee Careers)			
Interrupted Careers & Non-Careers	3.89(0.66)*	-	4.21(0.69)*
Professional Employee Careers	7.26(0.49)***	-	7.27(0.54)***
From Employee to Self-Employed	2.80(0.65)	-	3.20(0.74)
Gender Interaction Effects with Family and Occupational Trajectory Types			
Gender. Men (1) vs Women (0)	1.59(0.37)	-	1.61(0.37)
Marriage & One Child * Gender	0.42(0.86)	-	0.45(0.86)
Marriage & Three or More Children * Gender	0.60(0.58)	-	0.59(0.61)
Late Marriage * Gender	1.14(0.73)	-	1.26(0.85)
Marriage & Divorce * Gender	0.30(0.71)+	-	0.31(0.71)+
Interrupted Careers & Non-Careers * Gender	0.47(0.81)	-	0.46(0.83)
Professional Employee Careers * Gender	0.18(0.63)**	-	0.17(0.66)**
From Employee to Self-Employed * Gender	0.17(0.78)*	-	0.17(0.88)*
Financial, Well-Being and Positional Covariates			
Contribution to public pension fund. More than half of late careers (1) vs less the half of late careers (ref)	-	0.61(0.50)	0.69(0.62)
Contribution to occupational pension fund. More than half of late careers (1) vs less than half of late careers (ref)	-	1.06(0.22)	1.18(0.24)
Contribution to private pension fund. More than half of late careers (1) vs less than half of late careers (ref)	-	1.09(0.33)	1.04(0.34)
Financial hardship periods. Yes (1) vs No (ref)	-	1.22(0.23)	1.27(0.24)
Ill-health periods. More than one period (1) vs No periods of health illnesses. (ref)	-	1.92(0.36)+	2.16(0.35)*
Educational position relative to others in Maths during childhood. Better or Much Better (1) vs Much worse, Worse or About the same (ref)	-	0.61(0.38)	0.60(0.41)
Educational position relative to others in Language during child-hood. Better or Much Better (1) vs Much worse, Worse or About the same (ref)	-	1.72(0.28)+	1.41(0.31)
Socio-Cultural Background: Number of books in home in childhood. 26 books or more (1) vs less than 26 books (ref)	-	0.81(0.26)	0.86(0.28)
Birth Cohort: < 1930 (1) vs > 1936 (ref)	-	0.52(0.28)*	0.56(0.30)+
Birth Cohort: 1931-1936 (1) vs > 1936 (ref)	-	0.71(0.26)	0.76 (0.27)
Observations	450	450	450

Notes: Significant coefficients in grey (***: p < .001; **: p < .01; *: p < .05; +: p < .10). Standard errors of logits in brackets.

5. Summary and discussion

The study of occupational careers has been a particular focus of life course sociology. The study of the determinants of careers and the analysis of vulnerability experienced by some workers, has attracted the attention of many life course scholars.

However, most studies of labour market vulnerability have focused on early and middle adulthood, whereas this article aimed at examining the patterning and determinants of vulnerability in late careers, focusing specifically on the Swiss case.

In this article, Castel's notion of vulnerability was employed to understand the impact of different dimensions of vulnerability on social integration in society. These dimensions include having an insecure job and fragile relationship networks. Moreover, in order to measure vulnerability in late career, this study focused on four occupational dimensions: working-time, career continuity, income changes and retirement timing.

The first aim of this research was to understand how vulnerability could be understood in terms of

the four occupational dimensions above. After performing cluster analysis with a three-conglomerate solution, it was found that vulnerability involved a cluster grouping of workers with downward income trajectories, a move to part-time employment, interrupted careers and late retirements.

Furthermore, this research also aimed to analyse, through ordered logistic models, how different life course factors such as familial and occupational trajectories, financial well-being and positional indicators impacted on vulnerability in late career. The selection of those determinants was theoretically supported by the cumulative disadvantage perspective, which proposes that during the life course, cumulative familial and occupational experiences as well as the positional characteristics of workers can produce an effect on later life (Dannefer, 2003; Sapin et al., 2007).

Results showed well-defined trends concerning the influence of life course determinants on vulnerability. Women with a familial trajectory marked by divorce, and with an occupational trajectory characterized by unemployment, housework and employee positions, were more likely to be vulnerable in late career. Similarly, individuals with health problems during the life course were also more likely to be vulnerable later in life. Conversely, people who benefited from the economic growth during the post-war period were less likely to experience vulnerability in older age.

Given these results, a first conclusion could be linked to the longitudinal approach used in this research. The empirical outcomes of this study allow us to recognize the significant role played by familial and occupational experiences of early and middle adulthood on later life. Thus, prospective studies looking to understand later life processes should focus on antecedent life processes rather than on circumstances in old age such as health or economic position.

Another conclusion relates to the cumulative disadvantage perspective. It is possible to note that vulnerability in late career is currently a status experienced by individuals who, during their life courses, accumulated characteristics that led to worse outcomes in later life. Among those characteristics are family issues, periods of absence from the labour market, working mostly as an employee and health problems.

It is noteworthy that the majority of these characteristics apply more often to women. This means that cumulative disadvantage is built into trajectories which impact much more negatively on women than men. Put another way, those family issues, career difficulties and stratification characteristics are effectively factors of cumulative disadvantage for women employees.

This gendered scenario has sociological and institutional implications. From a sociological perspective, this implies a gendered structure to the life course, i.e. the asymmetric working of family lives for men and women (Levy & Widmer, 2013) can be observed not only in early and middle adulthood, but also in later life. This article suggests that social inequality between men and women — particularly in terms of professional and familial trajectories — is an obstacle to women fitting into traditional male models of career development and ageing processes.

Secondly, from an institutional point of view, this gendered scenario indicates that although the Swiss labour market shows increasing rates of older workers as well as active ageing policies aiming to extend work life, both processes are clearly incompatible or discordant with the internal dynamics of the institution of the family. Put in illustrative terms, it seems that the Swiss labour market is structured in a way that harms those workers, usually women, who are compelled to interrupt their occupational courses due to family issues. Stopping their careers in early or middle adulthood means that women in Switzerland not only lose potential networks or labour expertise (Rosende & Schoeni, 2012), but also—as this research has shown — experience more vulnerability in late career, which includes a greater likelihood of decreasing income, career interruption, part-time working and to late retirement.

In summary, the results obtained in this research contain relevant contributions for the life course study of vulnerability in late careers. First, the study puts forward a conception of vulnerability along four occupational dimensions, and secondly, it demonstrates the important role played by life trajectory and positional factors in occupational vulnerability in later life. Yet, there are clearly some characteristics of the current study that need to be considered and improved in prospective research.

Relevant remaining questions relate to the possibility of analysing how the impact of the life-course determinants revealed varies according to the different industrial segments in later career. Also, it would be interesting to compare the results of the Swiss context with other gendered labour markets but with different welfare state arrangements. This is because liberal welfare states like Switzerland might or might not generate stronger labour vulnerability in women than corporatist welfare states. Further research could seek to answer these and other questions.

