

Lifecourse Trajectories and Cross-generation Trends in Social Isolation: Findings from Five Successive British Birth Cohort Studies

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Abstract

Despite growing concerns in the UK about social isolation, there remains a lack of evidence on the extent and time trends of social isolation from longitudinal, population-based studies. There is also little research that assesses the multiple domains of social isolation across the lifecourse and between generations in a holistic way accounting for different contexts. By applying a multi-context, multiple-domain framework of social isolation to 5 successive British birth cohorts, we provide conceptual and empirical understanding of social isolation trajectories across the lifecourse and identify potential generational and sex differences in trends. Where data were available, comparable social isolation indicators were generated to enable lifecourse trajectories and cross-generation trends to be explored. Information on isolation was available across the following relational contexts: household i.e., living alone; partnership, family and friends outside the household; education and employment networks; and community engagement. Trajectories were modelled stratified by sex using a multilevel growth curve framework. We analysed data from 73,847 individuals (48.5% female), in 5 successive cohorts born in 1946 (N=5,362), 1958 (N=16,742), 1970 (N=16,950), 1989-90 (N=15,562), and 2000-01 (N=19,231). Exploration of a range of social isolation indicators across several contexts provided a nuanced picture of social isolation across the lifecourse and between generations in the UK, with no clear pattern of increased or decreased isolation over time. For example, more people are living alone, less women are out of education and employment in midlife, more people are volunteering, but fewer people regularly engage in religious activity. It therefore highlights the need to focus on a range of social isolation indicators across contexts to understand how people compensate for specific types of isolation, and to understand structural differences in social configurations in the UK, which may not only define the timing and sequencing of life transitions but also social isolation.

Key words: social connectedness, age effects, cohort effects, trajectories, trends, multi-context

Background

Despite growing concerns about social isolation and loneliness, there remains a lack of conceptual clarity, with inconsistent definitions and measurement across research, policy, and practice (Wigfield, 2020). Social isolation is an objective condition (d'Hombres et al., 2021; Huisman & van Tilburg, 2021). The number and frequency of social interactions, for example how often an individual meets with friends and family, can be quantitatively assessed and are objective indicators of social isolation (Holt-Lunstad & Steptoe, 2022). Of course, that is not to say that people experience social isolation in the same way. Qualitative assessments of the extent to which relationships satisfy expectations and provide value and meaning are subjective and dynamic. There may even be times when an individual voluntarily withdraws from their social network, opting for a temporary period of solitude (De Jong Gierveld et al., 2016). By contrast, loneliness is a negative subjective feeling that arises when an individual experiences a discrepancy between their actual and desired social network, perceiving the quantity or quality of social relationships to be inadequate (Perlman & Peplau, 1984; What Works Centre for Wellbeing, 2019). It is therefore possible to feel lonely despite being socially connected, and to feel content in solitude.

Many existing definitions conflate social isolation and loneliness, combining the objective quantity and structure of networks with the perceived quality and emotional appraisal of relationships (Wang et al., 2017; Zavaleta et al., 2017). Given that empirical research reveals only a modest association between objective social isolation and loneliness, it is important that they are treated as related but distinct dimensions of social relationships (Hughes et al., 2004). Furthermore, data collected in the European Social Survey revealed that 20.8% of the European adult population were socially isolated between 2002 and 2018, compared with 8.6% who reported frequent loneliness (2006-2014) (d'Hombres et al., 2021). Rates of isolation and loneliness remained relatively stable across these periods demonstrating consistently higher rates of isolation. There is also evidence to suggest that the two constructs independently predict lower wellbeing, poorer physical health, and mortality in older age, with comparable mortality risks and a stronger association between isolation and poor health outcomes (Coyle & Dugan, 2012; Golden et al., 2009; Steptoe et al., 2013; Holt-Lunstad et al., 2015).

Investigation of objective social isolation shifts the focus away from individuals and towards structural factors contributing to a lack of social connectedness, helping to identify areas that are modifiable through targeted policy and intervention. After all, as is true of many other social resources, social connections are not equally available across the population (Umberson et al., 2022). With evidence to support an association between social isolation and poor health and wellbeing independent from loneliness, more research is needed that develops frameworks for capturing multiple objective indicators of social isolation. Emphasis should be placed on the different relational contexts in which social isolation can exist at different life stages and for different populations. To date, most research in the United Kingdom (UK) has focused on single indicators of social isolation, exploring time trends in prevalence. For example, data from the Office for National Statistics (ONS) reveals that living alone has increased over time with over one million more people living alone in the UK in 2017 than in 1996 and an increase of 8.3% of people living alone in the UK over the last 10 years (ONS, 2017; ONS, 2022). Although indicative of social isolation within the household, living alone could be the motivation to seek social interactions elsewhere such as

volunteering in the community or spending more time with friends, and is therefore not necessarily a good proxy for a lack of social support (Perissinotto & Covinsky, 2014).

Based on this argument, Klinenberg (2016) recommended that public health researchers identify how common different forms of isolation are in different contexts and populations. For example, a study revealing that between 1985 and 2004, the number of Americans reporting having no one to confide in almost trebled (McPherson et al., 2006); but also demonstrated changes in the contexts in which social relationships occurred, with more non-kin relationships and social contact with community organisations and neighbours in 1985 than in 2004. This study follows patterns identified earlier by Putnam (2000) in the General Social Survey that showed a decline in social capital (e.g., connections between individuals which can be embodied in organisational and societal participation, such as political, religious, and social groups) after the 1960s.

Beyond a lack of research that comprehensively assesses objective indicators of social isolation across different contexts, there are very few longitudinal studies that explore trajectories in social isolation across the lifecourse. One recent example from the United States (US) demonstrated a steady increase in social isolation from adolescence to later life (Umberson et al., 2022). Longitudinal approaches are also increasingly being utilised to highlight persisting disadvantages in social isolation. For example, Ishida and Wels (2020) utilised data from The Japanese Lifecourse Panel Survey to explore the longitudinal relationship between unemployment and social isolation and revealed a reciprocal relationship. However, the association between unemployment and social isolation was confounded by social and economic disadvantage in early years.

Up to now, evidence on the gendered patterns of social isolation has been inconsistent except for living alone, known to dramatically increase in later life, particularly for women who, in most countries, commonly outlive men (Esteve et al., 2020). There is also some evidence to suggest that women have larger social networks and higher participation in social activities (Kendler et al., 2005; Hong et al., 2009). However, there is no consensus over evidence for higher social isolation in women (Naito et al., 2021), men (Cudjoe et al., 2020; Liu et al., 2020), and studies that find no gender difference (Kotwal et al., 2021). In the most recent and comprehensive study to date, Umberson et al. (2022) utilised data from two US longitudinal surveys and found that males were more socially isolated throughout the lifecourse based on information relating to romantic relationships, family, friends, and the community.

It is important to consider social isolation patterns in the context of gender differences in lifecourse trajectories. In recent times, we have seen a shift towards more complexity and diversity in the timing and nature of key life events (Widmer & Ritschard, 2009). Even with this overall diversity, gender differences remain, particularly with regard to employment participation and family formation (Roberson et al., 2017). Specifically, men are more likely to enter the labour market directly after completion of education, whereas female labour market trajectories are more complex on completion of education, involving movement between part-time work, full-time work, and family care (Widmer & Ritschard, 2009). With the aim of contributing further to this literature, we present our results separately for males and females to better understand the structural differences in social configurations in the UK, which may not only define the timing and sequencing of life transitions but also social isolation.

Multi-context, Multi-domain Framework of Social Isolation

In line with Klinenberg's (2016) recommendation for identifying the prevalence of different forms of social isolation across different contexts, the current study first developed a multi-context, multi-domain framework of social isolation to capture all relevant experiences across the lifecourse. Through scoping the literature, we identified multiple relational contexts within which social isolation can occur e.g., household, labour market (see Figure 1. a)). The relational contexts map onto the microsystem, presented in Bronfenbrenner's Ecological System Theory (Bronfenbrenner, 1992), focusing on individuals' social conditions within their immediate environment. By providing a more complete picture of the most common types of social isolation experienced at different life stages and across generations, the context specific approach can help identify the most appropriate contexts for intervention at different ages. In addition to considering the different types of social relationships and the contexts within which they occur, we reviewed pre-existing conceptualisations of social isolation to identify common domains and objective indicators e.g., network size and frequency of contact (see Supplementary Table S1. for scoping of the literature and Figure 1a. for the objective indicators of social isolation within each relational context).

We applied the multi-context, multi-domain framework of social isolation to the data collected across 5 successive British birth cohort studies. Questions and derived variables that related to objective indicators of social isolation, as opposed to subjective assessments of the closeness, importance, or function of different social relationships, were compiled for each cohort. Items were coded based on the type of relational context they referred to (e.g., household, family, friends, education, employment, or community), as well as the domain of social isolation assessed (e.g., network size or frequency of contact). Data were not always available for each domain of social isolation within each relational context across the lifecourse and between the 5 cohort studies. Where data were available, comparable variables were generated to enable lifecourse trajectories and cross-generation trends. This involved a process of identifying common variables and derivable data points across timepoints and cohorts. Figure 1b. presents a reduced set of relational contexts and domains of social isolation and indicates where there were enough data, consistently measured, to model lifecourse trajectories across these 5 cohorts i.e., at least 3 sweeps of data collected.

Rationale

Although we have seen increased policy interest in the UK, there remains a lack of evidence on the extent of social isolation from longitudinal, population-based studies. These have the unique advantage of providing insights based on the same individuals across time. In general, there is also little research that assesses objective indicators of social isolation in a holistic way across the lifecourse and between generations. Establishing the lifecourse trajectories of social isolation across multiple contexts and domains might have many benefits, including identifying key life stages and contexts for intervention. This project therefore aims to fill the above evidence gaps by investigating social isolation across the lifecourse and between 5 successive British birth cohort studies with an additional focus on gender differences. By answering the research questions below, we will develop a conceptual and empirical understanding of social isolation through different life stages and identify potential generational differences in trends.

