Life course partnership status and biomarkers in mid-life: Evidence from the 1958 British birth cohort.

Abstract

Numerous studies have found that married people have better health than the unmarried. The vast majority of these studies relied on self-reported health outcomes and considered only current marital status or transitions over relatively short periods, therefore ignoring the accumulated benefits and risks of marital status trajectories over the lifecourse. We employed data from a population based birth cohort to summarise longitudinal patterns of partnership status spanning 21 years that distinguished marital status and non-marital cohabitation. After controlling for selection due to early life and early adulthood characteristics, we found that lifecourse trajectories of partnership status were associated with haemostatic and inflammatory markers, the prevalence of metabolic syndrome and respiratory function in mid-life. Never marrying nor cohabiting was detrimental to health in mid-life for both genders but the effect was more pronounced in men. Women married during their late 20's or early 30's that remained married had the most optimal health in mid-life. Not married cohabiters of both genders had similar mid-life health outcomes with those that were married. We found that the accumulated effect of partnership status over 21 years affects a wide range of biomarkers in mid-life. Further research is needed to identify the pathways that link lifecourse trajectories of partnership status and mid-life health

Introduction

Numerous studies have found that married people have better health and lower mortality than the unmarried, with many showing the worst health and mortality among the formerly married, with these findings replicated in different countries and time periods [1-18]. Reducing health inequalities related to marital status has the potential to shift the distribution of risk and therefore improve population health [19]. However, to do so further understanding of the mechanisms linking marital status and health are needed. This includes further consideration of health related selection into various marital statuses, and the operation of health protective effects of marriage. With a few exceptions [20] studies of marital status and health have considered only current marital status or transitions over relatively short periods, therefore ignoring the accumulated benefits and risks of marital status trajectories over the adult lifecourse [15].

Furthermore, only a few studies have considered the association between non-marital cohabitation and health [12, 21], a topic of increasing importance given that cohabitation is becoming more common [22]. Of those studies which have used measures of health, rather than mortality as an outcome [23], most have employed self-reported measures and in the few studies where objective health indicators were used, sample sizes were relatively small [24, 25]. In this study we use data from a population based birth cohort to summarise longitudinal patterns of partnership status that distinguish marital status and non-marital cohabitation. We employed a model based approach that allowed us to capture stability as well as transitions in partnership status over a 21 year period (ages 23 to 44) and used this to investigate the effects that 21 year trajectories of partnership status have on a wide range of biomarkers in mid-life. Our objective was to investigate the cumulative effect that different trajectories of partnership status over the life-course have on objectively measured health indicators in mid-life.

Methods

Sample

We employed the National Child Development Study (NCDS), a birth cohort study which includes all persons born in England, Scotland and Wales during one week in March 1958. Cohort members have been followed-up periodically from birth into adulthood [26]. To derive the partnership status trajectories we used data from four sweeps of the NCDS, 1981 (N = 12537), 1991 (N= 11469), 2000 (N = 11419) and 2002-4 (N = 8018), when study members were aged 23, 33, 42 and 44-46 years respectively. Our outcomes are derived from the 2002-4 clinical examination that was carried out at participants' homes by 122 specially trained nurses from the National Centre for Social Research. In order to control for possible selection effects, we used information from earlier sweeps carried out between 1958 and 1974 (when study members were aged 0-16 years, N= 18858. Our analytic sample included participants with at least three valid responses in the marital status and cohabitation indicators (N= 5160 for women and N = 4877 for men, total N = 10037).

Measures

Indicators of partnership status

We used binary indicators representing whether a participant was married or was cohabiting with someone that they were not married to.at each measurement wave. Each of the four measurement waves is thus represented by two indicators (one for marital status and one for non-marital cohabitation). We also included in the model information on whether participants had been remarried by age 44 (see Table 1).

Biomarkers in mid-life

We used five haemostatic and inflammatory markers: C-reactive protein (CRP), fibrinogen [27], fibrin D-dimer (Ddimer) [28], von Willebrand factor (VWF) and tissue plasminogen activator antigen (TPA) [29]. Metabolic syndrome was characterised by the standard International Diabetes Federation definition[30]. Finally we used forced vital capacity (FVC), a marker of respiratory functioning. Further details of the laboratory procedures are available elsewhere [31, 32]. We used a wide range of objectively measured health indicators that represent different facets of overall health status in an attempt to further understand the specific effects that partnership status might have on health, but also to retain a holistic view of health status in mid-life.

Confounders

To control for possible selection into partnership status we included various early life and early adulthood (age 23) characteristics in our models. In the existing literature selection into partnership status has been found to be driven by income, educational attainment and health status [10, 33], which were all available in all sweeps of the NCDS. In our models we included serious financial hardship during the previous year at age 11, paternal social class at age 7, housing tenure at age 7 and paternal weekly net pay at age 16 were used as indicators of early life socio–economic position. Health centre attendance during the previous year at age 16, disability at age 16 and height at age 7 were used as indicators of early life health status. General ability measured at age 11 was used as an indicator of early life cognitive ability. We also controlled for variables measured at age 23: educational attainment, self–rated health, depression, smoking status, employment status, body mass index and presence of long standing disability. Finally, current use of medication and lab processing-related variables were are also included in the models.

INSERT TABLE 1 ABOUT HERE

Statistical modelling

We employed Latent Class Analysis (LCA) to derive a longitudinal typology of partnership status. The longitudinal trajectories are unknown but can be inferred from observed indicators of marital status and cohabitation measured over time. Since we employed nine binary indicators (Table 1) the number of possible response patterns in theory is $2^9 = 512$. However since participants who are married cannot simultaneously be non – married cohabiters there are three responses available at each wave making the number of possible response patterns equal to $2 \times (3^4) = 162$. In this instance LCA is used to summarise these patterns creating longitudinal profiles – trajectories – in a parsimonious way that can be used in further analysis. This approach can be viewed as an evidence-based approximation that improves a researcher's ability to identify, summarize, and communicate complex patterns in longitudinal data [34] that has been used in a wide range of applications [35], [36] [37].