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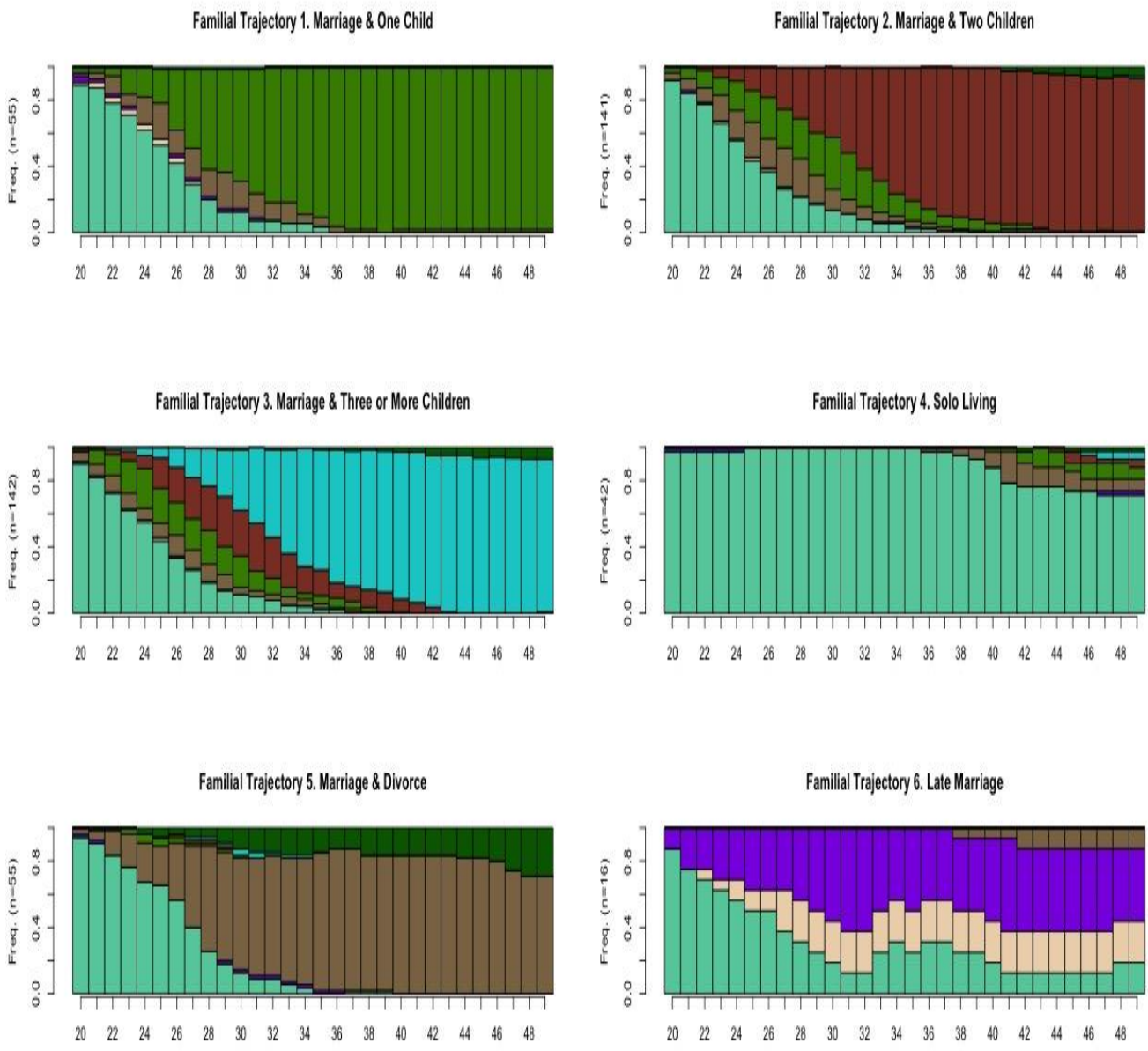
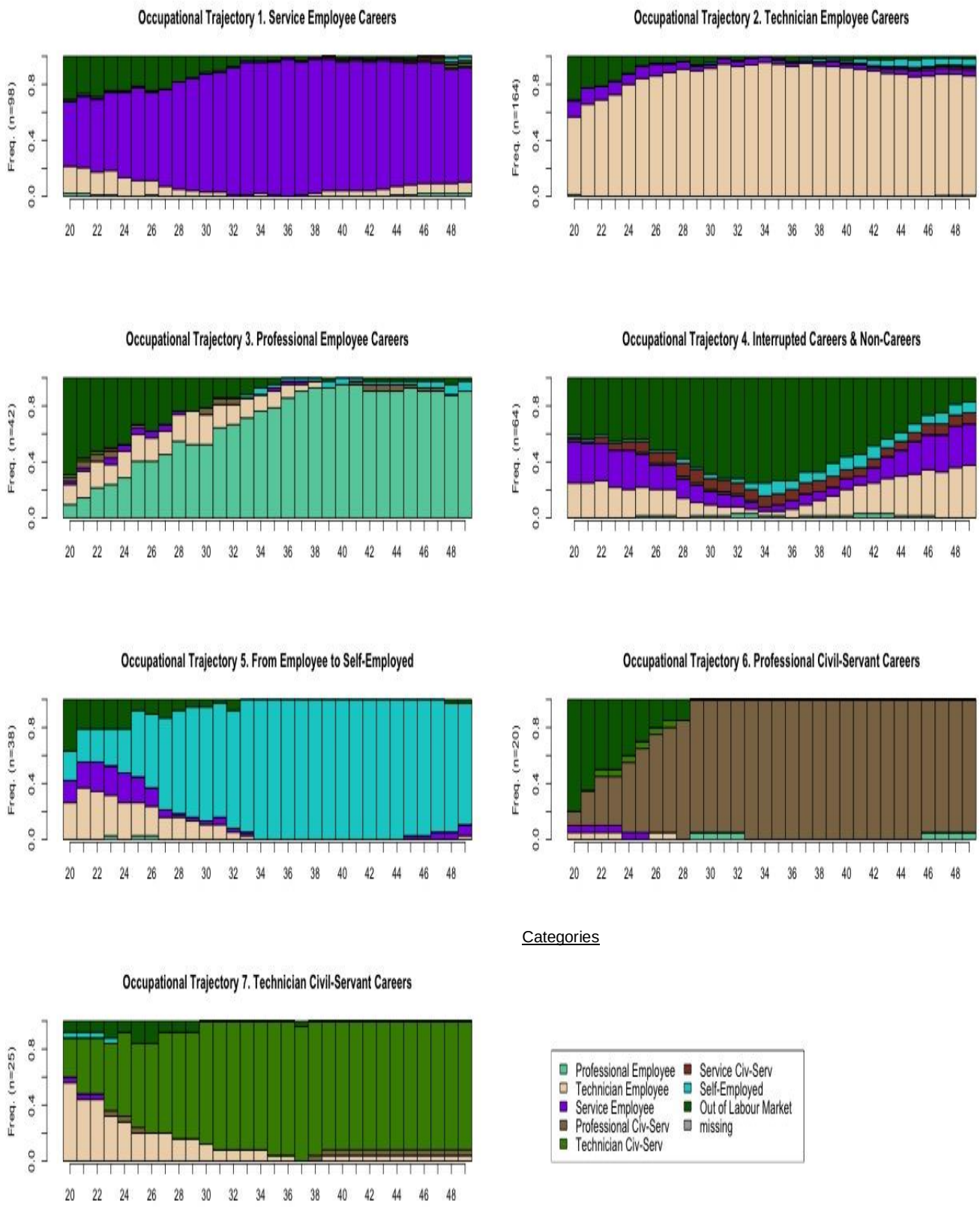
Appendix 1. Weighted frequencies in the study sample and in the Swiss sample of SHARELIFE