Research Questions:

1. What are the lifecourse trajectories of different objective indicators of social isolation?
2. Are there cross-generation differences in the lifecourse trajectories of objective social isolation?
3. Are there sex differences in the lifecourse and cross-generational trajectories of objective social isolation indicators?

< Figure 1 around here >

Method

Participants

Adolescence is defined by the World Health Organisation (WHO) as the period between age 10 and 19 years (WHO, 2014). This life stage is characterised by transitions out of compulsory education, into romantic relationships, and generally, a more independent social life, including for some, independent living. For these reasons, we decided to include data from 5 longitudinal British birth cohort studies from age 10 years and onwards. This decision was also informed by the fact that, in many of the British birth cohort studies, self-report questionnaires were not included in data collection sweeps before this age.

Medical Research Council National Survey of Health and Development (NSHD, 1946 British Birth Cohort) is the oldest of the British birth cohort studies. With an initial sample of 13,687 babies born in one week across England, Scotland, and Wales in March 1946, the survey aimed to explore the national distribution of medical and maternity service use, and the association with reduced infant mortality and better mother and infant health (Wadsworth et al., 2006). In early childhood, a socially stratified sample was selected for follow-up consisting of 5,362 singleton babies from the original sample that were born to married parents. Since then, cohort members have been followed up over 20 times.

National Child Development Study (NCDS, 1958 British Birth Cohort) is the second oldest national-level birth cohort study, and started out as a perinatal mortality survey to inform improvements to maternity services in Britain (Power & Elliott, 2006). The original sample consisted of 17,415 babies born in England, Scotland, and Wales in a single week in 1958. The childhood sweeps also saw the addition of 800 immigrant participants born in March 1958. Since birth, the cohort members have been followed up at ages 7, 11, 16, 23, 33, 42, 44, 46, 50 and 55.

1970 British Cohort Study (BCS70) is a multidisciplinary, longitudinal study following the lives of approximately 17,000 individuals born in one week in 1970 across England, Scotland and Wales (Elliott & Shepherd, 2006; Sullivan et al., 2022). An additional sample of immigrant participants were included in the study at ages 5 (n=68), 10 (n=270), 16 (n=57) and 26 (n=8). Since 1970, cohort members have been followed up nine times at ages 5, 10, 16, 26, 30, 34, 38, 42, and 46.

Next Steps (NS, born 1989-90), previously known as the Longitudinal Study of Young People in England, was originally funded by the Department of Education. Unlike NSHD, NCDS and BCS70, Next Steps did not start at birth and the initial survey was conducted when cohort

members were 14 years old and involved a sample of 15,770 individuals born within one year (1989-90) in England (Calderwood & Sanchez, 2016). Cohort members were followed up each year between ages 14 and 20 and then again at age 25.

Millennium Cohort Study (MCS, born 2000-02) is the newest of the multidisciplinary, longitudinal studies, and involves around 19,000 people born between 2000 and 2002 across England, Scotland, Wales and Northern Ireland (Connelly & Platt, 2014). Cohort members have since been followed up at ages 9 months, 3, 5, 7, 11, 14 and 17. To gain a sample representative of the UK population, sub-groups such as children living in disadvantaged areas and ethnic minority groups were over-sampled.

Objective Indicators of Social Isolation

Across all cohorts, we were able to generate comparable household variables at regular intervals across the lifecourse indicating the household size, and whether a cohort member was living alone. Partnership status was also available at multiple data collection sweeps. Variables were generated to indicate not being partnered, and included information relating to marital status, other partnerships, and for some data collection sweeps, non-cohabiting relationships. The younger cohorts were more likely to include details of any romantic relationships, regardless of marital or co-habiting status.

Frequency of contact with friends and family outside the household was considered at least monthly rather than weekly; chosen to emphasise the focus on the lack of social contact. Due to the nature of the questions asked, it was only possible to reduce the available data to whether a cohort member had at least one friend. Given the inconsistencies in measurement across cohorts, and the small number of sweeps at which this information was collected, no lifecourse trajectories were modelled for this domain. For details of these variables see Supplementary Table S2. The family network beyond the household was also difficult to consistently quantify as questions often related to specific relatives relevant at a particular life stage and to only a sub-set of the cohort, for example, absent parents in childhood, and grandchildren in later life.

For all cohorts, information was available indicating whether a cohort member was in education, employment, both or neither. For the purposes of investigating social isolation, variables were coded to identify those in neither education nor employment. It was not possible to generate a network size for community contact (individuals or organisations/clubs). Instead, social activities in the community were organised into 5 themes and variables were generated to indicate membership to a network or whether the cohort member took part in that activity at least monthly. The 5 groups of activities were: membership to any clubs or organisations, volunteer status, at least monthly religious activities, general social activities (e.g., going to the pub or the cinema), and sporting activities.

Analytical Strategy

Selection of Analytical Sample

When modelling the lifecourse trajectories of objective indicators of social isolation, the analytic sample included all cohort members alive, living in the United Kingdom, and with a valid measure at baseline (i.e., birth for all cohorts except NS which started data collection at age 14). Models were estimated using a full information maximum likelihood approach. Due to factors such as mortality, the target population in longitudinal studies is dynamic. Based

on the assumption that the mortality rate within cohorts is representative of the population (Mostafa et al., 2021), the analytic sample was defined and adjusted accordingly to generate descriptive statistics for cross-sectional comparisons. Due to very low rates of death in the younger cohorts (NS and MCS), descriptive statistics were generated post-imputation for the full analytic sample defined above. In NSHD, NCDS and BCS, where information was available on study members who had died, only those alive at each data collection sweep were included in the descriptive statistics sample.

To account for sampling, and design, provided weights were applied for all descriptive statistics and models in MCS, Next Steps and NSHD.

Missing Data

A full maximum likelihood approach was applied to models of the lifecourse trajectories of social isolation. For cross-sectional comparisons at different life stages across cohorts, missing data were dealt with for each sweep and cohort separately. The level of missing data was assessed for each social isolation variable (see Supplementary Table S3). Previous research conducted using data from NSHD, NCDS, BCS, NS and MCS, identified predictors of non-response in the data, improving the plausibility of the missing at random (MAR) assumption (Stafford et al., 2013; Mostafa & Wiggins, 2014; Mostafa & Ploubidis, 2017; Mostafa et al., 2020; Silverwood et al., 2020; Mostafa et al., 2021). We also used this research to inform the auxiliary variables included in the current study (Mustillo & Kwon, 2015).

A combination of variables of interest, and auxiliary variables were included in the final imputation models e.g., birth weight, parents' education level, childhood cognitive ability. For each cohort, data collected across the lifecourse were merged and multiple imputation using chained equations applied. Based on the proportion of missingness across social isolation variables, 20 imputations were deemed appropriate (Azur et al., 2011). The missing data strategy was consistent across the cohorts.

Modelling Trajectories

Trajectories of the different objective indicators of social isolation across the lifecourse were modelled, stratified by sex, using a multilevel growth curve framework. Multilevel models account for the clustering of observations (level 1) within individuals (level 2), where age is treated as an independent variable at the observation level (Suzuki, 2012). This therefore allows flexibility to model data with uneven time intervals. (Mostafa et al., 2020) Multilevel models also work under a MAR assumption (Steele, 2008). Given that most social isolation variables are binary e.g., living alone vs. not living alone, multilevel logit models were conducted.

Squared or cubic age polynomial terms were entered into the models to explore the best fit to the data. The Akaike information criterion (AIC) and Bayesian information criteria (BIC) were employed, with lower scores indicating a better model fit. For most social isolation indicators, the inclusion of a cubic age polynomial term produced the best model fit. With the aim of assessing cross-generation differences in trajectories, the decision was taken to universally apply the most complex, cubic models. Given that within each of the British birth cohort studies, cohort members were surveyed at approximately the same time points across the lifecourse, a fixed occasion design was applied, in which time was included as a fixed, explanatory variable. Between-individual differences in the intercepts and the slopes describing the growth curves were included in the model as random effects (Hox & Stoel,

2014). Cross-sectional descriptive statistics for the different indicators of social isolation at different life stages were computed post-imputation across the lifecourse for each of the cohorts. Growth curves are a data reduction technique, aiming to smooth over individual time points to generate the best fitting trajectory. For this reason, they are best interpreted as a general pattern and will not exactly match the changes between each underlying pair of scores.

Results

From here on, for ease of interpreting cross-generation comparisons, we refer to the cohorts by their birth years: NSHD (1946), NCDS (1958), BCS (1970), NS (1990), and MCS (2001). The analytic sample for modelling the lifecourse trajectories of social isolation included all cohort members alive, living in the United Kingdom, and with a valid measure at baseline resulting in a total sample of N=73,847 (48.5% female) of which N=5,362 (47.5% female) born in 1946, N=16,742 (48.5% female) born in 1958, N=16,950 (48.2% female) born in 1970, N=15,562 (49.1% female) born in 1990, and N=19,231 (48.6% female) born in 2000-01. For a small number of families (n= 252) in the 2001 cohort there was more than one cohort member due to multiple births; we randomly selected one for inclusion in the analytical sample. The proportion of missing data for social isolation indicators at each sweep across cohorts is presented in Supplementary Table S3. Multiple imputed descriptive statistics for social isolation indicators across ages in each cohort are presented in Table 1. These results are also presented for males and females separately in Supplementary Tables S4a and S4b.