We used the derived longitudinal typology to investigate the association between trajectories of partnership status with a wide range of biomarkers in mid-life. CRP, fibrinogen, D-dimer, t-PA and VWF were log transformed to normalize their distributions prior to performing analyses. Metabolic syndrome was modelled as a binary outcome, while FVC raw scores were used as they were normally distributed. All outcomes were analysed jointly within a single model; continuous outcomes were modelled with linear regression and metabolic syndrome with binary logistic regression. Missing data were handled with the Full Information Maximum Likelihood (FIML) method which is naturally incorporated into the generalised latent variable modelling framework. In this full likelihood context model

parameters and standard errors are estimated directly from the available data and the selection mechanism is ignorable under the Missing at Random (MAR) assumption [38, 39]. In this case MAR implies that if all the variables that are responsible for the missing data generating mechanism are included in the model, this "mechanism" can be ignored and maximum likelihood estimators are consistent. In our analysis, MAR is interpreted as follows: all systematic missingness is due to variables included in our models, (serious financial hardship during the last year at age 11, paternal social class at age 7, housing tenure at age 7, paternal weekly net pay at age 16, health centre attendance during the last year at age 16, disability at age 16, height at age 7, cognitive ability at 11, educational attainment at 23, smoking status at 23, self-rated health at 23, depression at 23, employment status at 23, body mass index at 23, presence of long standing disability at 23, current use of medication at 42). Any other missingness that is not accounted by these variables is assumed to be completely random since we assume that all systematic causes of attrition have been included in the model. We believe that this is a reasonable assumption since it has been shown that socio – economic position and age and are the main drivers of attrition in population surveys in the UK [40, 41]. All models were estimated with the Mplus 7 [42] software, using the robust maximum likelihood estimator (MLR) and Monte Carlo integration.

INSERT TABLE 2 ABOUT HERE

Results

In Table 2 we present information criteria, likelihood based tests and the entropy coefficient, a measure of classification quality (values close to 1 indicate good allocation quality – low classification error). As expected for both men and women model fit improved with each additional class. The classification quality as indicated by the entropy was highly satisfactory for all models. Since all BLRT tests returned significant p values, model selection was based on relative fit and substantive criteria. As can be observed from Table 2 and Graph 1 in Appendix I, the difference between models in all information criteria becomes smaller from the 6 class model onwards for both men and women, indicating that 6 - 8 classes would adequately describe the data. Closer inspection of the derived classes revealed that the additional 7^{th} and 8^{th} classes were largely replicating the patterns of already existing classes, but with a very small prevalence (<1%) for men and (<2 %) for women. We therefore selected 6 class models for both men and women as the most parsimonious description of the longitudinal patterns in the data.

INSERT TABLE 3 ABOUT HERE

Although the number of classes was identical for the two genders, the prevalence and interpretation of the latent longitudinal typologies differed. The probabilities of being married, cohabiting and/or remarried, conditional on group membership, are presented in Figure 1 (men) and Figure 2 (women), as well as in Tables 4 and 5 in the Appendix. In men the first and most prevalent class (N = 3010, 61.7%) comprised of men who were married in their 20's or early 30's and remained married, with this generally being their one and only marriage. The second class (N = 401, 8.2%) was characterised by men that got married in their 20's or early 30's, but later got divorced, with increasing cohabitation but little remarriage in their 40's. In the third class (N = 362, 7.4%) were allocated men that mostly never married, but cohabited from their late 20's or early 30's onwards. The fourth class (N = 462, 9.5%), included men that married in their mid or late 30's and remain married since,

preceded by cohabitation in their early 30's for many. The fifth class (N = 100, 2.1%) was characterised by men who divorced in their mid or late 30's but later remarried, with many cohabiting in between. Finally the sixth class (N = 542, 11.1%), comprised almost exclusively of men that never married and never cohabited.

In women, the most prevalent class (N = 2168, 42%) comprised women who got married in their early 20's and were married throughout, with this usually being their only marriage at age 44. The second class (N = 1199, 23.2%) was characterised by women who got married in their 30's with this being their only marriage until age 44. In the third class (N = 415, 8.0%) were allocated women that never married or married in their 20's and subsequently separated without remarrying, and who were more likely to cohabit from their early 30's onwards. The fourth class (N = 291, 5.6%) was characterised by women who got married and subsequently divorced in their 20's or early 30's, cohabited, then remarried. Women allocated to the fifth class (N = 446, 8.6%) married in their 20s or early 30s but divorced in their mid to late 30's, with many later cohabiting or remarrying. The sixth class (N = 641, 12.4%) was almost entirely women that never married or cohabited.

In Table 5 we present the estimated parameters and 95% confidence intervals that capture the association between the longitudinal partnership status typology and biomarkers in mid-life. Linear regression coefficients are presented for all outcomes with the exception of metabolic syndrome where odds ratios are presented. Men that never married or cohabited (Class 6) had worse health outcomes compared to the reference group (men that were married in their 20's or early 30's and remained married ever since – Class 1). They scored higher on fibrinogen, b = 0.034 (0.012 to 0.056), CRP, b = 0.148 (0.025 to 0.270) and TPA, b = 0.061 (0.006 to 0.116), while they score lower on FVC, b = -0.130 (-0.225 to -0.035). Furthermore, men who divorced in their late 30's, but did not remarry (Class 2) were less likely to have metabolic syndrome compared to the reference group OR = 0.756 (0.575 to 0.993). Men that were not married but cohabited since their late 20's or early 30's (Class 3), had lower FVC compared to the reference group, b = -0.112 (-0.214 to -0.009). There was evidence of effect modification by early life health and early life SEP indicators with respect to fibrinogen, CRP and FVC. The observed effects of the longitudinal typology were more pronounced in men that were healthy and comfortable financially during their childhood.

A different pattern of associations emerged in women. Women that never married or cohabited (Class 6) scored higher on fibrinogen, b = 0.028 (0.006 to 0.050) compared to the reference group (Class 1 - married in their early 20', still married, only marriage). Conversely, women that married during their late 20's or early 30's and remained married since (Class 2) had the best health. Compared to the reference group (Class 1) they scored lower on fibrinogen, b = -0.018 (-0.035 to -0.002) and higher on FVC b = 0.054 (0.002 to 0.106). Women who mainly cohabited with some early marriages and divorces (Class 3) were less likely to have metabolic syndrome compared to the reference group, OR = 0.673 (0.481 to 0.943). There was evidence of effect modification by early life health and early life SEP indicators with respect to fibrinogen and FVC. The observed effects of the longitudinal typology were more pronounced in women that were healthy and financially comfortable during their childhood.

