RESEARCH REPORT

Influence of marital history over two and three generations on early death. A longitudinal study of Danish men born in 1953

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Background: This study examined the effects of marital status over two and three generations on last generation's mortality, and tested the hypothesis of an effect of the latest status (proximity effect) as well as the hypothesis of an accumulative effect.

Methods: The study population covers a random sample of all boys born in the metropolitan area of Copenhagen with complete data from interviews and registers on two and three generation's marital status, socioeconomic position variables, and last generation's admission to psychiatric hospital, $n = 2614$. Among these 105 deaths occurred. Cox proportional hazards regression models were used to estimate the effect of marital status on mortality.

Results: Never married sons showed a considerably increased mortality compared with their married counterparts in the adjusted analyses. Mother's marital status at childbirth was also associated with increased mortality among the sons. There was no independent effect of maternal grandparent's experience of divorce on third generation's mortality. Son's marital status was the strongest marital status predictor of mortality. Accumulation of both two and three generations' marital status was significantly associated with mortality risk in a dose-response pattern. All analyses were adjusted for socioeconomic position variables and mental health.

Conclusions: These results support the proximity hypothesis as son's marital status was the strongest predictor of mortality, and suggest an accumulative effect as each of the three non-married generations added to an increased mortality risk.

Living alone or being unmarried are well known risk factors for poor health and mortality especially among men.^{1–4} Changes from being married to divorced or widowed is a strong predictor of mortality and accumulated years in the unmarried or divorced state increase mortality.^{5–7}

The potential health effects of socioeconomic and psychosocial environment measured over the life course have been described by several models: The model of cumulative effects states that the intensity and duration of exposure to unfavourable environments adversely affects health status in a dose-response manner.^{8–11} The sensitive period model implies that some periods in life are more sensitive to effects of harmful exposures, and lastly the proximity hypothesis suggests that the most recent exposure has the largest impact on health,^{6–9} which cannot be identified through the theory of accumulation and the theory of sensitive periods. In this study we focus on the proximity and cumulative effects respectively of marital status over several generations on last generation's mortality.

Earlier studies have shown a cumulative effect of disadvantaged social class throughout the life course on mortality in one and two generations.^{12–14} To our knowledge only one study has analysed the cumulative effect of marital status over several generations on mortality in the offspring generation. Modin found that Swedish men born between 1915 and 1929, who themselves were never married and who were born out of wedlock had significantly higher risk of ischaemic heart disease mortality than their never married counterparts with married mothers.¹⁵ But no earlier study has looked at the effects in a younger cohort.

A number of possible mechanisms have been suggested to explain the association between marital status and mortality. The health selection hypothesis suggests that healthy persons

are selected into marriage while unhealthy people, for example, people with mental health problems are at a higher risk of never getting married or of getting divorced.^{16–18} The social causation hypothesis argues that marriage is protective against ill health, for example through better health behaviours of the married,¹⁹ or through higher economic security or higher degree of social integration.⁷ In this study both inter-generational and intra-generational effects of marital status are studied. Health selection is studied as a mechanism for the intra-generational effects. We did not have access to information about mother's and maternal grandparent's health, and were consequently not able to analyse the possible inter-generational health selection effects. The accumulative model both permits social selection and social causation, which in this study was analysed by including variables about social circumstances in both mother's and son's generation thereby allowing for both intra-generational and inter-generational effects.

With this study we aim to investigate the contributions of marital status in first, second, and third generation to the risk of premature death in a cohort of men born in the metropolitan area of Copenhagen in 1953 to test the hypothesis of a proximity effect. We also investigate the potential effect of accumulated marital status over two and three generations on mortality in the offspring generation. Moreover, we examine to what extent this contribution is explained by socioeconomic position and mental health variables.