Social Isolation Across Each Context

Household

Indicators of social isolation within the household included living alone and mean household size. Figure 2. shows that across multiple successive generations, the probability of living alone increased with age and cohort i.e., younger generations more likely to live alone across the lifecourse than older generations. For the cohort born in 1990, there was a particular increase in the probability of living alone during the early 20's. Overall, males had a higher probability of living alone in early to midlife and females in later life. In the older cohorts, the probability of living alone appeared to converge between the ages of 40-50, particularly for females. Household size decreased through early life to midlife, levelled off or increased in midlife and then declined later in life. For the oldest cohort (1946), the average household size decreased more steadily across the lifecourse, whereas for the cohort born in 1990, there was a sharp drop in average household size in the mid-20s. The average household size appeared to be declining across generations and this is most prominent before the age of 40. In general, males show a slightly smaller household size than females in adulthood, whereas females show a bigger decline in average household size in adulthood across generations.

< Figure 2 around here >

Friends and Family

Figure 3. shows the lifecourse trajectories and cross-generation trends in model predicted probability of not being partnered and not regularly having contact with friends or family outside of the household. In the oldest cohort (b.1946), the probability of not being partnered decreased from adolescence to early-mid adulthood then increased from age 40-65. Lifecourse trajectories of partnership status were similar for males and females. However, males were slightly more likely to not have a partner in earlier life and females later in life.

Overall, few cohort members were isolated based on the criteria of at least monthly contact with friends and relatives outside the household. Between ages 40-50, the cohorts born in 1958 and 1970 were much less likely to report no contact with friends and relatives outside the household compared with the oldest cohort (b.1946). Males were slightly more likely to not have regular contact with friends and family outside the household in later life, with a decrease in regular contact from age 35-70. For females, contact remained more constant. However, for the younger cohorts, males and females showed more similar trends in contact.

<Figure 3 around here>

Education and Employment

As shown in Figure 4. the probability of being neither in education nor employment increased throughout early adulthood and then declined to mid-50's when it started to increase again, likely due to retirement. There are large differences between males and females in early adulthood likely due to differences in labour market activities and childcare. Across generations, the probability of females being neither in education nor employment during this life stage decreased, possibly indicating changing patterns of family formation and labour market participation. The peak has also slightly shifted right, perhaps reflecting people starting families later. In the older cohorts, females were more likely to be out of education and employment in older age, especially post state retirement and pension age. Following school leaving, males born in 1990 were more likely to be out of education and employment than females.

<Figure 4 around here>

Community

Social isolation within the community was split into five indicators relating to a lack of membership to clubs or organisations, volunteering, and regular religious, social, and sporting activities (Figure 5). First, the probability of not being a member of a club or organisation increased from mid adulthood to older adulthood and then decreased in older age for the oldest cohort (b.1946). In addition, there were large differences between males and females in this cohort, with males more likely to be a member of a club or organisation in early adulthood than females. This could be due to labour market patterns and childcare norms. There was a bigger generational difference between the 1958 and 1970 cohorts for males, with males born in 1958 less likely to be a member of a club than those born in 1970 at this life stage. Overall, the younger cohorts showed a lower likelihood of belonging to a

club or organisation. For those born in 1990 the probability of not being a member of a club or organisation decreased from adolescence to mid-20s in both males and females.

Second, the probability of volunteering increased across generations, particularly from mid adulthood onwards. Overall, females were more likely to report volunteering than males across cohorts. Third, regular religious activity became less common across generations. Across the oldest three cohorts, males were less likely than females to be engaging in regular religious activity; however, this was more even across sexes in the two recent generations (b.1990, b.2001). Fourth, regular social activity in the oldest cohort decreased in adulthood and then increased post retirement age of 65. The probability of not engaging in regular social activity was quite similar for males and females across the lifecourse, with a slightly higher probability for females in the older cohorts in mid older adulthood. Finally, regular sporting activity was less likely for females in the younger cohorts, whereas the gender difference was less pronounced in the older generations.

< Figure 5 around here >

Social Isolation Across Generations

Figure 6 reshapes the data from Figures 1-5 by cohort, and provide the opportunity to compare across different social isolation contexts in each cohort. Overall, the figure highlights that there is no clear pattern of increased or decreased isolation across time and contexts.

Across all cohorts, the probability of living alone across the lifecourse was relatively low compared to other types of isolation. In the cohort born in 1990, both males and females had a higher probability of living alone by 25 than being out of education and employment, not engaging in regular social activity, and having contact with friends and family outside of the household. Lifecourse. Both males and females in the older cohorts, showed a high probability of regular contact with friends and family outside the household, even when living alone in late adulthood. However, in the oldest cohort, the age we observe a drop in the probability of having no regular social activities, corresponds to a spike in the probability of not being in education or employment. Overall, community networks appeared to be the least common across males and females compared to the other relational contexts within which isolation may occur.

< Figure 6 around here >

To further illustrate the utility of a multi-context approach and examine cross-generation trends in social isolation in the oldest three cohorts, a cumulative social isolation score was also generated in the mid-40s (ages 42-46). This life stage was chosen due to all three cohorts having information across all social isolation contexts enabling a comparable total score to be calculated (see suppl for details). Figure 7. shows the cumulative % of cohort members isolated at ages 42-46 across contexts for the 1946, 1958, and the 1970 cohorts.

< Figure 7 around here >

We observe a steady increase in the percentage of people experiencing no social isolation across generations (Figure 7). This could be driven by a greater number of people experiencing multiple forms of isolation in the oldest cohort, specifically a slightly higher proportion of women experiencing isolation across 2 or more contexts e.g., out of education and employment during this life stage plus another form of isolation. Although the number of cohort members experiencing all four types of social isolation was small across generations, there was a slight increase in the younger cohorts.

Discussion

As noted, despite increased policy focus on social isolation in the UK, there is a lack of evidence on the extent of social isolation from longitudinal, population-based studies. Few studies assess objective indicators of social isolation from across a range of relational contexts across the lifecourse. We therefore know little about the lifecourse trajectories of social isolation and possible generational and sex differences in these experiences. By examining social isolation using data across five generations spanning seven decades, we provide a conceptual and empirical understanding of social isolation illustrating patterns across contexts, the lifecourse, and how these changed across time for men and women in the UK. The focus on several contexts helps to capture the complexity of social isolation and explore possible ways that social and economic changes over the last century have shaped peoples' experiences.

Compared with social isolation in other contexts, the probability of living alone across the lifecourse and between generations was relatively low. This emphasises the need to assess multiple indicators of social isolation, and to take caution when using living alone as a proxy for a lack of social connectedness or support (Perissinotto & Covinsky, 2014). Having said this, the current study replicates previous findings in the UK by showing an increased number of people living alone in more recent generations (ONS, 2017; ONS, 2022). Lifecourse trajectories also showed that, in general, the probability of living alone increases with age and males have a higher probability of living alone in early to mid-life. In line with previous research, females were more likely to live alone in later life, likely due to more commonly outliving partners (Esteve et al., 2020). In the oldest cohort, the steadier decline in household size could be due to larger family sizes when the cohort members were children i.e., not having as many children as their parents, children leaving home, partnerships dissolving, and partners dying. Whereas in the younger cohort (born 90), both males and females had a higher probability of living alone by 25 than being out of education and employment, not engaging in regular social activity, and having contact with friends and family outside of the household. This unique finding could be due to a societal shift away from leaving the parental home to form own relationships and family, and towards leaving the family home for further education or employment.

A shift of this kind maps onto the Second Demographic Transition (SDT), a theoretical framework for observing family and fertility changes at the societal and individual level (Zaidi & Morgan, 2017), and an ideological shift towards more individualistic approaches (Van de Kaa, 1987). The SDT identifies a fertility delay (Van de Kaa 2001), which could be driving the larger number of people living alone in younger generations in the current study while they focus on gaining financial security. The SDT also encourages more consideration of the role of women in these fertility changes, including increased labour market participation and increased autonomy (Lesthaeghe, 1995). Findings in the current study

relating to being out of education and employment show clear generational and sex differences to support the transition. For example, across generations, the probability of females being neither in education nor employment during early adulthood has decreased, possibly indicating changing patterns of family formation and labour market participation. The peak has also slightly shifted towards later age, perhaps reflecting people starting families later. In contrast, men born in 1990 were more likely to be out of education and employment in their early adult life than those from the older generations at the same age, and this is likely to result from an economic downturn. As would be expected due to retirement, in the older cohorts, the number of people in neither education nor employment increased from age 53 and accelerated after age 60-64. This trend was similar in males and females, with a slightly higher probability of being out of education and employment for women, particularly in the cohort born in 1958.

Lifecourse trajectories of partnership status in the current study showed less clear support for the SDT. In the oldest cohort, the number of people without a partner gradually decreased into early mid adulthood and then increased from age 40-65, likely due to divorce or partner death. The probability of not being partnered in early adulthood was slightly lower for those born in 1970, but this could be because questions in this cohort accounted for non-cohabiting relationships as well as spouse or cohabiting partner. Overall, males were slightly more likely to not have a partner in earlier life and females later in life, likely due to outliving partners. In the cohort born in 1990, there was a higher proportion of people with no partner in early adulthood, in particular males, which aligns with a higher rate of living alone in this cohort and could be support for relationship and fertility delays (Van de Kaa 2001). Furthermore, males were more likely to not have a partner than to be out of education and employment in the oldest three cohorts, particularly in early adulthood but the opposite was true for females.

Overall, the proportion of people reporting social isolation in the form of no regular contact with friends and relatives outside the household was relatively low. For example, in the cohort born in 1990, both males and females were more likely to live alone than not engage regularly with family and friends outside the household showing possible compensatory social connections. Similarly, both males and females in the older cohorts showed a high probability of regular contact with friends and family outside the household, even when living alone in late adulthood. Although there are some mixed findings relating to gender differences in social isolation based on family and friend networks and frequency of contact, there is some evidence, including from a recent US longitudinal study (Umberson et al., 2022), that males are more socially isolated throughout the lifecourse and women have larger social networks and higher participation in social activities (Kendler et al., 2005; Hong et al., 2009).