Covariates	Weighted Frequencies in Study Sample (N=451)	Weighted Frequencies in Swiss Sample of SHARELIFE (N=1296)
Ill-health periods	0: No (89.8%), 1: Yes (10.2%)	0: No (90.3%), 1: Yes (9.7%)
Financial hardship periods	0: No (69.3%); 1: Yes (30.7%)	0: No (68.5%); 1: Yes (31.5%)
Gender	1: Men (60.3%), 0: Women (39.7%)	1: Men (45.9%), 0: Women (54.1%)
Educational position relative to others in maths during childhood	1: Better or Much Better (88.8%), 0: Much worse, Worse or About the same (11.2%)	1: Better or Much Better (86.4%), 0: Much worse, Worse or About the same (13.6%)
Educational position relative to others in language during childhood	1: Better or Much Better (86.4%), 0: Much worse, Worse or About the same (13.6%)	1: Better or Much Better (87.4%), 0: Much worse, Worse or About the same (12.6%)
Number of books in home in childhood	1: 26 books or more (83.1%), 0: Less than 26 books (16.9%)	1: 26 books or more (77.6%), 0: Less than 26 books (22.4%)
Birth Cohort	1: Before 1930 (27.4%), 2:1931-1936 (23.4%), 3:1936-1942 (29.8%), 4: After 1942 (19.3%)	1: Before 1930 (17.5%), 2:1931-1936 (12.8%), 3:1936-1942 (15.7%), 4: After 1942 (54.1%)

Appendix 2. Types of familial trajectories in Switzerland between ages 20 to 49



Appendix 3. Types of occupational trajectories in Switzerland between ages 20 to 49



RESEARCH NOTE

Fantasy, unrealistic and uncertain aspirations and children's emotional and behavioural adjustment in primary school

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Abstract

We examined the aspirations expressed by 7-year-olds in association with their emotional and behavioural problems, based on data from 12,014 children in the UK's Millennium Cohort Study (MCS). We classified their written responses to the question 'when you grow up, what would you like to be' as aspirations for rare (34.7%) or non-rare (56.8%) occupations, fantasy aspirations (1.1%), aspirations for non-work related future states (2.3%), and uncertain aspirations (5.1%). Most children had occupational aspirations, suggesting that at age 7, children already envisage future careers. Though few had fantasy occupations, which are more common in younger children, many gave unrealistic answers which are more developmentally typical for 7-year-olds. Children with fantasy aspirations at age 7 were more hyperactive, and had more conduct and peer problems. Having non-work-related and uncertain aspirations at this age was not associated with adverse outcomes. Compared to children who aspired to rare occupations, those who aspired to non-rare occupations had more emotional and peer problems. Children with ambitions for rare occupations may have higher self-efficacy and believe they can influence their choices. These findings were robust to adjustment for earlier emotional and behavioural problems, verbal cognitive ability, ethnicity, family structure, social class and poverty, and maternal education and depressed mood.

Keywords: aspirations, emotional and behavioural problems, MCS , seven-year old children

Introduction

Aspirations reflect what someone would like to achieve rather than what they think they will achieve. Aspirations are hopes and ambitions in an ideal world, while expectations are more realistic assessments for future outcomes, usually taking account of ability and structural constraints. Aspirations in children over 5 tend to reflect the job a child would like to do rather than desires regarding other life domains (Auger, Blackhurst, & Herting, 2005). Importantly, aspirations are linked to later outcomes.

There has been much research relating aspirations, particularly in adolescence, to later outcomes. High educational and career aspirations during adolescence are associated with greater educational achievement, occupational prestige, and earnings in adulthood (Schoon, Martin, & Ross,

2007). By contrast, having low or uncertain educational aspirations in adolescence is related to poorer later outcomes (Gutman, Schoon, & Sabates, 2012). However, for some adolescents uncertainty about career aspirations also preceded later success (Gutman & Schoon, 2012). Most of this research is based on the premise that aspirations are related to children's outcomes because they reflect children's achievement goals, optimism and self-esteem (Malmberg, 2002; Nurmi, 1991), and self-efficacy (Bandura, 1995; 1997). Related constructs are locus of control (Rotter, 1966) and expectancy for success (Eccles et al., 1983). Children with an internal locus of control feel they can influence their successes and failures. Similarly, expectancy beliefs are self-beliefs about success in upcoming tasks, in either the immediate or the long-term future. These constructs drive the development of aspirations and well-being, with high self-efficacy, expectancy beliefs and internal locus of control being associated positively with well-being.

There has been much less research about the role of younger children's aspirations, particularly in emotional and behavioural outcomes. However, early aspirations may be especially important for later outcomes, as they may reflect children's self-efficacy and self-esteem more directly than later aspirations, which are constrained by societal expectations. This Research Note sets out to fill this gap. Using data from the UK Millennium Cohort Study (MCS), we investigated the association between aspirations and emotional and behavioural problems in primary school children.

How aspirations develop

In general, children's aspirations develop from vague representations of possible future outcomes to more realistic career preferences. Career development theorists argue that children go through a fantasy stage where aspirations are based solely on their interests and desires. Gottfredson (1981) maintains that after age 5, most children no longer report that they aspire to be animals or fantasy characters, or classify adulthood in simple terms (e.g. 'mum', 'tall'). Similarly, more recent work (Atance & Meltzoff, 2005) suggests that children under the age of 5 have difficulty in representing themselves in future states. By age 7, children can envisage themselves in the future, but their aspirations "oscillate between fantasy and reality" (Seginer, 2009). In the US, boys tend to report more fantasy aspirations than girls across all ages (Helwig, 2001).