METHODS

The study population was all boys born in 1953 in the metropolitan area of Copenhagen, Denmark, who met the following inclusion criteria: (1) Identified by the Civic

Table 1 Indicators of low socioeconomic position and mental health problems by mother's and son's marital status, prevalences (%), n = 2614. The Metropolit study of men born in Copenhagen, Denmark 1953

	Maternal grandparents experienced a divorce before 1968			Mother's marital status 1953			Son's marital status 1992			
	No	Yes	p value	Married	Not married	p value	Married	Never married	Divorced/widowed	p value
% Low family social class 1968	53	59	0.05	53	75	<0.0001	52	56	60	0.01
% Rented housing 1968	59	70	<0.0001	60	76	<0.0001	58	63	69	0.0004
% No car 1968	35	37	0.40	34	55	<0.0001	31	42	38	<0.0001
% No summer house 1968	81	80	0.66	80	86	0.05	80	80	84	0.21
% Sons with primary school education in 1971–72	16	21		17	28		13	23	24	
% Sons with secondary school (low level) education or skilled workers	29	29		28	40		31	23	36	
% Sons with secondary school education (medium level) or short/medium further education	21	25		22	15		22	22	20	
% Sons with unknown educational level in 1971–72	8	9	<.001	8	7	<.0001	7	10	6	<.0001
% Low social class by 2002	55	60		54	68		50	60	67	
% Unknown social class by 2002	8	9	0.014	8	11	<0.0001	5	12	9	<0.001
% Admitted to psychiatric hospital 1968–92	7	11	0.015	8	15	0.0004	3	13	17	<0.0001

Registration System in 1968. (2) Participated in a school survey and cognition test in 1965 (69% of all boys born 1953, n = 7987). (3) Their mother/carer participated in an interview based family survey in 1968. The family survey included a random one in four sample, and in addition the highest scoring 10% and the lowest scoring 10% on the cognition test. Those chosen twice were only included in the random sample, participation rate 82%, n = 2929. (4) Alive and living in Denmark at age 39, n = 2742. (5) Data on educational status available from the conscription data at age 18–19 years (1971–1972). (6) Full records on all applied variables, n = 2614, with 105 deaths between 1992 and 2002 (when 39–49 years old). In the spring 2002, the Danish CRS provided information on the study members' vital status from January 1992 to January 2002.^{20 21}

Variables

Marital status history

The family interview in 1968 provided information about if mother's grandparents had ever experienced a divorce (yes v no).

Information on mother's marital status was available from birth records from 1953 and dichotomised into: married compared with single, divorced, and widowed. The CRS provided information about the son's marital status in 1992 at age 39 years, categorised as never married, married, and divorced/widowed.

Accumulated measures of marital status over two and three generations were created for each participant by counting the number of "not married" status at the selected points in time, range 0–3.

Education

Son's own educational status was based on conscription data from 1971–72 and categorised into four levels: primary school education; secondary school education (low level) or skilled worker; secondary school education (medium level) and/or short/medium further education; secondary school education (high level) and/or long further education. The scale has been described earlier.²²

Socioeconomic position

Information from the family interview in 1968 on the mother's and her husband's occupational class, dichotomised into: high (non-manual) and low (manual). Family social class refers to the highest ranking parent.

Furthermore, we included three indicators of material wealth: owning a summer cottage, owning a car, and living in owner occupied residence.

Information on study participant's last occupational social class was retrieved from the CRS from 1968 and 2002 and coded high (non-manual), low (manual), and unknown (including unemployed). Persons who died in that period were registered with their latest occupation.

Sample variable

(1) The random one in four sample of the birth cohort, (2) the 10% highest scoring, and (3) the 10% lowest scoring on the cognition test in the school survey in 1965.

Mental health

Information on time of son's admission to psychiatric wards from 1968 to 1992 was obtained from the Danish Psychiatric Central Register and coded yes (1+admissions) or no (0 admissions).

Statistical methods

We used Cox's proportional hazards regression models with age as the underlying time scale and entry time was 1992—that is, follow up for mortality risk from the age of 39 to 49 years. Follow up ended at the age of death, migration or January 2002 whichever came first. We added the control variables one at a time to study how much they changed the initial effects of marital status on mortality. The variables that changed estimates for marital status the most were: family social class in 1968, sons' educational attainment 1971–72, son's own social class in 2002, and mental health. Lastly, a model including these selected covariates was tested. Similar analyses were performed for the individual effect of maternal grandparent, mother and son's marital status respectively and for the two accumulated measures of marital status. The possible interaction between mother and son's

Table 2 Hazard ratios (HR) for marital status over two generations and 10 year all cause mortality 1992–2002 in adult offspring. The Metropolit study of men born in Copenhagen, Denmark 1953