With the exception of the 1970 cohort, in which there was a slightly higher probability that females did not have regular contact with family and friends during the 30's (perhaps due to childcare responsibilities and a double disadvantage with employment and household responsibilities causing time constraints), males were overall slightly more likely to report no regular contact with friends and relatives outside of the household. This gender difference was also seen in later life, with a decrease in regular contact from age 35-70, and in the youngest cohort (born 2000-02) in late adolescence. Overall, females' contact was more constant however, males and females' trends were more similar in the younger cohorts. In the oldest cohort, males' higher probability of not regularly seeing friends and family outside

the household between the ages of 40-60 could be due to gendered labour market participation, with men more likely to not have regular contact with friends and family than to be out of education and employment. However, compared to the cohorts born in 1958 and 1970, those born in 1946 were overall much more likely to report no regular contact with friends and relatives between ages 40-50, which could indicate a generational shift towards more social contact with people outside the household.

Overall, community networks appeared to be the least common across males and females indicating that community isolation may be more likely than in other relational contexts. Cohort members were least likely to report being a member of a community organisation or club, volunteering, or engaging in regular religious activity. Recent generations had a higher probability of not belonging to a club or organisation and, although religious activity remained relatively stable across the lifecourse, those in recent generations were less likely to engage in religious activity. In the most recent cohort born in 2000-01, very few cohort members reported regular religious activity and, although the gap has narrowed, males were generally less likely to report regular religious activities than females across all generations. These generational trends show some support for Putnam's (2000) observation of reduced organisational and societal participation over time. However, the current study shows the opposite pattern for volunteering, with younger generations more likely to volunteer than older generations, particularly from mid adulthood onwards. Like religious activity, females were more likely to report volunteering across cohorts than males. Although the probability of regular social and sporting activity was higher, findings relating to informal social networks in the current study provide a more nuanced picture than the one Putnam (2000). For example, males born in the oldest cohort are more likely to have no contact with friends and family than those from younger cohorts which contradicts the patterns expected by Putnam's theory. Moreover, we can see that for the oldest cohort there is a higher probability of having no regular social activity for both men and women compared to those from the younger cohorts. During midlife, cumulative social isolation scores also indicate a more complicated picture. Younger generations were less likely to report social isolation across contexts indicating a reduction of social isolation over generations, which is contrary to Putnam's theory. However, although the number of people experiencing social isolation across all contexts was small in all generations, there was a slight increase in the younger cohorts.

Strengths and limitations

The current study is the first to model lifecourse trajectories of social isolation in the UK using data from multiple, longitudinal, population-based studies and drawing on a range of social isolation indicators across several relational contexts. Analysing data from adolescence onwards in five cohorts representing successive generations, provided the unique opportunity to explore generational changes in social isolation at different life stages and between sexes. By using a multi-context, multi-domain framework of social isolation, we highlight the importance of considering a range of different contexts in which social isolation can occur and avoiding using single experiences (e.g., living alone) as a proxy for social isolation. The focus on different life stages and sex differences across a range of social isolation experiences provides a deeper understanding of demographic trends in isolation, and an insight into the complexity and multi-context nature in which social isolation is experienced. This work is therefore a good starting point for understanding who is at risk and at what life stages to enable future work with different stakeholders to identify policy implications and actions that might help reduce social isolation across the lifecourse.

The project involved careful harmonisation of social isolation variables within the cohorts, providing information for future researchers about the availability of social isolation indicators at different life stages across studies. It therefore highlights the wealth of questions available across the British birth cohort studies relating to social isolation and the potential for more focused research questions on the topic e.g., lifecourse trajectories of social isolation by socioeconomic status, a focus on early adulthood in younger generations who are more likely to live alone, or investigations into who compensates for isolation in which contexts and at what ages. Although the project demonstrates the vast potential for future research in the area, the process of compiling and harmonising social isolation variables across the lifecourse and across multiple generations also highlighted where there was limited availability of variables pertaining to certain domains of social isolation. For example, it was not possible in the current study to model lifecourse trajectories of friendship network size due to inconsistent and infrequent questioning on this topic. The project also highlights changing measurement practices across generations, which could potentially be the underlying cause of some of the study's findings. For example, in the older cohorts, marital status and cohabiting partnership was the only information available regarding romantic partners, whereas in the younger cohorts, participants were asked about boyfriends and girlfriends in adolescence and non-cohabiting partners in adulthood. These changes often reflect changing social attitudes and in themselves are an interesting historical study of changing norms across the last seven decades.

Conclusions

The present analyses provide a nuanced picture of social isolation across the lifecourse between generations with no clear pattern of increased or decreased isolation across time. The likelihood of living alone increases throughout the lifecourse especially for women and living alone is more common than it used to be with many more young adults living alone than in previous generations. However, these younger generations are much more likely to live alone than lack connections with friends and family outside the household or be out of education or employment, indicating the importance of capturing social connections across a range of contexts and possible compensatory behaviour when isolation occurs within one context. The current study also provides some support for changing patterns in family formation and labour market participation, with more women in education and employment across generations and possible partnership and fertility delays. Males were slightly less likely to report regular contact with friends and relatives outside of the household at different life stages and to engage in regular religious activity and volunteering. Overall, generational trends show some support for reduced organisational and societal participation over time. However, younger generations were more likely to report volunteering than previous generations. The methods and findings of this study highlight the need to focus on a range of social isolation indicators across contexts to understand how people compensate for isolation in any context, and to understand structural differences in social configurations in the UK over time, which may not only define the timing and sequencing of life transitions but also social isolation.

References

- Azur, M. J., Stuart, E. A., Frangakis, C., & Leaf, P. J. (2011). Multiple imputation by chained equations: what is it and how does it work? *International Journal of Methods in Psychiatric Research*, 20(1), 40–49. <https://doi.org/10.1002/mpr>
- Bronfenbrenner, U. (1992). *Ecological Systems Theory*. <https://doi.org/10.1007/978-0-387->

79061-9_4406

- Calderwood, L., & Sanchez, C. (2016). Next Steps (formerly known as the Longitudinal Study of Young People in England). *Open Health Data*, 4, 2–4. <https://doi.org/10.5334/ohd.16>
- Connelly, R., & Platt, L. (2014). Cohort profile: UK Millennium Cohort Study (mcs). *International Journal of Epidemiology*, 43(6), 1719–1725. <https://doi.org/10.1093/ije/dyu001>
- Coyle, C. E., & Dugan, E. (2012). Social isolation, loneliness and health among older adults. *Journal of Aging and Health*, 24(8), 1346–1363. <https://doi.org/10.1177/0898264312460275>
- Cudjoe, T. K. M., Roth, D. L., Szanton, S. L., Wolff, J. L., Boyd, C. M., & Thorpe, R. J. (2020). The Epidemiology of Social Isolation: National Health and Aging Trends Study. *Journals of Gerontology - Series B Psychological Sciences and Social Sciences*, 75(1), 107–113. <https://doi.org/10.1093/geronb/gby037>
- d’Hombres, B., Barjaková, M., & Schnepf, S. V. (2021). *Loneliness and Social Isolation: An unequally shared burden in Europe*. 14245, 23. <https://www.iza.org/publications/dp/14245/loneliness-and-social-isolation-an-unequally-shared-burden-in-europe>
- De Jong Gierveld, J., Van Tilburg, T. G., & Dykstra, P. A. (2016). New Ways of Theorizing and Conducting Research in the Field of Loneliness and Social Isolation. *The Cambridge Handbook of Personal Relationships*, 1–30. <https://repub.eur.nl/pub/93235%0Ahttps://repub.eur.nl/pub/93235/>
- Elliott, J., & Shepherd, P. (2006). Cohort profile: 1970 British Birth Cohort (BCS70). *International Journal of Epidemiology*, 35(4), 836–843. <https://doi.org/10.1093/ije/dyl174>
- Esteve, A., Reher, D. S., Treviño, R., Zueras, P., & Turu, A. (2020). Living Alone over the Life Course: Cross-National Variations on an Emerging Issue. *Population and Development Review*, 46(1), 169–189. <https://doi.org/10.1111/padr.12311>
- Golden, J., Conroy, R. M., Bruce, I., Denihan, A., Greene, E., Kirby, M., & Lawlor, B. A. (2009). Loneliness, social support networks, mood and wellbeing in community-dwelling elderly. *International Journal of Geriatric Psychiatry*, 24(7), 694–700. <https://doi.org/10.1002/gps.2181>
- Holt-Lunstad, J., Smith, T. B., Baker, M., Harris, T., & Stephenson, D. (2015). Loneliness and Social Isolation as Risk Factors for Mortality: A Meta-Analytic Review. *Perspectives on Psychological Science*, 10(2), 227–237. <https://doi.org/10.1177/1745691614568352>
- Holt-Lunstad, J., & Steptoe, A. (2022). Social isolation: An underappreciated determinant of physical health. *Current Opinion in Psychology*, 43, 232–237. <https://doi.org/10.1016/j.copsyc.2021.07.012>
- Hong, S. I., Hasche, L., & Bowland, S. (2009). Structural Relationships between Social Activities and Longitudinal Trajectories of Depression among Older Adults. *Gerontologist*, 49(1), 1–11. <https://doi.org/10.1093/geront/gnp006>
- Hox, J., & Stoel, R. D. (2014). Multilevel and SEM Approaches to Growth Curve Modeling. *Wiley StatsRef: Statistics Reference Online*, 0–10. <https://doi.org/10.1002/9781118445112.stat06603>
- Hughes, M. E., Waite, L. J., Hawkey, L. C., & Cacioppo, J. T. (2004). A short scale for measuring loneliness in large surveys: Results from two population-based studies.