As children grow older, aspirations become more realistic through a process of channelling, selection, adjustment and reflection (Nurmi, 2004). The falling prevalence of expressed fantasy aspirations and the rise of realistic aspirations with age have been supported, for example, by Croll (2008). Children's aspirations are also strongly gendered. Currently, the most popular occupational choices for British adolescents are for girls: hairdresser/beautician, doctor, veterinarian or teacher; and for boys: entertainer/sportsman and the skilled trades (Croll, Attwood & Fuller, 2010). Ethnicity has also been related to children's aspirations. In Britain, children from ethnic minorities tend to have higher educational and occupational aspirations than white children (Croll et al., 2010). Parents' education, occupation, income and aspirations for their children have all been associated with children's aspirations (Mau & Bikos, 2000; Schoon et al., 2007). Finally, parental depression is related, both directly and via parenting, to lower optimism and an external locus of control in children.

Aspirations and emotional and behavioural problems

Aspirations impact on choices and direct future activities, which are themselves related to emotional and behavioural outcomes. The pursuit of one's aspirations has been shown to be beneficial for one's well-being, as it increases the likelihood of goal attainment and a sense of self-efficacy (Bandura, 1997; Eccles et al., 1983). In particular, goals that match the challenges and demands of a particular life stage or situation contribute to an individual's well-being (Nurmi & Salmela-Aro, 2002). Previous work has focused on the role of aspirations in educational and occupational outcomes rather than other outcomes, such as emotional and behavioural adjustment. Though scarce, empirical evidence on such relationships suggests that they may be important. For example, a study of 12-14 year-olds found that higher academic aspirations for the future were associated with less anti-social behaviour in the present (Boxer, Goldstein, Delorenzo, Savoy, & Mercado, 2010). Children with higher, compared to lower, future expectations tend to have less anxiety and depression. According to Wyman, Cowen, Work &

Kerley (1993), "…future expectations seem to be part of the fabric of a child's ongoing self-experience and the attitudes and feelings with which he or she engages the world" (p. 658). Using the MCS, Flouri & Panourgia (2012) showed that high occupational aspirations might contribute to building resilience to externalising problems for primary school children in poverty.

The present investigation

This Research Note presents an operationalisation of a taxonomy of general types of younger children's aspirations based on the realism of the aspiration and the vocational maturity (Gottfredson, 1981). Other studies have looked at young children's aspirations by social rank (Flouri & Panouragia, 2012) and a three-way classification of prestige, femininity/masculinity and level of intrinsic/extrinsic motivation (Moulton, Flouri, Joshi & Sullivan, forthcoming). Using data from the MCS, we investigated the association between aspirations (fantasy, non-work related, uncertain, and for rare and non-rare occupations) and parent-reported emotional and behavioural problems in primary school children. We expected that young children who expressed an aspiration for an occupation would have fewer emotional and behavioural problems than children who had non-work related, fantasy, or uncertain aspirations. Seven year olds who express a fantasy or non-work related aspiration may be falling behind developmentally. Fantasy future orientations may also be an escape from the stresses of everyday life (Nuttin & Lens, 1985). We therefore expected these children to have more emotional and behavioural problems. Uncertain aspirations may reflect goal avoidance or difficulties in episodic future thinking, which, we hypothesised, would be linked to emotional and behavioural problems. We also expected that children with aspirations for rare occupations would have more positive emotional and behavioural outcomes compared to children aspiring to common (non-rare) occupations. Children aspiring to rare occupations at this age may be expressing unconstrained hopes for the future, evidence that they have high self-efficacy and strong beliefs that they can influence their choices, regardless of the difficulty of their goals.

We adjusted for a number of family- and child-level variables that may jointly determine aspirations and emotional and behavioural problems in children: family poverty and parental education, social class and mental health (Bradley & Corwyn, 2002; Nurmi, 1991; Nurmi & Pulliainen, 1991; Shanahan, Copeland, Costello, & Angold, 2008).To adjust for children's earlier emotional and behavioural difficulties (Shanahan et al., 2008), we measured children's emotional and behavioural problems both at ages 7 and 5 (at the previous MCS sweep).

Method

Participants

We used data from the Millennium Cohort Study (MCS), a birth cohort study of some 19,000 children born in the UK in 2000-02. MCS was designed to over-represent areas with high proportions of ethnic minorities in England, areas of high child poverty, and the three smaller UK countries (Plewis, 2007). We took information from the main respondents (usually the child's mother) and the children themselves at age 7 (Sweep 4), when aspirations were measured for the first time. Sweep 4 included 14,043 children aged around 7, of whom 13,681 were singletons, 332 twins and 30 triplets. We used data from the first four sweeps (at children's ages 9 months, and 3, 5 and 7 years) and from only the first-born twin or triplet, so that we had one cohort member per family. Our analytic sample (N = 12,014) comprised those children giving an interpretable response to the aspiration question and a valid score on one of the emotional and behavioural SDQ subscales (see below) at age 7. This sample comprised more girls and children from white backgrounds, with higher verbal ability, and with lower scores on all of the SDQ subscales than the remaining 1,843. Parents in the analytic sample were less likely to be in poverty, and more likely to be in a higher social class. The mothers in the analytic sample were more highly qualified and less likely to be lone parents, and, on average, had lower psychological distress scores.

Measures

Aspirations were assessed using the children's written responses at age 7 to the open-ended question 'When you grow up, what would you like to be?' If a child needed help understanding or completing the question on their own, the interviewer was available to help them. The children's responses were subsequently coded (Flouri, Moulton, & Panourgia, 2012). In this

investigation, children's responses were grouped into five categories. Occupational aspirations were sub-divided into those for 'rare' *and 'non-rare' occupations*. If the aspired job was held by less than one in a thousand of the UK working population in 2008, when Sweep 4 of MCS took place, then it was labelled '*rare*'. '*Non-rare*' occupations were those jobs held by more than 0.1% of the UK working population in 2008. We used the Quarter 2 (April-June) 2008 Labour Force Survey (LFS), roughly contemporary with Sweep 4, to identify the proportion of people employed in occupations (coded to the unit groups of the Standard Occupational Classification 2000). Rare occupations, taken together, accounted for a small percentage (6.6%) of the adult working population in 2008 (LFS), but a high proportion (37.8%) of the children's occupational aspirations (MCS4). These jobs are typical of children's responses in other studies. '*Rare*' occupations included 'sports person', 'vet', 'pop star' or 'spy'. '*Non-rare*' occupations included jobs such as 'teacher', 'police officer', 'doctor', 'hairdresser' or 'builder'. The three non-occupational categories were fantasy, descriptive and uncertain aspirations. '*Fantasy*' aspirations were 'magical' or not achievable (such as 'royalty', 'superhero', 'fairy'). '*Descriptive*' were responses reflecting traits or states of mind (such as 'happy', 'helpful', 'normal', 'good'), or adult roles (such as 'adult', 'tall', ' man', ' mum'). '*Uncertain*' aspirations combined the 'don't know' and the few 'nothing' responses.