Discussion

A longitudinal typology of partnership status spanning 21 years was associated with a wide range of inflammatory and haemostatic markers as well as other objectively measured health outcomes in mid-life after controlling for well-known selection mechanisms. The observed effects differed between men and women implying that the mechanisms that link

partnership status and health may be gender specific. In men, those that never married or cohabited had significantly higher levels on three haemostatic function biomarkers as well as detrimental respiratory function compared to men that were married and remained married for the duration of the observation period. This finding is largely in agreement with studies using self-reported health outcomes as well as studies on mortality [9, 12, 17, 18, 43]. A different pattern of associations emerged in women. Those that married in mid/late 20's or early 30's and remained married for the whole observation period had the best health, having lower fibrinogen levels and better respiratory function compared to women who married in their early 20's. As expected from the previous literature women that never married or cohabited had worse health compared to married women. However, this effect was only manifested in fibrinogen levels, indicating that not marrying or cohabiting is less detrimental in women compared to men, or as it has been suggested, being married appears to be more beneficial to men [10, 20, 44-46].

We found that with the exception of worse respiratory functioning in men, non-marital cohabitation has similar effects to being married on mid-life health. Not married cohabiters of both genders did not differ from married participants in the health outcomes used in our study, a finding with implications for public health considering the increasing number of individuals that choose to cohabit and not marry. Policies aiming to encourage marriage operate on the assumption that being married protects health, but our results show that non marital cohabitation may have similar protective effects and if encouraged could potentially result in improving individual as well as population health. Our results are in agreement with recent findings on self-rated health [47] but contradict earlier findings on depression and self-reported physical health in the USA [48]. Further research is required to shed more light on whether non–married cohabiters have worse health compared to married people, or as our results suggest the differences found in other studies are due to self–reporting bias or because the effect of non-marital cohabitation on health differs between the UK and the USA, since in the USA being married is more strongly associated with socio – economic position and race[49-51]. Similarly, it appears that for both genders transitions from and to marriage or non-marital cohabitation do not have a detrimental effect on mid-life health. We did not observe a difference in the biomarkers used in our study between participants that divorced and subsequently remarried or cohabited and those that were married for the duration of the observation period. We also found that men who divorced during their late 30's and did not subsequently remarry or cohabit were less likely to suffer from metabolic syndrome in mid-life. Both results are in accordance with previous findings where it has been shown that after an initial decline in health men tend to bounce back to pre-divorce health status [52].

All effects reported in the present study were observed after controlling for factors that influence partnership status (direct selection) or both partnership status and health (indirect selection). In accordance with previous findings [10, 12, 44, 53, 54] as well as a recent study in the UK [33] we found evidence of selection mainly due to early life socio-economic position and early life health, but also due to educational attainment in early adulthood (results not presented here, available from the corresponding author). However, assuming that all sources of direct and indirect selection were represented by variables included in our models, our finding that partnership status is associated with mid-life health implies that this effect is independent of selection. Several explanations of the mechanism that links partnership status and health have been proposed, including fertility history, social support, health related behaviour and socio-economic position [55-58]. An added complexity to understanding the proposed mechanism is that these pathways may differ between longitudinal trajectories of partnership status and may also be gender specific. This analysis is beyond the scope of the present paper, but we hope to address these questions in a future

study where the mechanism that underlies the association between the longitudinal partnership status typology on mid-life biomarkers will be investigated.

Strengths of this study are the inclusion of a wide range of biomarkers as health outcomes in mid-life, the availability of data to control for well-known selection mechanisms and the derivation of a longitudinal typology which allowed us to capture trajectories of partnership status over 21 years. However, there are several limitations that should be considered while interpreting our results. We employed observational data and despite the wealth of the 1958 cohort, bias due to unknown unmeasured confounders cannot be ruled out. Furthermore, our longitudinal typology captured the cumulative effect of different trajectories of partnership status in biomarkers in mid-life. Thus, the investigation of the short term effects of stressful events such as marital dissolution on health suggested by the literature [11, 59] was not possible. Another important limitation is that our data on partnership status were based on self-reports. Although the latent variable specification of our longitudinal typology controls for measurement error, extreme bias (a participant misreporting in all nine indicators of our typology) due to social desirability may have influenced our results. Finally, we note that our results can be generalised to those born in 1958 and perhaps to other cohorts born close to this year. The partnership status trajectories as well as the association between these and health outcomes may be different in other – especially younger – cohorts and future research is needed to investigate these possibilities.

References

1. Cheung, Y.B., *Marital status and mortality in British women: a longitudinal study.* International Journal of Epidemiology, 2000. **29**(1): p. 93-99.
2. Eaker, E.D., et al., *Marital status, marital strain, and risk of coronary heart disease or total mortality: The Framingham Offspring Study.* Psychosomatic Medicine, 2007. **69**(6): p. 509-513.
3. Hu, Y.R. and N. Goldman, *MORTALITY DIFFERENTIALS BY MARITAL-STATUS - AN INTERNATIONAL COMPARISON.* Demography, 1990. **27**(2): p. 233-250.
4. Hughes, M.E. and L.J. Waite, *Health in household context: Living arrangements and health in late middle age.* Journal of Health and Social Behavior, 2002. **43**(1): p. 1-21.
5. Huijts, T. and G. Kraaykamp, *MARITAL STATUS, NATION MARITAL STATUS COMPOSITION, AND SELF-ASSESSED HEALTH A multilevel test of four hypotheses in 29 European countries.* European Societies, 2011. **13**(2): p. 279-305.
6. Johnson, N.J., et al., *Marital status and mortality: The National Longitudinal Mortality Study.* Annals of Epidemiology, 2000. **10**(4): p. 224-238.
7. Kisker, E.E. and N. Goldman, *PERILS OF SINGLE LIFE AND BENEFITS OF MARRIAGE.* Social Biology, 1987. **34**(3-4): p. 135-152.
8. Koskenvuo, M., et al., *DIFFERENCES IN MORTALITY FROM ISCHEMIC-HEART-DISEASE BY MARITAL-STATUS AND SOCIAL-CLASS.* Journal of Chronic Diseases, 1980. **33**(2): p. 95-106.
9. Lahorgue, Z., *Morbidity and marital status.* Journal of chronic diseases, 1960. **12**: p. 476-98.
10. Martikainen, P., et al., *Differences in mortality by marital status in Finland from 1976 to 2000: Analyses of changes in marital-status distributions, socio-demographic and household composition, and cause of death.* Population Studies-a Journal of Demography, 2005. **59**(1): p. 99-115.
11. Martikainen, P. and T. Valkonen, *Mortality after the death of a spouse: Rates and causes of death in a large Finnish cohort.* American Journal of Public Health, 1996. **86**(8): p. 1087-1093.
12. Murphy, M., K. Glaser, and E. Grundy, *Marital status and long-term illness in Great Britain.* Journal of Marriage and the Family, 1997. **59**(1): p. 156-164.