- Research on Aging*, 26(6), 655–672. <https://doi.org/10.1177/0164027504268574>
- Huisman, M., & van Tilburg, T. G. (2021). Social exclusion and social isolation in later life. In *Handbook of Aging and the Social Sciences*. INC. <https://doi.org/10.1016/b978-0-12-815970-5.00007-3>
- Ishida, K., & Wels, J. (2020). The Reciprocal Relationship Between Unemployment and Social Isolation in Contemporary Japan: A Longitudinal Approach Using the Japanese Life Course Panel Survey. *SSRN Electronic Journal*, 120. <https://doi.org/10.2139/ssrn.3650644>
- Kendler, K. S., Myers, J., & Prescott, C. . (2005). Sex Differences in the Relationship Between Social Support and Risk for Major Depression : A Longitudinal Study of Opposite-Sex Twin Pairs. *American Journal of Psychiatry*, 162(2), 250–256.
- Klinenberg, E. (2016). Social Isolation, Loneliness, and Living Alone: Identifying the Risks for Public Health. *American Journal of Public Health*, 106(5), 786–787. <https://doi.org/10.2105/AJPH.2016.303166>
- Kotwal, A. A., Cenzer, I. S., Waite, L. J., Covinsky, K. E., Perissinotto, C. M., Boscardin, W. J., Hawkey, L. C., Dale, W., & Smith, A. K. (2021). The epidemiology of social isolation and loneliness among older adults during the last years of life. *Journal of the American Geriatrics Society*, 69(11), 3081–3091. <https://doi.org/10.1111/jgs.17366>
- Lesthaeghe, R. (2020). The second demographic transition, 1986–2020: sub-replacement fertility and rising cohabitation—a global update. *Genus*, 76(1). <https://doi.org/10.1186/s41118-020-00077-4>
- Liu, H., Zhang, M., Yang, Q., & Yu, B. (2020). Gender differences in the influence of social isolation and loneliness on depressive symptoms in college students: a longitudinal study. *Social Psychiatry and Psychiatric Epidemiology*, 55(2), 251–257. <https://doi.org/10.1007/s00127-019-01726-6>
- Mcperson, M., Smith-lovin, L., & Brashears, M. E. (2006). Social isolation in America: changes in core discussion networks over two decades. *American Sociological Review*, 1, 353–375.
- Mostafa, T., Narayanan, M., Pongiglione, B., Dodgeon, B., Goodman, A., Silverwood, R. J., & Ploubidis, G. B. (2020a). Improving the plausibility of the missing at random assumption in the 1958 British birth cohort: A pragmatic data driven approach. *CLS Working Paper 2020/6*. <https://cls.ucl.ac.uk/wp-content/uploads/2020/04/CLS-working-paper-2020-6-Improving-the-plausibility-of-the-missing-at-random-assumption-in-the-1958-British-birth-cohort.pdf>
- Mostafa, T., Narayanan, M., Pongiglione, B., Dodgeon, B., Goodman, A., Silverwood, R. J., & Ploubidis, G. B. (2020b). *Improving the plausibility of the missing at random assumption in the 1958 British birth cohort: A pragmatic data driven approach*. <https://cls.ucl.ac.uk/wp-content/uploads/2020/04/CLS-working-paper-2020-6-Improving-the-plausibility-of-the-missing-at-random-assumption-in-the-1958-British-birth-cohort.pdf>
- Mostafa, Tarek, Narayanan, M., Pongiglione, B., Dodgeon, B., Goodman, A., Silverwood, R. J., & Ploubidis, G. B. (2021). Missing at random assumption made more plausible: evidence from the 1958 British birth cohort. *Journal of Clinical Epidemiology*, 136, 44–54. <https://doi.org/10.1016/j.jclinepi.2021.02.019>
- Mostafa, Tarek, & Ploubidis, G. (2017). *Millennium Cohort Study - Sixth Survey 2015-2016 Technical report on response (Age 14). February*. https://doc.ukdataservice.ac.uk/doc/8156/mrdoc/pdf/mcs6_report_on_response.pdf

- Mostafa, Tarek, & Wiggins, R. D. (2014). Handling attrition and non-response in the 1970 British Cohort Study. *CLS Working Paper 2014/2, June*.
- Mustillo, S., & Kwon, S. (2015). Auxiliary Variables in Multiple Imputation When Data Are Missing Not at Random. *Journal of Mathematical Sociology, 39*(2), 73–91. <https://doi.org/10.1080/0022250X.2013.877898>
- Naito, R., Leong, D. P., Bangdiwala, S. I., McKee, M., Subramanian, S. V., Rangarajan, S., Islam, S., Avezum, A., Yeates, K. E., Lear, S. A., Gupta, R., Yusufali, A., Dans, A. L., Szuba, A., Alhabib, K. F., Kaur, M., Rahman, O., Seron, P., Diaz, R., ... Yusuf, S. (2021). Impact of social isolation on mortality and morbidity in 20 high-income, middle-income and low-income countries in five continents. *BMJ Global Health, 6*(3). <https://doi.org/10.1136/bmjgh-2020-004124>
- Office for National Statistics. (2017). *Families and households in the UK: 2017*.
- Perissinotto, C. M., & Covinsky, K. E. (2014). Living Alone, Socially Isolated or Lonely—What are We Measuring? *Journal of General Internal Medicine, 29*(11), 1429–1431. <https://doi.org/10.1007/s11606-014-2977-8>
- Perlman, D., & Letitia Anne Peplau. (1984). *LONELINESS RESEARCH: A SURVEY OF EMPIRICAL FINDINGS*. <https://doi.org/10.1037/024538>
- Power, C., & Elliott, J. (2006). Cohort profile: 1958 British birth cohort (National Child Development Study). *International Journal of Epidemiology, 35*(1), 34–41. <https://doi.org/10.1093/ije/dyi183>
- Putnam, R. D. (2000). *Bowling Alone: The Collapse and Revival of American Community*. New York: Simon & Schuster.
- Roberson, P. N. E., Norona, J. C., Zorotovich, J., & Dirnberger, Z. (2017). Developmental Trajectories and Health Outcomes Among Emerging Adult Women and Men. *Emerging Adulthood, 5*(2), 128–142. <https://doi.org/10.1177/2167696816662118>
- Silverwood, R. J., Calderwood, L., Sakshaug, J. W., & Ploubidis, G. B. (2020). A data driven approach to understanding and handling non-response in the Next Steps cohort. *Centre for Longitudinal Studies Working Paper*.
- Stafford, M., Black, S., Shah, I., Hardy, R., Pierce, M., Richards, M., Wong, A., & Kuh, D. (2013). Using a birth cohort to study ageing: Representativeness and response rates in the National Survey of Health and Development. *European Journal of Ageing, 10*(2), 145–157. <https://doi.org/10.1007/s10433-013-0258-8>
- Steele, F. (2008). Multilevel models for longitudinal data. *Journal of the Royal Statistical Society. Series A: Statistics in Society, 171*(1), 5–19. <https://doi.org/10.1111/j.1467-985X.2007.00509.x>
- Stephens, A., Shankar, A., Demakakos, P., & Wardle, J. (2013). Social isolation, loneliness, and all-cause mortality in older men and women. *Proceedings of the National Academy of Sciences of the United States of America, 110*(15), 5797–5801. <https://doi.org/10.1073/pnas.1219686110>
- Suzuki, E. (2012). Time changes, so do people. *Social Science and Medicine, 75*(3), 452–456. <https://doi.org/10.1016/j.socscimed.2012.03.036>
- Umberson, D., Lin, Z., & Cha, H. (2022). Gender and social isolation across the life course. *Journal of Health and Social Behavior, 1*–17. <https://doi.org/10.1177/00221465221109634>
- Wadsworth, M., Kuh, D., Richards, M., & Hardy, R. (2006). Cohort profile: The 1946

- National Birth Cohort (MRC National Survey of Health and Development). *International Journal of Epidemiology*, 35(1), 49–54. <https://doi.org/10.1093/ije/dyi201>
- Wang, J., Lloyd-Evans, B., Giacco, D., Forsyth, R., Nebo, C., Mann, F., & Johnson, S. (2017). Social isolation in mental health: a conceptual and methodological review. *Social Psychiatry and Psychiatric Epidemiology*, 52(12), 1451–1461. <https://doi.org/10.1007/s00127-017-1446-1>
- Wellbeing, W. W. C. for. (2019). A conceptual review of loneliness across the adult life course (16+ years). *University London, July*. <https://whatworkswellbeing.org/wp-content/uploads/2020/02/V3-FINAL-Loneliness-conceptual-review.pdf>
- Widmer, E. D., & Ritschard, G. (2009). The de-standardization of the life course: Are men and women equal? *Advances in Life Course Research*, 14(1–2), 28–39. <https://doi.org/10.1016/j.alcr.2009.04.001>
- Wigfield, A. (2020). Developing a new conceptual framework of meaningful interaction for understanding social isolation and loneliness. *Social Policy and Society*.
- World Health Organization. (2014). *Adolescence: a period needing special attention - age-not-the-whole-story*. <http://apps.who.int/adolescent/second-decade/section2/page2/age-not-the-whole-story.html>
- Zaidi, B., & Morgan, S. P. (2017). The second demographic transition theory: a review and appraisal. *Annu Rev Sociol.*, 43, 473–492. <https://doi.org/10.1146/annurev-soc-060116-053442>.THE
- Zavaleta, D., Samuel, K., & Mills, C. T. (2017). Measures of Social Isolation. *Social Indicators Research*, 131(1), 367–391. <https://doi.org/10.1007/s11205-016-1252-2>

Table 1. Descriptive statistics for social isolation indicators across ages in each cohort