Emotional and behavioural problems at age 5 and 7 were measured using the main respondent's report of the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997). The four 'difficulties' subscales were used in this investigation: conduct problems (α = 0.60), hyperactivity (α = 0.78), emotional symptoms (α = 0.65), and peer problems (α = 0.57). Scores on each subscale ranged from 0 to 10. Few of the children's scores were 'borderline' or 'abnormal' on each of the SDQ subscales (hyperactivity 18.5%, M=3.31, SD=2.48; conduct problems 19.5%, M=1.36, SD=1.52; emotional symptoms 13.2%, M=1.51, SD=1.52 and peer problems 17.4%, M=1.19, SD=1.52).

The *family-level* covariates were family poverty, parental social class, lone parenthood, and mother's depressed mood and highest academic qualification. Family poverty was measured (as in Malmberg & Flouri, 2011) by a four-item summative index of the following socio-economic disadvantages: over-crowding, non-ownership of home, receipt of income support and income poverty). The index ranges from 0 to 4, reflecting a family's level of material deprivation and social exclusion. Family poverty was measured when children were aged 5 and 7. Mother's depressed mood was assessed by the Kessler Psychological Distress Scale, when the children were aged 5 (Kessler et al, 2003). A 6-item (K6) scale ranging from 0 to 24 (α = 0.85), it measures depressive and anxiety symptoms experienced in the last 30 days. Lone parenthood was a dichotomous variable indicating whether the main respondent had been a single parent at any of the four MCS sweeps. Mother's highest academic qualification as at Sweep 4 ranged from 'no qualification' to 'higher degree'. Parental social class was constructed from information from all four sweeps. The highest value of the National Statistics Socio-economic Classification (NS-SEC) for either parent since Sweep 1 was coded to one of the seven NS-SEC groups, ranging from 'Higher Managerial'/'Professional' to 'Routine'.

The *child-level variables* were age (in days) at the day of the Sweep 4 interview, gender, ethnicity, and verbal cognitive ability at age 7. Verbal cognitive ability was measured with the British Ability Scales (BAS) II Reading Achievement scale, which measures word reading ability. Children's scores were adjusted for their age according to the mean scores of the BAS norming group, and were computed using the BAS manual's conversion tables.

Missing data imputation

Overall, 3.2% of the values of the explanatory variables in the analytic sample were missing and were identified as not missing completely at random (Little's chi-square $p < 0.001$; Little & Rubin, 2002). A multiple imputation (MI) approach to handling missing data was adopted. Given the level of missingness, five imputed datasets (Graham, Olchowski, & Gilreath, 2007) were generated in SPSS 20 using the Markov Chain Monte Carlo procedure. The imputation included all the variables in the model, with the exception of the outcome variables (SDQ subscales at Sweep 4), in a fully inclusive model (Collins, Schafer, & Kam, 2001). We fitted our models in SPSS which pooled the results from the analyses carried out in each imputed dataset.

Analytic plan

We first examined the prevalence of different types of response to the aspirations question, and the association of aspirations and emotional and behavioural problems by gender. Then, we fitted a series of multiple linear regression models to each of the emotional and behavioural domain subscales at age 7. The first model regressed these outcomes on aspirations, gender and ethnicity. We then added the appropriate SDQ subscale at age 5 to adjust for earlier measures of difficulties, thereby focusing on the change in problem behaviour from age 5 to age 7. Model 3 also included verbal cognitive ability, and the final model added all the remaining covariates. All models controlled for the MCS survey design ('stratum'). We assumed that, conditioning on the design variables, the sampling mechanism is ignorable.

Results

Descriptives and correlations

In the analytic sample, over half (56.8%) of the aspirations were for non-rare occupations, and just over a third (34.7%) were for rare occupations. Very few children had fantasy (1.1%) or descriptive (2.3%) aspirations. Some children were uncertain (5.1%) of what their aspirations for the future might be. Table 1 shows the mean SDQ subscale scores in each of the 'aspirations' category by gender. The highest means across all emotional and behavioural problems were for fantasy aspirations, ranging from 4.67 for hyperactivity and 1.62 for peer problems. The lowest problem scores were for aspirations for rare occupations, ranging from 3.26 for hyperactivity and 1.05 for peer problems. Boys averaged significantly higher scores on conduct, peer and hyperactivity problems than girls. Girls had significantly higher scores on emotional symptoms than boys.

Regressions

Table 2 presents the models for conduct problems. Model 1 showed that, compared to children with aspirations for non-rare occupations, children with fantasy aspirations had more conduct problems at age 7. By contrast, compared to children with aspirations for non-rare occupations, those who aspired to rare occupations had fewer conduct problems. In Model 2, adjusting for conduct problems at age 5 made no difference to terms on aspirations. In Model 3, the association between aspirations for rare occupations and conduct problems became nonsignificant. In Model 4, fantasy aspirations (b = 0.33, 95% CI: 0.10, 0.56) remained associated with conduct problems.

Table 1. Mean SDQ subscale scores in each aspiration category by gender

	Conduct problems (n = 12,007)			Hyperactivity (n=11,965)			Emotional symptoms (n=11,983)			Peer problems (n=11,991)		
Aspiration category	**Total**	**Boys**	**Girls**	**Total**	**Boys**	**Girls**	**Total**	**Boys**	**Girls**	**Total**	**Boys**	**Girls**
Non-rare Occupation	1.36	1.54***	1.22***	3.28	3.81***	2.88***	1.56	1.53	1.58	1.27	1.41***	1.16***
Rare Occupation	1.32	1.43***	1.15***	3.26	3.56***	2.81***	1.39	1.35	1.43	1.05	1.11**	.96**
Fantasy	1.81	1.87	1.72	4.67	5.20**	3.87**	1.94	2.09	1.71	1.62	1.61	1.63
Descriptive	1.51	1.66	1.39	3.76	4.42***	3.22***	1.62	1.57	1.66	1.36	1.60*	1.16*
Uncertain	1.38	1.58***	1.12***	3.41	3.83***	2.86***	1.63	1.69	1.56	1.19	1.34**	.99**
Total	1.36	1.51***	1.21***	3.31	3.74***	2.88***	1.51	1.47*	1.54*	1.19	1.29***	1.10***

*Note. Significant mean difference between boys and girls (*p < .05, ** p < .01, ***p < .001)*

Table 2. Conduct problems at age 7: unstandardised regression coefficients (standard errors) – multiple linear regression (N =12,007)