13. Murphy, M., E. Grundy, and S. Kalogirou, *The increase in marital status differences in mortality up to the oldest age in seven European countries, 1990-99.* Population Studies-a Journal of Demography, 2007. **61**(3): p. 287-298.
14. Murphy, M., M. Vessey, and L. Villard, *MARITAL-STATUS AND CERVICAL-CANCER IN YOUNG-WOMEN.* Lancet, 1989. **1**(8651): p. 1385-1386.
15. Robards, J., et al., *Marital status, health and mortality.* Maturitas, 2012. **73**(4): p. 295-299.
16. Schoenborn, C.A., *Marital status and health: United States, 1999-2002.* Advance data, 2004(351): p. 1-32.
17. Verbrugge, L.M., *MARITAL-STATUS AND HEALTH.* Journal of Marriage and the Family, 1979. **41**(2): p. 267-285.
18. Zheng, H. and P.A. Thomas, *Marital Status, Self-Rated Health, and Mortality: Overestimation of Health or Diminishing Protection of Marriage?* Journal of Health and Social Behavior, 2013. **54**(1): p. 128-143.
19. Rose, G., *Sick individuals and sick populations.* International Journal of Epidemiology, 1985. **14**(1): p. 32-38.
20. Grundy, E.M. and C. Tomassini, *Marital history, health and mortality among older men and women in England and Wales.* BMC Public Health, 2010. **10**: p. 554.
21. Glaser, K., M. Murphy, and E. Grundy, *Limiting long-term illness and household structure among people aged 45 and over, Great Britain 1991.* Ageing and Society, 1997. **17**: p. 3-19.
22. Statistics, O.f.N., *Chapter 5 - Marriage and cohabitation.* , in *General Lifestyle Survey Overview -a report on the 2011 General Lifestyle Survey*. 2013, Office for National Statistics.
23. Kravdal, O., et al., *Family Life History and Late Mid-Life Mortality in Norway.* Population and Development Review, 2012. **38**(2): p. 237-+.
24. Loucks, E.B., et al., *Social integration is associated with fibrinogen concentration in elderly men.* Psychosomatic Medicine, 2005. **67**(3): p. 353-358.
25. Holt-Lunstad, J., W. Birmingham, and B.Q. Jones, *Is there something unique about marriage? The relative impact of marital status, relationship quality, and network social support on ambulatory blood pressure and mental health.* Annals of Behavioral Medicine, 2008. **35**(2): p. 239-244.
26. Power, C. and J. Elliott, *Cohort profile: 1958 British Birth Cohort (National Child Development Study).* International Journal of Epidemiology, 2006. **35**(1): p. 34-41.
27. Danesh, J., et al., *Plasma fibrinogen level and the risk of major cardiovascular diseases and nonvascular mortality - An individual participant meta-analysis.* Jama-Journal of the American Medical Association, 2005. **294**(14): p. 1799-1809.
28. Danesh, J., et al., *Fibrin D-dimer and coronary heart disease - Prospective study and meta-analysis.* Circulation, 2001. **103**(19): p. 2323-2327.
29. Tabassum, F., et al., *Effects of Socioeconomic Position on Inflammatory and Hemostatic Markers: A Life-Course Analysis in the 1958 British Birth Cohort.* American Journal of Epidemiology, 2008. **167**(11): p. 1332-1341.
30. Povel, C.M., et al., *Metabolic Syndrome Model Definitions Predicting Type 2 Diabetes and Cardiovascular Disease.* Diabetes Care, 2013. **36**(2): p. 362-368.
31. Calvin, C.M., et al., *Childhood intelligence and midlife inflammatory and hemostatic biomarkers: the National Child Development Study (1958) cohort.* Health Psychol, 2011. **30**(6): p. 710-8.
32. Hyppönen, E., et al., *25-Hydroxyvitamin D and Pre-Clinical Alterations in Inflammatory and Hemostatic Markers: A Cross Sectional Analysis in the 1958 British Birth Cohort.* PLoS ONE, 2010. **5**(5): p. e10801.
33. Demey, D., et al., *Pathways into living alone in mid-life: Diversity and policy implications.* Advances in Life Course Research, 2013. **18**(3): p. 161-174.

34. Nagin, D.S. and R.E. Tremblay, *What has been learned from group-based trajectory modeling? Examples from physical aggression and other problem behaviors.* Annals of the American Academy of Political and Social Science, 2005. **602**: p. 82-117.
35. Colman, I., et al., *A longitudinal typology of symptoms of depression and anxiety over the life course.* Biological Psychiatry, 2007. **62**(11): p. 1265-1271.
36. Mavandadi, S., K.S. Rook, and J.T. Newsom, *Positive and negative social exchanges and disability in later life: An investigation of trajectories of change.* Journals of Gerontology Series B-Psychological Sciences and Social Sciences, 2007. **62**: p. S361-S370.
37. Sturgis, P. and L. Sullivan, *Exploring social mobility with latent trajectory groups.* Journal of the Royal Statistical Society Series a-Statistics in Society, 2008. **171**: p. 65-88.
38. Little, R.J.A. and D.B. Rubin, *THE ANALYSIS OF SOCIAL-SCIENCE DATA WITH MISSING VALUES.* Sociological Methods & Research, 1989. **18**(2-3): p. 292-326.
39. Little, R.J.A. and D.B. Rubin, *Statistical Analysis with Missing Data* Second Edition ed. 2002, Chichester: Willey.
40. Noah Uhrig, S., *The Nature and Causes of Attrition in the British Household Panel Survey*. 2008, Institute for Social and Economic Research.
41. Durrant, G. and H. Goldstein, *Analysing The Probability Of Attrition In A Longitudinal Survey*. 2008, Southampton Statistical Sciences Research Institute.
42. Muthen, L.K. and B.O. Muthen, *Mplus User's Guide. Seventh Edition*, ed. M. Muthen. 1998-2012, Los Angeles, CA.
43. Wu, Z. and R. Hart, *The effects of marital and nonmarital union transition on health.* Journal of Marriage and Family, 2002. **64**(2): p. 420-432.
44. Waldron, I., M.E. Hughes, and T.L. Brooks, *Marriage protection and marriage selection - Prospective evidence for reciprocal effects of marital status and health.* Social Science & Medicine, 1996. **43**(1): p. 113-123.
45. Liu, H. and D.J. Umberson, *The times they are a changin': Marital status and health differentials from 1972 to 2003.* Journal of Health and Social Behavior, 2008. **49**(3): p. 239-253.
46. Lillard, L.A. and L.J. Waite, *TIL DEATH DO US PART - MARITAL DISRUPTION AND MORTALITY.* American Journal of Sociology, 1995. **100**(5): p. 1131-1156.
47. Pollard, M. and K. Mullan Harris, *Nonmarital cohabitation, marriage, and health among adolescents and young adults*. 2013, University of North Carolina, Cahpel Hill.
48. Brown, S.L., J.R. Bulanda, and G.R. Lee, *The significance of nonmarital cohabitation: Marital status and mental health benefits among middle-aged and older adults.* Journals of Gerontology Series B-Psychological Sciences and Social Sciences, 2005. **60**(1): p. S21-S29.
49. Phillips, J.A. and M.M. Sweeney, *Premarital cohabitation and marital disruption among White, Black, and Mexican American women.* Journal of Marriage and Family, 2005. **67**(2): p. 296-314.
50. Trent, K. and S.J. South, *SOCIODEMOGRAPHIC STATUS, PARENTAL BACKGROUND, CHILDHOOD FAMILY-STRUCTURE, AND ATTITUDES TOWARD FAMILY FORMATION.* Journal of Marriage and the Family, 1992. **54**(2): p. 427-439.
51. Trent, K. and S.J. South, *Spousal alternatives and marital relations.* Journal of Family Issues, 2003. **24**(6): p. 787-810.
52. Williams, K. and D. Umberson, *Marital Status, Marital Transitions, and Health: A Gendered Life Course Perspective.* Journal of Health and Social Behavior, 2004. **45**(1): p. 81-98.
53. Joung, I.M.A., et al., *A longitudinal study of health selection in marital transitions.* Social Science & Medicine, 1998. **46**(3): p. 425-435.
54. Goldman, N., *MARRIAGE SELECTION AND MORTALITY PATTERNS - INFERENCES AND FALLACIES.* Demography, 1993. **30**(2): p. 189-208.