Cohort		1946 cohort (NSHD)							
Age at sweep	11	15	26	36	43	53	63-64	69-70	
N	5,122	5,112	5,072	5,039	5,001	4,886	4,615	4,336	
Household									
Household size Mean (SE)	5.02(.03)	4.87(.03)	3.22(.02)	3.80(.03)	3.50(.03)	2.57(.02)	2.09(.02)	1.95(.02)	
Living alone % (SE)	0.0(.00)	0.1(.00)	3.5(.00)	2.7(.00)	4.1(.00)	8.5(.01)	11.1(.01)	12.6(.01)	
Family and Friends									
No partner % (SE)		**	23.8(.01)	13.4(.01)	21.2(.01)	24.1(.01)	27.2(.01)	29.6(.01)	
No regular contact with family and friends outside household % (SE)				11.8(.01)	22.4(.01)	22.0(.01)	27.9(.01)	22.9(.01)	
Education and Employment									
Neither in education nor employment % (SE)	0.0(.00)	0.0(.00)	28.2(.01)	22.8(.01)	13.7(.01)	22.7(.01)	50.5(.01)	81.4(.01)	
Community									
No membership to clubs/organisations/groups % (SE)	61.0(.01)	33.8(.01)	32.5(.01)	37.6(.01)	62.7(.01)		55.7(.01)	50.1(.01)	
No volunteering % (SE)				92.1(.01)	91.7(.01)		80.3(.01)	82.0(.01)	
No regular religious activity % (SE)	22.7(.01)	90.2(.01) ** Age 16		48.7(.01)	86.0(.01)		87.8(.01)	82.4(.01)	
No regular social activity % (SE)				9.4(.01)	26.2(.01)		55.2(.01)	16.4(.01)	
No regular sporting activity % (SE)		94.6(.00) ** Age 16		25.7(.01) **	48.3(.01)	51.4(.01)	67.6(.01)	64.0(.01)	
Cohort		1958 cohort (NCDS)							
Age at sweep	11	16	23	33	42	46	50	55	
N	16,574	16,542	16,467	16,383	16,237	16,118	15,994	15,800	
Household									
Household size Mean (SE)	5.13(.01)	4.82(.01)	3.15(.01)	3.39(.01)	3.42(.01)	3.17(.01)	2.85(.01)	2.51(.01)	
Living alone % (SE)	0.0(.00)	0.1(.00)	4.5(.00)	6.0(.00)	6.7(.00)	8.2(.00)	9.1(.00)	10.8(.00)	
Family and Friends									
No partner % (SE)			49.3(.00)	20.4(.00)	20.7(.00)	13.3(.00)	16.4(.00)	30.9(.00)	
No regular contact with family and friends outside household % (SE)	14.7(.00)		5.5(.00)		2.2(.00)	1.4(.00) **Age 44	7.9(.00)		
Education and Employment									
Neither in education nor employment % (SE)	0.0(.00)	0.0(.00)	24.2(.00)	20.8(.00)	15.8(.00)	14.9(.00)	16.9(.00)	21.8(.00)	
Community									
No membership to clubs/organisations/groups % (SE)	40.2(.00)			88.5(.00)		68.9(.00)	56.1(.01)	53.6(.00)	
No volunteering % (SE)		61.8(.00)	76.5(.00)	90.3(.00)		67.6(.01)	76.4(.00)	75.5(.00)	
No regular religious activity % (SE)			90.4(.00)	86.2(.00)	87.7(.00)	85.1(.00)	86.9(.00)		
No regular social activity % (SE)		4.5(.00)	31.0(.00)				26.8(.00)	28.2(.01)	
No regular sporting activity % (SE)	12.5(.00)	19.5(.00)	52.8(.00)			98.3(.00)	29.8(.01)	26.0(.00)	
Cohort		1970 cohort (BCS)							
Age at sweep	10	16	26	30	34	38	42	46	
N	16,585	16,554	16,467	16,423	16,376	16,318	16,242	16,228	

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Household								
Household size Mean (SE)	4.65(.01)	4.24(.01)	2.74(.01)	2.83(.01)	3.09(.01)	3.32(.01)	3.32(.01)	3.15(.01)
Living alone % (SE)	0.0(.00)	1.5(.00)	8.7(.00)	9.6(.00)	8.2(.00)	6.7(.00)	7.3(.00)	7.8(.00)
Family and Friends								
No partner % (SE)		67.2(.01)	23.5(.00)	14.3(.00)		17.0(.00)	16.1(.00)	16.4(.00)
No regular contact with family and friends % (SE)		21.6(.01)		1.1(.00)	25.7(.01)		4.0(.00)	5.6(.00)
Education and Employment								
Neither in education nor employment % (SE)	0.0(.00)	0.0(.00)	17.6(.00)	17.8(.00)	17.0(.00)	16.6(.00)	15.7(.00)	14.8(.00)
Community								
No membership to clubs/organisations/groups % (SE)	31.1(.00)	39.4(.01)		76.8(.01)	76.6(.00)			56.8(.01)
No volunteering % (SE)		80.6(.01)		74.0(.01)	64.3(.00)		56.0(.01)	
No regular religious activity % (SE)		78.4(.01)		90.8(.00)	89.0(.00)		90.2(.00)	
No regular social activity % (SE)	8.2(.00)	4.2(.00)			6.6(.01)		27.6(.01)	
No regular sporting activity % (SE)	1.7(.00)	32.1(.01)					22.1(.01)	16.3(.00)
Cohort								
1990 cohort (NS)								
Age at sweep	14	15	16	17	18	19	20	25
N	15,498	15,498	15,498	15,498	15,498	15,498	15,498	15,498
Household								
Household size Mean (SE)	4.31(.01)	4.27(.01)	4.21(.01)	4.10(.01)	3.99(.01)	3.83(.01)	3.68(.01)	2.41(.02)
Living alone % (SE)	0.1(.00)	0.1(.00)	0.2(.00)	0.8(.00)	1.9(.00)	3.4(.00)	4.7(.00)	16.8(.01)
Family and Friends								
No partner % (SE)						51.1(.01)	49.0(.01)	55.2(.01)
No regular contact with family and friends outside household % (SE)	15.2(.00)	14.0(.00)						4.7(.00)
Education and Employment								
Neither in education nor employment % (SE)	0.0(.00)	0.0(.00)	0.0(.00)	8.3(.00)	11.3(.00)	15.3(.00)	15.2(.00)	13.6(.00)
Community								
No membership to clubs/organisations/groups % (SE)	79.2(.00)	82.3(.00)		81.2(.00)				56.8(.01)
No volunteering % (SE)	95.7(.00)	94.0(.00)				91.6(.00)	68.3(.01)	60.5(.01)
No regular religious activity % (SE)	91.2(.00)	92.3(.00)		92.2(.00)				92.6(.00)
No regular social activity % (SE)	12.0(.00)	10.7(.00)		8.7(.00)				12.2(.00)
No regular sporting activity % (SE)	35.1(.00)	38.4(.00)		22.3(.00)				23.3(.01)
Cohort								
2001 cohort (MCS)								
Age at sweep	11	14	17					
N	19,231	19,231	19,231					
Household								
Household size Mean (SE)	4.38(.01)	4.30(.01)	4.15(.01)					
Living alone % (SE)	0.0(.00)	0.0(.00)	0.3(.00)					
Family and Friends								
No partner % (SE)		82.2(.00)	66.8(.01)					

Lifecourse Trajectories and Cross-generation Trends in Social Isolation

No regular contact with family and friends outside household % (SE)	3.1(.00)	3.3(.00)	11.1(.00)					
Education and Employment								
Neither in education nor employment % (SE)	0.0(.00)	0.0(.00)	0.0(.00)					
Community								
No membership to clubs/organisations/groups % (SE)		44.6(.01)	62.4(.01)					
No volunteering % (SE)			43.6(.01)					
No regular religious activity % (SE)	74.5(.00)	82.5(.00)	87.4(.00)					
No regular social activity % (SE)		46.3(.01)	35.6(.01)					
No regular sporting activity % (SE)	22.9(.00)							

Note: 64 cohort members with missing weight in Next Steps reducing analytic sample from 15,562 to 15,498. **1958 cohort no regular contact with family and friends outside household taken from age 44 biomedical sweep, 1946 cohort marital status ages 16-26 not imputed, age 15 religious and sporting activity taken from age 16 sweep, additional information available for sporting activity age 31.

Figure legends

Figure 1. Social isolation frameworks. 1a. *Multi-context, multi-domain framework of social isolation: objective indicators of social isolation within each relational context, 1b. Objective indicators of social isolation available across sweeps and cohorts within the reduced set of relational contexts used in this study*

Figure 2. *Lifecourse trajectories and cross-generation trends in model predicted probability of living alone and mean household size*

Figure 3. *Lifecourse trajectories and cross-generation trends in model predicted probability of not being partnered and not regularly having contact with friends or family outside of the household*

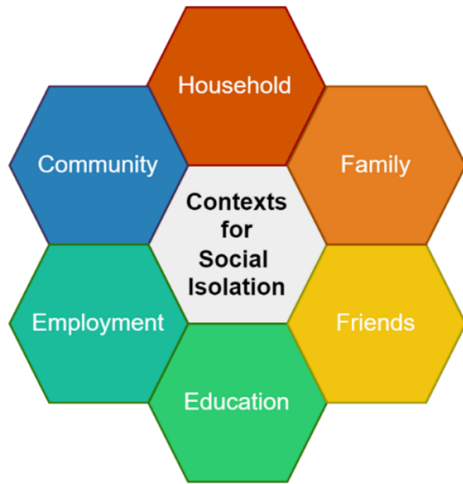
Figure 4. *Lifecourse trajectories and cross-generation trends in model predicted probability of being in neither education nor employment (note: dotted lines indicate age of compulsory education for the different generations)*

Figure 5. *Lifecourse trajectories and cross-generation trends in model predicted probability of no membership to clubs/organisations, no volunteering, and no regular religious, social and sporting activities*

Figure 6. *Lifecourse trajectories of social isolation indicators modelled by gender for each cohort*

Figure 7. *Cumulative % of cohort members socially isolated at age 42-26 across contexts for the 1946, 1958, and the 1970 cohorts split by sex*

a.