	1	2	3	4
Aspiration: Non-rare occupation (ref)				
Rare occupation	-0.08(0.03)**	-0.07(0.03)*	-0.04(0.03)	-0.02(0.03)
Fantasy	0.40(0.13)**	0.36(0.12)**	0.35(0.12)**	0.33(0.12)**
Descriptive	0.14(0.09)	0.12(0.09)	0.07(0.09)	0.03(0.09)
Uncertain	-0.00(0.06)	-0.01(0.06)	-0.02(0.06)	0.02(0.06)
Stratum: England-advantaged (ref)				
England-disadvantaged	0.39(0.04)***	0.25(0.04)***	0.21(0.04)***	0.07(0.04)*
England-ethnic	0.38(0.07)***	0.12(0.09)	0.11(0.09)	-0.08(0.09)
Wales-advantaged	-0.08(0.07)	-0.11(0.06)	-0.16(0.06)*	-0.14(0.06)*
Wales-disadvantaged	0.29(0.05)***	0.13(0.05)*	0.01(0.05)	-0.11(0.05)*
Scotland-advantaged	-0.04(0.06)	-0.06(0.06)	-0.07(0.06)	-0.04(0.06)
Scotland-disadvantaged	0.23(0.06)***	0.12(0.07)	0.06(0.07)	-0.03(0.07)
Northern Ireland-advantaged	-0.24(0.07)**	-0.19(0.07)	-0.26(0.07)***	-0.20(0.07)**
Northern Ireland-disadvantaged	0.25(0.06)***	0.09(0.07)	-0.03(0.07)	-0.16(0.07)*
Girl	-.31(0.03)***	-0.23(0.03)***	-0.21(0.03)***	-0.23(0.03)***
Ethnicity: White (ref)				
Mixed	-0.08(0.09)	-0.15(0.09)	-0.12(0.09)	-0.18(0.08)*
Indian	-0.17(0.10)	-0.13(0.10)	-0.05(0.10)	-0.00(0.10)
Pakistani/Bangladeshi	-0.08(0.08)	-0.26(0.13)	-0.22(0.12)	-0.28(0.11)*
Black/Black British	-0.33(0.09)***	-0.48(0.10)***	-0.44(0.10)***	-0.53(0.09)***
Other ethnic group	-0.23(0.14)	-0.31(0.16)	-0.26(0.16)	-0.27(0.15)
Conduct problems, age 5		0.27(0.03)***	0.26(0.02)***	0.23(0.02)***
Verbal cognitive ability, age 7			-0.01(0.00)***	-0.01(0.00)***
Mother's highest qualification: None (ref)				
Higher degree				-0.20(0.08)*
First degree				-0.32(0.06)***
A level/HE diploma				-0.24(0.05)***
GCSEa-c				-0.19(0.04)***
GCSEd-g				-0.01(0.05)
Other				-0.24(0.09)*
Parents' highest social class: Routine (ref)				
Higher managerial/professional				-0.16(0.10)
Lower managerial/professional				-0.19(0.09)
Intermediate				-0.14(0.08)
Small employers				-0.12(0.11)
Lower supervisory				-0.06(0.09)
Semi-routine				-0.08(0.08)
Family poverty, age 5				0.05(0.03)
Family poverty, age 7				0.05(0.02)*
Ever in lone-parent family				0.22(0.04)***
Maternal depressed mood, age 5				0.04(0.01)**
Constant	1.48(0.41)***	1.36(0.42)**	3.16(0.44)***	2.93(0.44)***
R squared adjusted	0.03-0.03	0.15 – 0.18	0.17 – 0.20	0.21 – 0.23

Notes. R squared adjusted shows the range of the five imputed datasets for each model. In SPSS 20 a model summary is not given for the pooled results. *p < .05, ** p < .01, ***p < .001

The models for hyperactivity are presented in Table 3. Model 1 showed that, compared to children with aspirations for non-rare occupations, children with fantasy or descriptive aspirations were more hyperactive at age 7, and that children who aspired to rare occupations were less hyperactive. In Model 2 onwards, the terms for descriptive and rare occupational aspirations became nonsignificant. In Models 3 and 4, fantasy aspirations (b = 0.71, 95% CI: 0.39, 1.04) remained associated with hyperactivity.

Table 4 shows the results for emotional symptoms. Model 1 showed that, compared to children with aspirations for non-rare occupations, those with fantasy aspirations had more emotional symptoms and that children with aspirations for rare occupations had fewer. In Models 2 and 3 there was no change in the association with aspirations. In Model 4, the coefficient for fantasy aspirations became nonsignificant, while aspirations for rare occupations (b = -0.09, 95% CI: -0.15, -0.03) remained negatively associated with emotional symptoms.

The models for peer problems are presented in Table 5. Model 1 showed that, compared to children with aspirations for non-rare occupations, children with fantasy aspirations had more peer problems at age 7, and that those who aspired to rare occupations had fewer peer problems. In Models 2 and 3, adjusting for peer problems at age 5 and verbal cognitive ability made little difference to these estimates. In Model 4, fantasy aspirations remained associated with peer problems (b = 0.26, 95% CI: 0.02, 0.49), and aspirations for rare occupations with fewer peer problems (b = -0.15, 95% CI: -0.21, -0.10).

Looking at the results across outcomes, they have the common feature that neither descriptive nor uncertain aspirations ever show a significant relationship; this is likely to be due to their small numbers. However, the other small category, fantasy aspirations, shows a significant positive difference from non-rare aspirations (more problems) for each type of difficulty, in all models, although there is some attenuation in its size. Non-rare occupations tend to show a negative relationship, but this also attenuates (and, for conduct problems and hyperactivity, loses significance) as the models move towards including other terms. In the full model (4) the estimate for fantasy is better determined for conduct problems, hyperactivity and peer problems, whereas for emotional symptoms, the effect of non-rare occupations is more robust. In terms of the mean of each of the subscales, fantasy aspirations 'raised' the conduct problem score by 24.26% of its average, hyperactivity by 21.45% of its average, and peer problems by 21.85% of the average score. On all outcomes, having a fantasy aspiration raises the problem score more than a non-rare aspiration reduces it.

Table 3. Hyperactivity at age 7: unstandardised regression coefficients (standard errors) – multiple linear regression (N =11,965)