55. Yannakoulia, M., et al., *Eating patterns may mediate the association between marital status, body mass index, and blood cholesterol levels in apparently healthy men and women from the ATTICA study.* Social Science & Medicine, 2008. **66**(11): p. 2230-2239.
56. Ortega, F.B., et al., *In Fitness and Health? A Prospective Study of Changes in Marital Status and Fitness in Men and Women.* American Journal of Epidemiology, 2011. **173**(3): p. 337-344.
57. Martikainen, P., et al., *Differences in mortality by marital status in Finland from 1976 to 2000: Analyses of changes in marital-status distributions, socio-demographic and household composition, and cause of death.* Population Studies, 2005. **59**(1): p. 99-115.
58. Lindstrom, M., *Marital status, social capital, material conditions and self-rated health: A population-based study.* Health Policy, 2009. **93**(2-3): p. 172-179.
59. Martikainen, P. and T. Valkonen, *Mortality after death of spouse in relation to duration of bereavement in Finland.* Journal of Epidemiology and Community Health, 1996. **50**(3): p. 264-268.

Table 1. Marital status and non-marital cohabitation indicators.

		Men		Women				Men		Women	
		f	%	f	%			f	%	f	%
Married at 23	No	4084	65.2	2861	45.6	**Cohabiting at 23**	No *	5833	95.2	5779	94.2
	Yes	2179	34.8	3409	54.4		Yes	296	4.8	358	5.8
Married at 33	No	1660	31.0	1569	27.9	**Cohabiting at 33**	No	4679	89.1	4982	90.3
	Yes	3701	69.0	4063	72.1		Yes	570	10.9	535	9.7
Married at 40	No	1644	29.4	1667	28.9	**Cohabiting at 40**	No	4952	90.5	5136	91.1
	Yes	3948	70.6	4098	71.1		Yes	520	9.5	503	8.9
Married at 42	No	1220	27.0	1325	28.9	**Cohabiting at 42**	No	3845	87.9	3892	88.0
	Yes	3303	73.0	3262	71.1		Yes	529	12.1	533	12.0
Remarried	No	5299	86.2	5240	84.1						
	Yes	847	13.8	993	15.9						

*Includes all other partnership status categories (Married, single, divorced, widowed)

Table 2. Log-Likelihood and information criteria for competing latent class analysis models

Men	Parameters	Log-Likelihood	AIC	BIC	ssa BIC	Entropy	BLRT	p
1 Class	9	-18113.063	36244.126	36302.557	36273.958	1.000		
2 Classes	19	-15085.063	30208.127	30331.480	30271.105	0.927	6056.001	0.001
3 Classes	29	-14513.203	29084.406	29272.682	29180.530	0.946	1143.721	0.001
4 Classes	39	-14248.346	28574.693	28827.892	28703.964	0.931	529.713	0.001
5 Classes	49	-14004.856	28107.713	28425.835	28270.130	0.909	486.981	0.001
6 Classes	59	-13881.343	27880.687	28263.731	28076.250	0.922	247.026	0.001
7 Classes	69	-13779.315	27696.629	28144.612	27925.339	0.925	204.058	0.001
8 Classes	79	-13704.204	27566.407	28079.298	27828.264	0.912	150.222	0.001
9 Classes	89	-13657.883	27493.767	28071.580	27788.770	0.921	92.641	0.001
10 Classes	99	-13624.711	27447.421	28090.156	27775.570	0.924	66.347	0.001
Women	Parameters	Log-Likelihood	AIC	BIC	ssa BIC	Entropy	BLRT	p
1 Class	9	-19548.128	39114.255	39173.193	39144.594	1.000		
2 Classes	19	-15989.385	32016.771	32141.196	32080.820	0.945	7117.485	0.001
3 Classes	29	-15383.938	30825.875	31015.787	30923.635	0.962	1210.895	0.001
4 Classes	39	-15100.217	30278.435	30533.834	30409.905	0.940	567.440	0.001
5 Classes	49	-14884.450	29866.899	30187.785	30032.079	0.918	431.536	0.001
6 Classes	59	-14710.590	29539.180	29925.553	29738.071	0.905	347.719	0.001
7 Classes	69	-14612.640	29363.279	29815.139	29595.880	0.916	195.901	0.001
8 Classes	79	-14524.971	29207.942	29725.289	29474.253	0.935	175.337	0.001
9 Classes	89	-14476.328	29130.656	29713.489	29430.677	0.933	97.286	0.001
10 Classes	99	-14436.959	29071.918	29720.239	29405.650	0.938	78.737	0.001