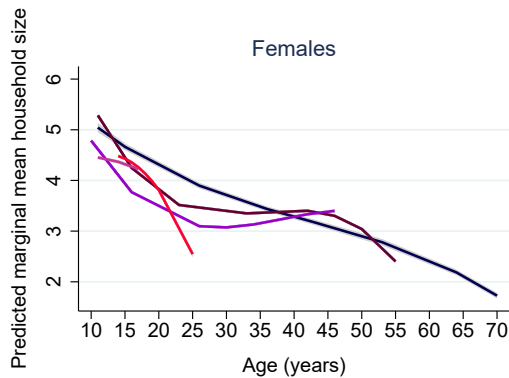
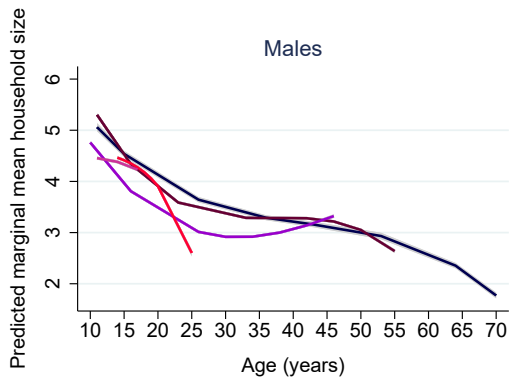
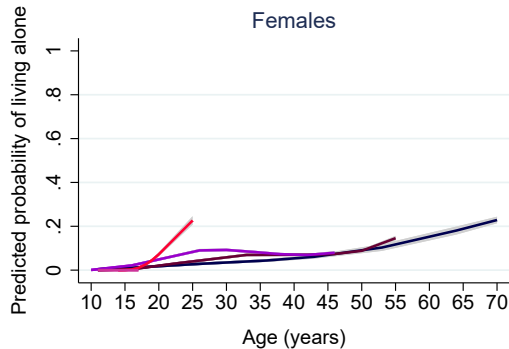
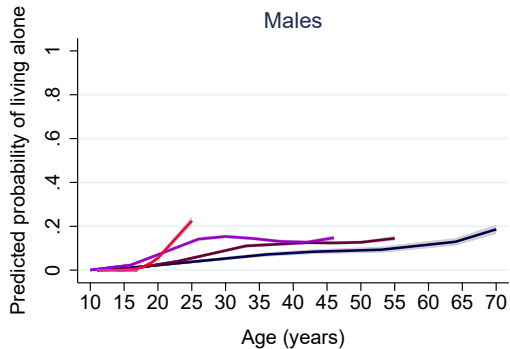
<p>Network size Living alone Household size</p> <p>Network composition Indicators of household members e.g., parent, partner, child, non-relative)</p>	<p>Network size Size of family network outside of household</p> <p>Network composition Composition of family network outside of household</p> <p>Frequency of contact Frequency of contact with family outside of household e.g. seeing a parent that does not live with you</p>	<p>Network size Partnership status (cohabiting vs. non-cohabiting) Size of friend network outside of household</p> <p>Network composition Composition of partners/friends outside of household e.g., similarity of friends in terms of age, ethnicity, religion</p> <p>Frequency of contact Frequency of contact with non-cohabiting partner and/or friends outside of household</p>	<p>Network size In education vs. not in education, number of education networks</p> <p>Network composition Composition of education networks</p> <p>Frequency of contact Frequency of attendance e.g., full vs. part time education</p>	<p>Network size In employment vs. not in employment, number of jobs</p> <p>Network composition Composition of employment networks</p> <p>Frequency of contact Frequency of attendance e.g., full vs. part time employment</p>	<p>Network size Size of community network e.g., number of memberships to clubs/organisations, volunteering status, number of neighbours known</p> <p>Network composition Composition of community networks</p> <p>Frequency of contact Frequency of contact with community networks and social activity in the community e.g., religious activity</p>
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b.



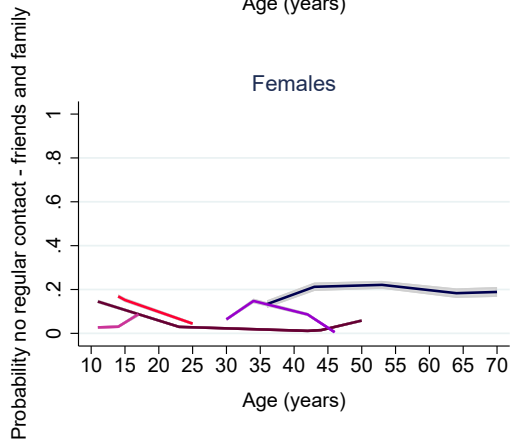
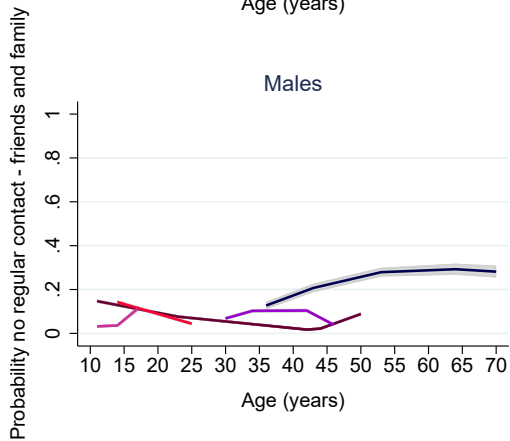
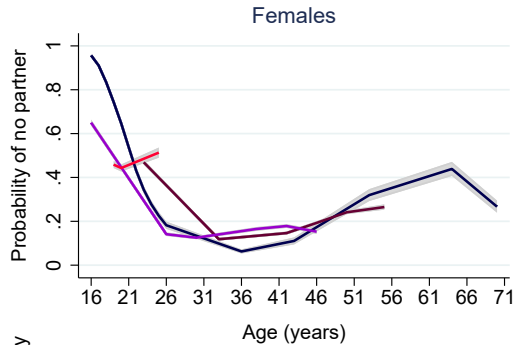
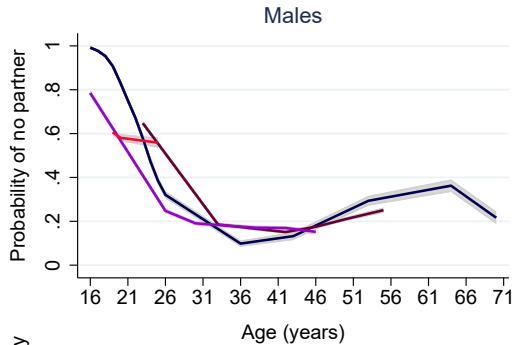
<p>Network size Living alone ** Household size **</p> <p>Network composition Indicators of household members e.g., parent, partner, child, non-relative)</p>	<p>Network size No partner ** No friends</p> <p>Frequency of contact Less than monthly contact with family and friends outside of the household **</p>	<p>Network size In education In employment Both Neither **</p>	<p>Network size No membership to clubs/organisations ** No volunteering **</p> <p>Frequency of contact Less than monthly Religious activity ** Social activity e.g., going to the pub ** Sporting activity **</p>
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** Indicates domains of social isolation with enough data and consistent measurement to model life course trajectories across cohorts