	1	2	3	4
Aspiration: Non-rare occupation (ref)				
Rare occupation	-0.14(0.05)**	-0.05(0.04)	-0.00(0.04)	0.00(0.04)
Fantasy	1.22(0.21)***	0.71(0.17)***	0.71(0.17)***	0.71(0.17)***
Descriptive	0.45(0.15)**	0.14(0.13)	0.08(0.12)	0.07(0.12)
Uncertain	0.07(0.10)	0.08(0.09)	0.06(0.08)	0.09(0.08)
Stratum: England-advantaged (ref)				
England-disadvantaged	0.51(0.06)***	0.21(0.05)***	0.14(0.05)**	0.08(0.05)
England-ethnic	0.55(0.11)***	0.31(0.09)**	0.27(0.09)**	0.18(0.09)
Wales-advantaged	-0.11(0.11)	-0.03(0.09)	-0.11(0.09)	-0.10(0.09)
Wales-disadvantaged	0.48(0.08)***	0.17(0.07)*	-0.01(0.07)	-0.07(0.07)
Scotland-advantaged	-0.28(0.10)**	-0.17(0.08)*	-0.19(0.08)*	-0.18(0.08)*
Scotland-disadvantaged	0.31(0.10)**	0.03(0.08)	-0.05(0.08)	.-0.10(0.08)
Northern Ireland-advantaged	-0.28(0.12)*	-0.08(0.10)	-0.18(0.10)	-0.06(0.08)
Northern Ireland-disadvantaged	0.21(0.10)*	0.07(0.08)	-0.13(0.08)	-0.18(0.08)*
Girl	-.89(0.05)***	-0.42(0.04)***	-0.39(0.04)***	-0.41(0.04)***
Ethnicity: White (ref)				
Mixed	-0.06(0.14)	-0.17(0.12)	-0.12(0.11)	-0.17(0.12)
Indian	-0.12(0.16)	-0.20(0.13)	-0.08(0.12)	-0.06(0.12)
Pakistani/Bangladeshi	0.13(0.13)	-0.12(0.11)	-0.07(0.10)	-0.10(0.11)
Black/Black British	-0.57(0.14)***	-0.46(0.12)***	-0.42(0.11)***	-0.50(0.12)***
Other ethnic group	-0.18(0.22)	-0.28(0.31)	-0.21(0.30)	-0.25(0.30)
Hyperactivity, age 5		0.65(0.01)***	0.62(0.01)***	0.60(0.01)***
Verbal cognitive ability, age 7			-0.02(0.00)***	-0.02(0.00)***
Mother's highest qualification: None (ref)				0.08(0.11)
Higher degree				-0.04(0.08)
First degree				0.02(0.07)
A level/HE diploma				0.07(0.07)
GCSEa-c				0.01(0.08)
GCSEd-g				0.29(0.14)*
Other				
Parents' highest social class: Routine (ref)				0.06(0.10)
Higher managerial/professional				0.09(0.10)
Lower managerial/professional				0.05(0.10)
Intermediate				0.01(0.11)
Small employers				0.07(0.10)
Lower supervisory				0.18(0.10)
Semi-routine				
Family poverty, age 5				0.04(0.03)
Family poverty, age 7				0.05(0.03)
Ever in lone-parent family				0.09(0.05)
Maternal depressed mood, age 5				0.02(0.00)**
Constant	6.59(0.66)***	3.41(0.53)***	6.27(0.55)***	6.00(0.56)***
R squared adjusted	0.05-0.05	0.40 – 0.41	0.42 – 0.43	0.42 – 0.43

Notes. R squared adjusted shows the range of the five imputed datasets for each model. In SPSS 20 a model summary is not given for the pooled results. *p < .05, ** p < .01, ***p < .001

Table 4. Emotional symptoms at age 7: unstandardised regression coefficients (standard errors) – multiple linear regression (N =11,983)

	1	2	3	4
Aspiration: Non-rare occupation (ref)				
Rare occupation	-0.14(0.04)***	-0.11(0.03)**	-0.11(0.03)**	-0.09(0.03)**
Fantasy	0.40(0.15)**	0.29(0.14)*	0.29(0.14)*	0.27(0.14)
Descriptive	0.06(0.11)	-0.02(0.10)	-0.02(0.10)	-0.52(0.10)
Uncertain	0.12(0.07)	0.04(0.07)	-0.04(0.07)	0.08(0.07)
Age	0.05(0.07)	0.00(0.06)	-0.04(0.06)	-0.06(0.06)
Stratum: England-advantaged (ref)				
England-disadvantaged	0.29(0.04)***	0.19(0.04)***	0.14(0.04)**	0.05(0.04)
England-ethnic	0.34(0.08)***	0.17(0.07)*	0.15(0.07)*	0.01(0.07)
Wales-advantaged	-0.08(0.08)	-0.12(0.07)	-0.16(0.08)*	-0.15(0.07)*
Wales-disadvantaged	0.12(0.06)	0.02(0.10)	-0.09(0.10)	-0.18(0.09)
Scotland-advantaged	-0.18(0.07)**	-0.18(0.07)*	-0.19(0.07)**	-0.17(0.07)*
Scotland-disadvantaged	0.07(0.07)	-0.07(0.11)	-0.12(0.11)	.-0.19(0.10)
Northern Ireland-advantaged	-0.06(0.08)	-0.06(0.08)	-0.11(0.08)	-0.06(0.08)
Northern Ireland-disadvantaged	0.17(0.07)*	0.04(0.10)	-0.07(0.10)	-0.15(0.10)
Girl	.05(0.03)	0.02(0.03)	0.05(0.03)	0.05(0.03)
Ethnicity: White (ref)				
Mixed	-0.12(0.10)	-0.25(0.13)	-0.23(0.13)	-0.29(0.12)*
Indian	-0.06(0.11)	-0.13(0.11)	-0.07(0.11)	-0.02(0.11)
Pakistani/Bangladeshi	0.29(0.09)**	0.05(0.11)	0.08(0.11)	0.04(0.10)
Black/Black British	-0.25(0.10)*	-0.63(0.18)*	-0.59(0.18)*	-0.66(0.16)**
Other ethnic group	0.14(0.15)	-0.06(0.19)	-0.02(0.19)	-0.08(0.19)
Emotional symptoms, age 5		0.33(0.05)**	0.33(0.05)**	0.30(0.05)**
Verbal cognitive ability, age 7			-0.01(0.00)***	-0.01(0.00)***
Mother's highest qualification: None (ref)				-0.07(0.10)
Higher degree				-0.12(0.08)
First degree				-0.09(0.07)
A level/HE diploma				-0.07(0.06)
GCSEa-c				-0.01(0.10)
GCSEd-g				-0.14(0.16)
Other				
Parents' highest social class: Routine (ref)				0.03(0.10)
Higher managerial/professional				0.07(0.09)
Lower managerial/professional				-0.02(0.09)
Intermediate				0.08(0.09)
Small employers				0.08(0.09)
Lower supervisory				0.15(0.09)
Semi-routine				
Family poverty, age 5				0.05(0.03)
Family poverty, age 7				0.02(0.03)
Ever in lone-parent family				0.19(0.05)***
Maternal depressed mood, age 5				0.06(0.01)***
Constant	1.07(0.47)*	.99(0.45)*	2.52(0.48)***	2.10(0.49)***
R squared adjusted	0.01-0.01	0.14 – 0.19	0.15 – 0.20	0.17 – 0.21

Notes. R squared adjusted shows the range of the five imputed datasets for each model. In SPSS 20 a model summary is not given for the pooled results. *p < .05, ** p < .01, ***p < .001

Table 5. Peer problems at age 7: unstandardized regression coefficients (standard errors) – multiple linear regression (N =11,991)