AIC – Akaike Information Criterion
BIC – Bayesian Information Criterion
ssa BIC – sample size adjusted Bayesian Information Criterion
BLRT – Bootstraped likelihood ratio test comparison for n vs n – 1 class models

Table 3. Model parameters and 95% confidence intervals

Men	**Fibrinogen**		**CRP**		**VWF**		**TPA**		**Ddimer**		**Metabolic Syndrome**		**FVC**	
Class1	0		0		0		0		0		1		0	
Class2	0.019	-0.006 to 0.045	0.131	-0.006 to 0.268	0.029	-0.010 to 0.069	0.036	-0.029 to 0.100	0.035	-0.036 to 0.105	**0.756**	**0.575 to 0.993**	0.071	-0.026 to 0.168
Class3	0.010	-0.014 to 0.033	-0.013	-0.161 to 0.135	-0.001	-0.046 to 0.044	0.026	-0.041 to 0.093	0.043	-0.029 to 0.114	1.067	0.808 to 1.410	**-0.112**	**-0.214 to -0.009**
Class4	0.008	-0.015 to 0.031	0.008	-0.113 to 0.128	0.003	-0.036 to 0.041	0.003	-0.053 to 0.059	0.054	-0.014 to 0.123	1.077	0.843 to 1.376	-0.076	-0.168 to 0.015
Class5	0.028	-0.021 to 0.076	0.064	-0.215 to 0.342	-0.006	-0.081 to 0.070	0.045	-0.078 to 0.169	0.016	-0.116 to 0.148	0.759	0.457 to 1.261	0.050	-0.129 to 0.229
Class6	**0.034**	**0.012 to 0.056**	**0.148**	**0.025 to 0.270**	0.020	-0.016 to 0.057	**0.061**	**0.006 to 0.116**	0.038	-0.029 to 0.105	0.867	0.677 to 1.111	**-0.130**	**-0.225 to -0.035**
Women	**Fibrinogen**		**CRP**		**VWF**		**TPA**		**Ddimer**		**Metabolic Syndrome**		**FVC**	
Class1	0		0		0		0		0		1		0	
Class2	**-0.018**	**-0.035 to -0.002**	-0.087	-0.186 to 0.011	-0.011	-0.038 to 0.017	-0.036	-0.081 to 0.010	-0.002	-0.048 to 0.043	1.009	0.810 to 1.257	**0.054**	**0.002 to 0.106**
Class3	0.001	-0.023 to 0.023	-0.032	-0.173 to 0.110	-0.014	-0.055 to 0.027	-0.011	-0.075 to 0.053	0.016	-0.046 to 0.079	**0.673**	**0.481 to 0.943**	0.026	-0.046 to 0.098
Class4	0.010	-0.018 to 0.038	**0.195**	**0.028 to 0.361**	0.038	-0.008 to 0.085	-0.026	-0.111 to 0.058	-0.037	-0.105 to 0.031	1.043	0.712 to 1.528	0.004	-0.094 to 0.101
Class5	-0.012	-0.037 to 0.014	-0.013	-0.161 to 0.134	0.003	-0.040 to 0.045	0.012	-0.058 to 0.082	-0.064	-0.131 to 0.002	0.778	0.560 to 1.081	0.033	-0.043 to 0.109
Class6	**0.028**	**0.006 to 0.050**	0.029	-0.104 to 0.162	0.022	-0.015 to 0.058	-0.030	-0.088 to 0.028	-0.012	-0.070 to 0.047	0.776	0.581 to1.038	-0.051	-0.116 to 0.014

*Adjusted for serious financial hardship during the last year at age 11, paternal social class at age 7, housing tenure at age 7, paternal weekly net pay at age 16, health centre attendance during the last year at age 16, disability at age 16, height at age 7, cognitive ability at 11, educational attainment at 23, smoking status at 23, self rated health at 23, depression at 23, employment status at 23, body mass index at 23, presence of long standing disability at 23, current use of medication at 42 and lab processing related variables.

** All outcomes modelled with linear regression link functions, except from metabolic syndrome where a logistic link function was used

Figure 1. Longitudinal typologies of probability of marriage (blue line) and cohabitation (red line) in men.