Cohort year of birth

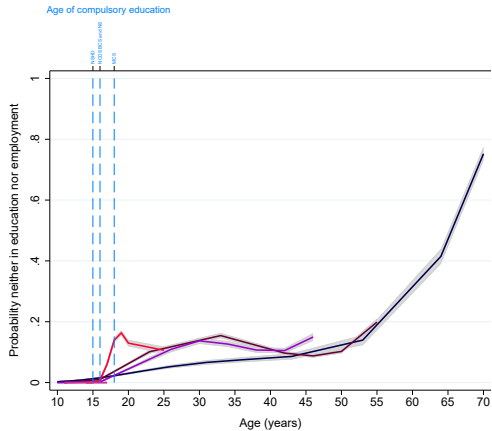




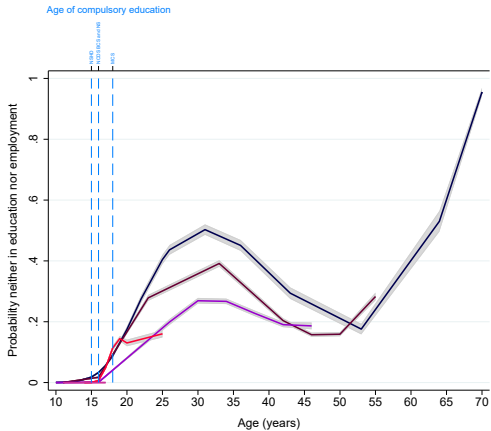
Cohort year of birth



Males



Females



Cohort year of birth

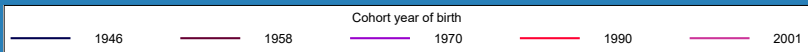
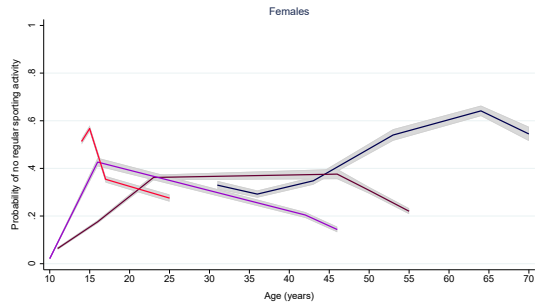
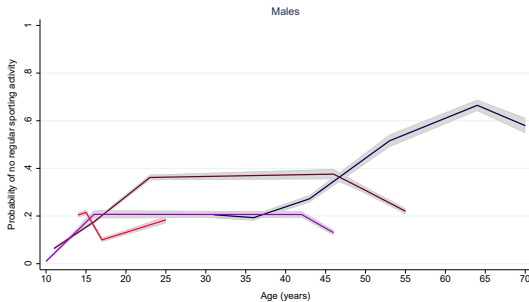
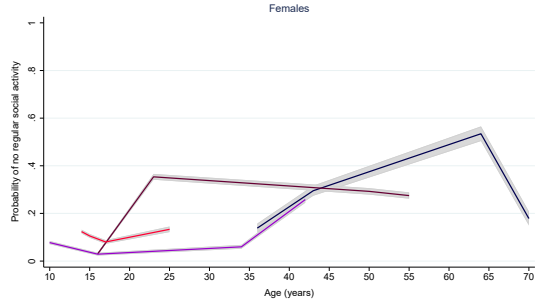
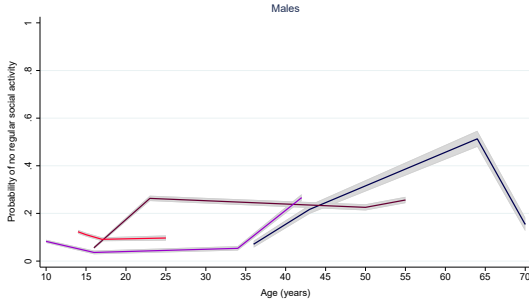
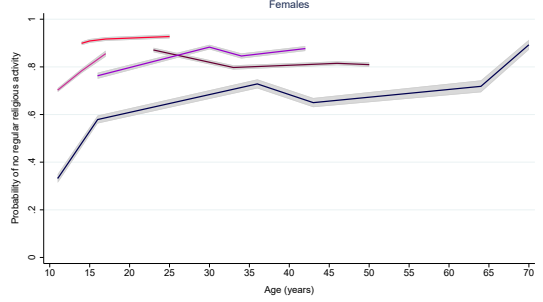
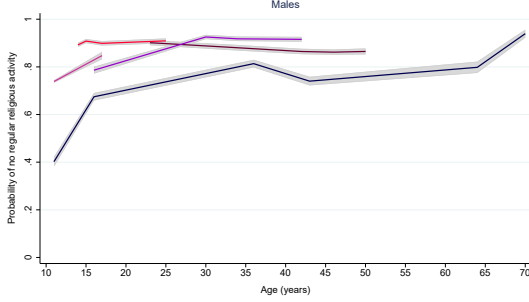
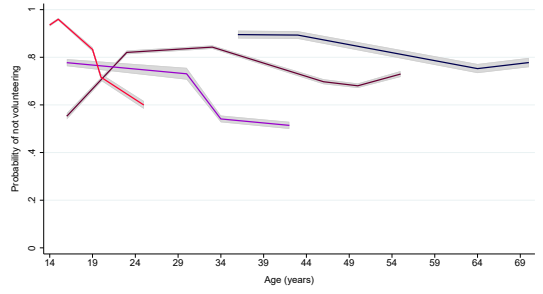
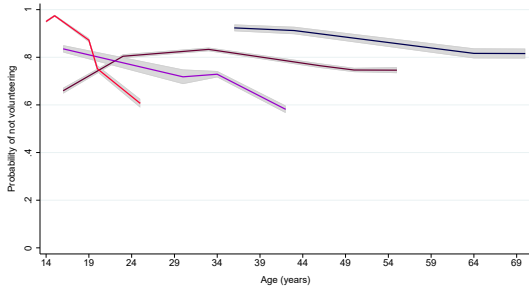
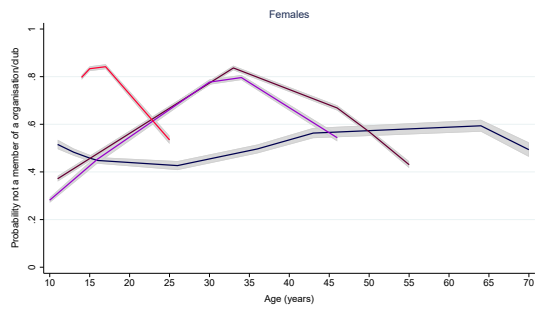
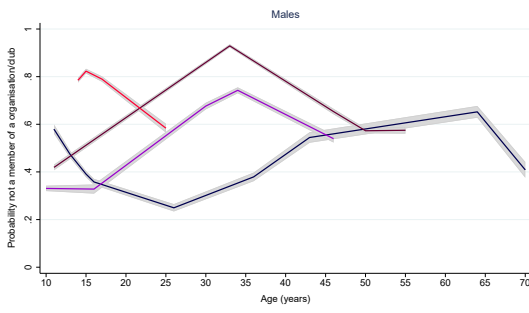
1946

1958

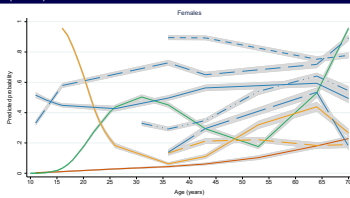
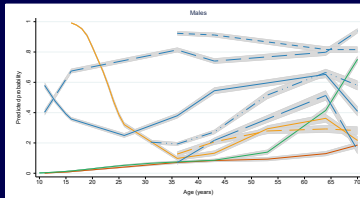
1970

1990

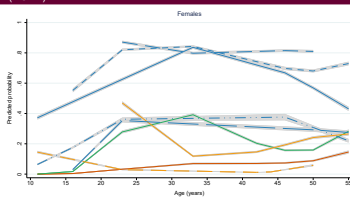
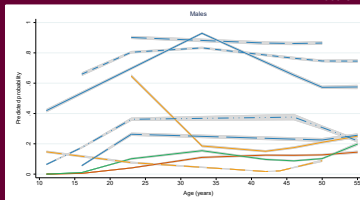
2001



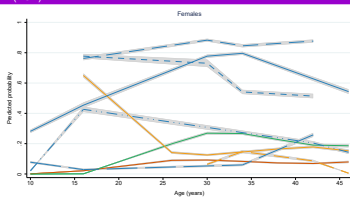
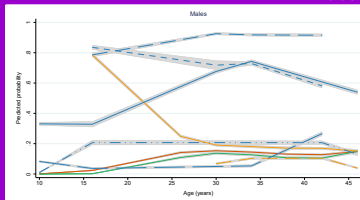
1946 Cohort (NSHD)



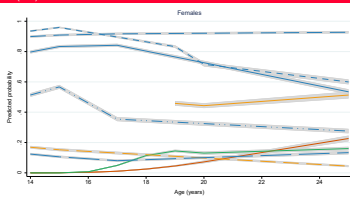
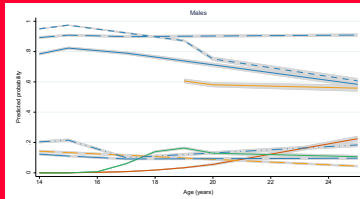
1958 Cohort (NCDS)



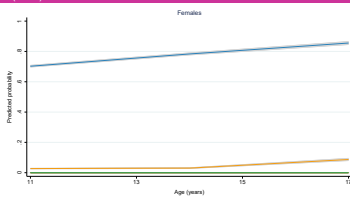
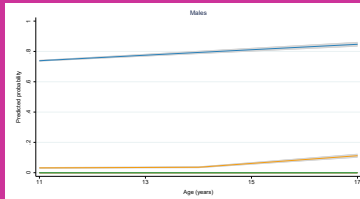
1970 Cohort (BCS)



1990 Cohort (NS)



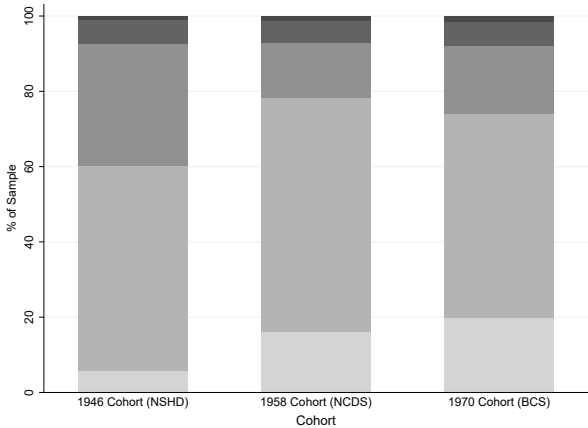
2001 Cohort (MCS)



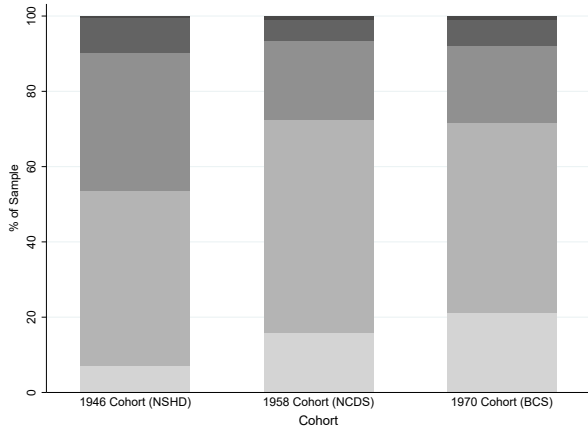
Social Isolation Indicator

- Living alone
- - - No partner
- No membership to community organisation/club
- - - No regular social activity
- . - . No regular sporting activity
- Neither in education nor employment
- - - No regular contact - friends and family
- - - No regular religious activity
- . - . No volunteering

Males



Females



Cumulative Social Isolation Score