	1	2	3	4
Aspiration: Non-rare occupation (ref)				
Rare occupation	-0.21(0.03)***	-0.19(0.03)***	-0.17(0.03)***	-0.15(0.03)***
Fantasy	0.33(0.13)*	0.28(0.12)*	0.27(0.12)*	0.26(0.12)*
Descriptive	0.07(0.09)	-0.01(0.09)	-0.04(0.09)	-0.06(0.09)
Uncertain	-0.05(0.06)	-0.07(0.06)	-0.08(0.06)	-0.04(0.06)
Age	-0.04(0.06)	-0.08(0.06)	-0.12(0.06)*	-0.14(0.06)*
Stratum: England-advantaged (ref)				
England-disadvantaged	0.36(0.04)***	0.25(0.04)***	0.21(0.04)***	0.11(0.04)**
England-ethnic	0.32(0.07)***	0.12(0.09)	0.10(0.09)	-0.04(0.09)
Wales-advantaged	-0.10(0.07)	-0.14(0.07)	-0.17(0.07)*	-0.15(0.07)*
Wales-disadvantaged	0.19(0.05)***	0.08(0.05)	-0.01(0.05)	-0.10(0.05)
Scotland-advantaged	-0.16(0.06)**	-0.18(0.06)**	-0.19(0.06)**	-0.16(0.06)**
Scotland-disadvantaged	0.15(0.06)*	0.04(0.07)	-0.00(0.06)	.-0.08(0.06)
Northern Ireland-advantaged	-0.24(0.07)**	-0.25(0.07)***	-0.30(0.07)***	-0.24(0.07)**
Northern Ireland-disadvantaged	0.13(0.06)*	0.02(0.07)	-0.07(0.07)	-0.16(0.07)*
Girl	-.22(0.03)***	-0.18(0.03)***	-0.16(0.03)***	-0.17(0.03)***
Ethnicity: White (ref)				
Mixed	0.18(0.09)*	0.12(0.09)	0.14(0.09)	0.07(0.09)
Indian	0.32(0.10)**	0.21(0.11)	0.27(0.11)*	0.32(0.11)**
Pakistani/Bangladeshi	0.63(0.08)***	0.31(0.12)*	0.34(0.12)*	0.30(0.11)*
Black/Black British	0.14(0.09)	-0.07(0.09)	-0.04(0.09)	-0.11(0.09)
Other ethnic group	0.27(0.14)*	0.08(0.16)	0.12(0.16)	0.06(0.16)
Peer problems, age 5		0.22(0.01)***	0.21(0.01)***	0.20(0.01)***
Verbal cognitive ability, age 7			-0.01(0.00)***	-0.01(0.00)***
Mother's highest qualification: None (ref)				-0.07(0.08)
Higher degree				-0.10(0.07)
First degree				-0.07(0.05)
A level/HE diploma				-0.02(0.05)
GCSEa-c				0.01(0.07)
GCSEd-g				0.13(0.11)
Other				
Parents' highest social class: Routine (ref)				0.00(0.09)
Higher managerial/professional				0.07(0.08)
Lower managerial/professional				-0.02(0.09)
Intermediate				0.11(0.09)
Small employers				0.13(0.10)
Lower supervisory				0.13(0.08)
Semi-routine				
Family poverty, age 5				0.07(0.03)*
Family poverty, age 7				0.01(0.03)
Ever in lone-parent family				0.22(0.04)***
Maternal depressed mood, age 5				0.05(0.01)***
Constant	1.48(0.41)***	1.54(0.41)***	2.85(0.43)***	2.39(0.42)***
R squared adjusted	0.05-0.05	0.40 – 0.42	0.42 – 0.43	0.42 – 0.43

Notes. R squared adjusted shows the range of the five imputed datasets for each model. In SPSS 20 a model summary is not given for the pooled results. *p < .05, ** p < .01, ***p < .001

Discussion

This Research Note presents an operational-isation of a taxonomy of the aspirations of primary school age children, based on data which had never previously been collected on such a large scale for this age. It explores the association of the type and maturity of the aspiration with the children's emotional and behavioural problems. Using data from the Millennium Cohort Study (MCS), we found, as expected, an association between seven-year-old children's aspirations and their emotional and behavioural problems at age 7. For most (91.5%) children in our sample, their first reported aspirations were occupational, suggesting that at age 7 children may already have dreams or ambitions for future careers. Children giving fantasy aspirations were more likely than children with aspirations for non-rare occupations to be hyperactive and have conduct and peer problems at age 7. Compared to aspirations for non-rare occupations, aspirations for rare occupations were associated with fewer peer problems and emotional symptoms.

This exploratory study showed that very few (1.1%) of the seven-year-olds in MCS aspired to be fantasy characters but many children (34.7%) had hopes for rare occupations. Rare occupational aspirations at this age may be an expression of hopes for the future, free from constraints. Children with ambitions for rare occupations may have higher self-efficacy and self-esteem and believe they can influence their choices regardless of the difficulty of their goals. This confidence in their abilities may also be reflected, in part, in their positive relations with peers. By contrast, fantasy aspirations at age 7 were associated with hyperactivity, conduct and peer problems. Although these findings may just represent how articulate the children are, which is linked to behavioural adjustment, this pattern of results accords with previous findings (Gottfredson, 1981) that children showing magical thinking in middle childhood may be behind on their development.

Some of our findings were unexpected. We had hypothesised that descriptive and uncertain aspirations would be associated with negative child outcomes. Uncertain aspirations were not associated with negative child outcomes, also found in Gutman and Schoon's (2012) study of uncertain adolescent aspirations. It seems that having uncertain occupational aspirations at age 7 and in adolescence does not result in negative outcomes, unlike having uncertain educational aspirations. Finally, age 7 descriptive aspirations were related to hyperactivity, but the association was not robust to adjustment for age 5 hyperactivity. A reason for this may be the heterogeneity of the responses labelled as descriptive aspirations. These ranged from desired physical attributes (e.g., 'tall') and emotional states (e.g., 'happy') to hopes for adult roles ('mum'). Some of these responses need not imply developmental difficulties. In the future, a more refined coding scheme could address this heterogeneity.

This Research Note has its limitations. The use of a large cohort is an important strength, but, as with all multi-purpose studies, there were limits to the scope of the questions included. Although the MCS children were given the opportunity to describe their aspirations in as much detail as they wished, they were not asked about the reasons for their choices. In addition, the aspiration question has so far been asked only in one sweep, and so no validation across sweeps can be made. Further, it is not clear how 'aligned' or 'misaligned' the children's aspirations were with their expectations. The seven-year-olds in MCS were not asked what they expected to be or thought they would be. Without asking directly about expectations, we cannot know whether some of them really thought they would be 'footballers' or 'fairies', for example, in the future. Finally, as aspirations were only available at one time point, causal inferences are difficult to defend. Aspirations at 7 are by no means the strongest factor associated with behavioural or emotional difficulties at this age. This Research Note showed aspirations play a minor role, but it remains to be seen how they may contribute to later attainments and difficulties as the cohort grows older. Despite these caveats, this investigation showed that middle childhood is a more fruitful source of evidence on cognition about the future than has been reflected in research to date.

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