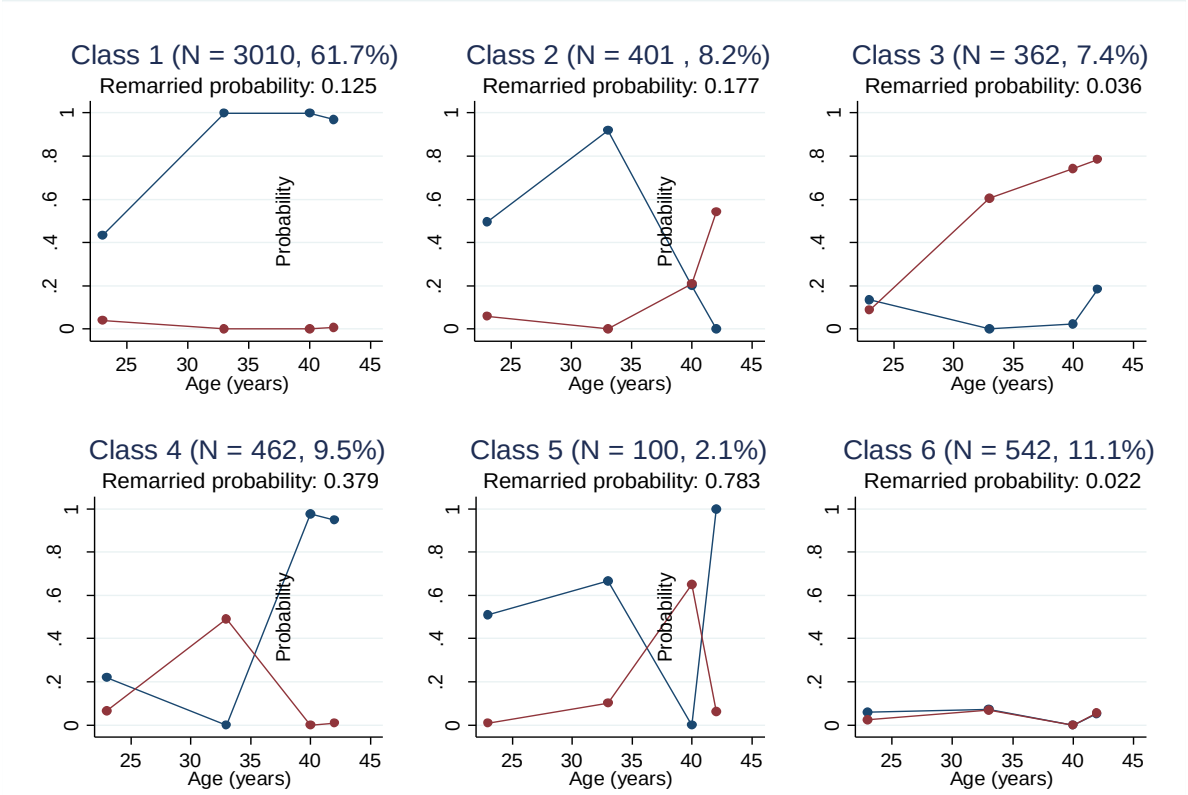
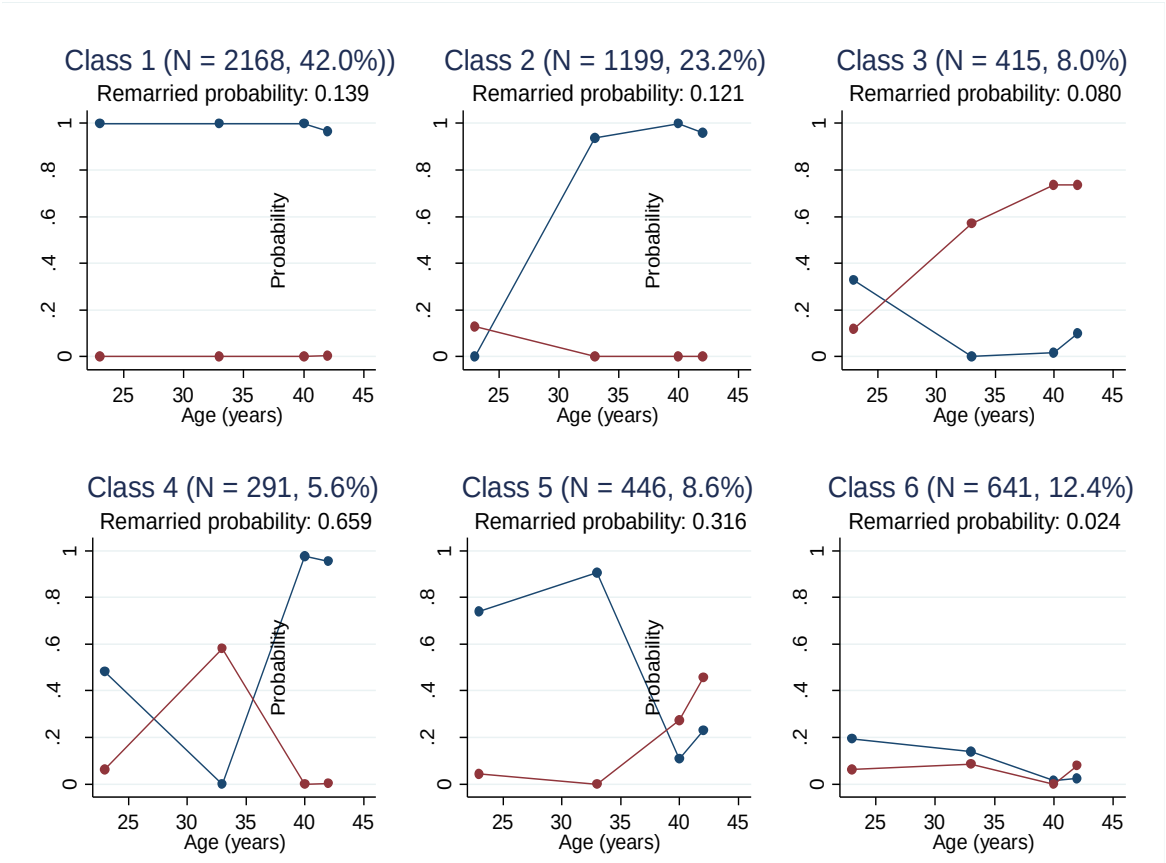
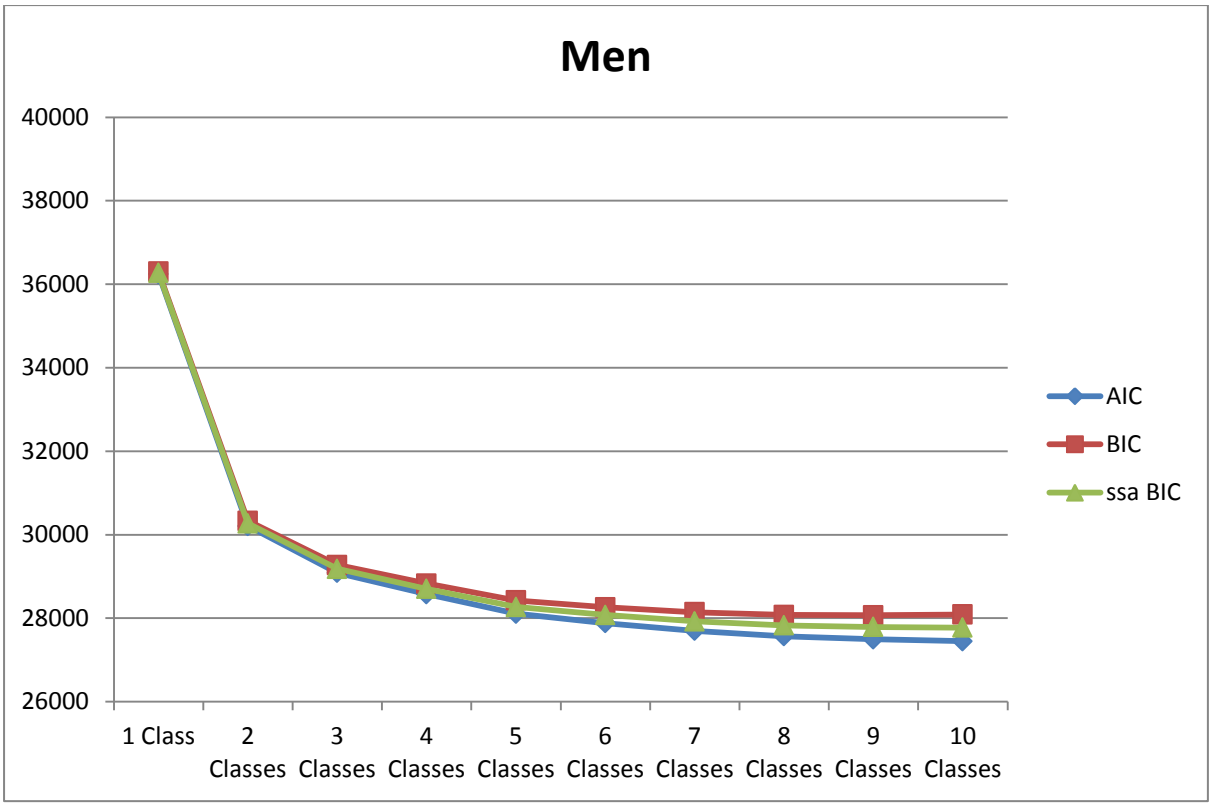


Figure 2. Longitudinal typologies of probability marriage (blue line) and cohabitation (red line) in women.



Appendix – I Added information on LCA model selection



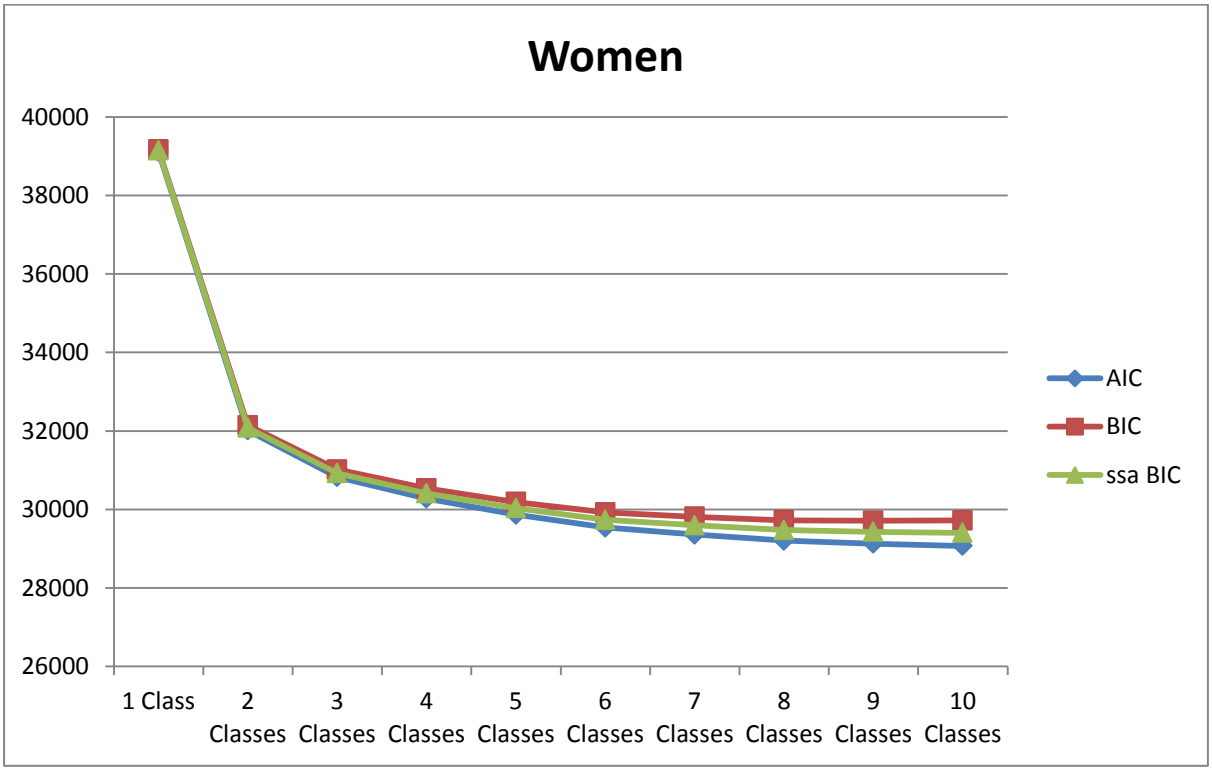


Table 4. Conditional probabilities of partnership status indicators after class allocation - Men

Men	**Class 1 (N = 3010, 61.7%)**	**Class 2 (N = 401, 8.2%)**	**Class 3 (N = 362, 7.4%)**	**Class 4 (N = 462, 9.5%)**	**Class 5 (N = 100, 2.1%)**	**Class 6 (N = 542, 11.1%)**
	Married in 20's/early 30's, only marriage	Divorced at late 30's not remarried or cohabited	Not married, cohabiting	Married at mid/late 30's, remain married	Divorced at 30's, later remarried	Never married or cohabited
Married at 23	0.432	0.498	0.137	0.219	0.510	0.058
Cohabiting at 23	0.041	0.060	0.087	0.065	0.007	0.024
Married at 33	1.000	0.919	0.000	0.000	0.666	0.073
Cohabiting at 33	0.000	0.000	0.604	0.492	0.101	0.070
Married at 40	0.997	0.198	0.024	0.975	0.000	0.000
Cohabiting at 40	0.000	0.210	0.744	0.000	0.650	0.000
Married at 42	0.971	0.000	0.184	0.949	1.000	0.054
Cohabiting at 42	0.008	0.543	0.786	0.008	0.063	0.057
Remarried	0.125	0.177	0.036	0.379	0.783	0.022

Table 5. Conditional probabilities of partnership status indicators after class allocation - Women

Women	**Class 1 (N = 2168, 42%)**	**Class 2 (N = 1199, 23.2%)**	**Class 3 (N = 415, 8.0%)**	**Class 4 (N = 291, 5.6%)**	**Class 5 (N = 446, 8.6%)**	**Class 6 (N = 641, 12.4%)**
	Married in early 20's - only marriage remain married	Married in late 20's early 30's, only marriage remain married	Cohabiting after 30	Divorced in 20's early 30's, cohabited, then remarried	Divorced at mid/late 30's, later remarried or cohabited	Never married or cohabited
Married at 23	1.000	0.000	0.328	0.482	0.739	0.193
Cohabiting at 23	0.000	0.129	0.119	0.063	0.043	0.063
Married at 33	1.000	0.939	0.000	0.000	0.905	0.140
Cohabiting at 33	0.000	0.000	0.570	0.579	0.000	0.086
Married at 40	1.000	1.000	0.018	0.975	0.108	0.015
Cohabiting at 40	0.000	0.000	0.736	0.000	0.273	0.000
Married at 42	0.967	0.959	0.101	0.954	0.228	0.025
Cohabiting at 42	0.004	0.000	0.736	0.003	0.455	0.078
Remarried	0.139	0.121	0.080	0.659	0.316	0.024