	Total number/ no deaths 2614/105	Model 1		Model 2		Model 3			Model 4		Model 5		Final model	
		HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	
Marital status in two generations														
Mother married in 1953	2440/91	1.00		1.00		1.00		1.00		1.00		1.00		
Mother not married in 1953	174/14	2.02	1.13, 3.62	1.76	0.98, 3.17	1.74	0.97, 3.14	1.75	0.97, 3.14	1.69	0.94, 3.05	1.44	0.79, 2.60	
Son married in 1992	1446/33	1.00		1.00		1.00		1.00		1.00		1.00		
Son never married in 1992	841/57	3.07	1.99, 4.74	3.01	1.95, 4.65	2.89	1.86, 4.49	2.53	1.63, 3.94	2.32	1.48, 3.64	2.08	1.31, 3.29	
Son divorced or widowed in 1992	327/15	2.03	1.10, 3.75	1.91	1.03, 3.54	1.80	0.97, 3.33	1.74	0.94, 3.23	1.43	0.76, 2.70	1.26	0.67, 2.39	

Model 1: mutually adjusted. Model 2: model 1 + family social class 1968. Model 3: model 1 + son's educational attainment 1971–72. Model 4: model 1 + son's social class by 2002. Model 5: model 1 + son's psychiatric admission. Final model: model 1 + family social class, son's educational attainment, son's social class, son's psychiatric admission.

marital status was also tested. The statistical analyses were performed using PROC PHREG, SAS version 8. For all variables the proportional hazards assumption was tested graphically and should be fulfilled before inclusion into our analyses using PROC LIFETEST, SAS version 8.

RESULTS

Almost 16% of the maternal grandparents had experienced a divorce; 7% of the mothers were not married at childbirth in 1953, 32% of the sons were never married, and 13% were divorced or widowed at age 39 years (data not shown).

Mothers whose parents had experienced a divorce were at higher risk of not being married at childbirth in 1953 (9%) than mothers with parents without this experience (6%). Sons of unmarried mothers were at a considerably higher risk of becoming divorced or widowed themselves (20%), compared with sons born inside marriage (12%). Furthermore, sons of unmarried mothers were less likely to become married themselves (48%) compared with sons of married mothers (56%) (data not shown).

Among men whose maternal grandparents experienced a divorce there was an increased prevalence of being: from low family social class and living in rented housing in 1968; belonging to low or unknown social class in 2002; admitted to psychiatric hospital. Among men with an unmarried mother at birth there was a higher prevalence of being from low family social class in 1965, living in rented housing 1968, having no car in 1968, having low education in 1971–72, belonging to low or unknown social class by 2002, and

having experienced psychiatric hospital admission between 1968 and 1992. Similar patterns were seen concerning the son's own marital status in 1992 (table 1).

There was no significant effect of maternal grandparent's experience of divorce on the last generation's mortality risk after adjustment for mother's and son's marital status and this variable was consequently left out of the analyses testing the proximity hypothesis.

Table 2 shows the effects of mother's marital status at birth and son's marital status in 1992 on son's mortality risk. Both first and second generation's marital status was predictive of the son's mortality—that is, sons with unmarried mothers at birth experienced a doubled mortality compared with their counterparts with married mothers. In crude analyses, never married sons showed a more than doubled mortality compared with married sons, and likewise the divorced sons showed an increased mortality, however not statistically significant (data not shown). In model 1, where the variables for marital status were mutually adjusted the divorced sons appeared with a doubled and the never married with a tripled mortality risk. Adjustment for socioeconomic variables during childhood slightly attenuated the effects of marital status on mortality risk (data not shown) with family social class contributing the most (model 2). Inclusion of son's own educational attainment in 1971–72 and social class by 2002 showed a stronger attenuation of the associations between marital status variables and mortality risk (model 3+4). Inclusion of the sample variable attenuated the estimates for the marital status variables to some degree (data not shown),

Table 3 Hazard ratios (HR) for accumulated marital status over two generations and 10 year all cause mortality 1992–2002 in adult offspring. The Metropolit study of men born in Copenhagen, Denmark 1953.

	Total number/no deaths 2614/105	Model 1		Model 2		Model 3		Model 4		Model 5		Final model	
		HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI
Marital history over two generations													
Both mother and son married	1363/31	1.00		1.00		1.00		1.00		1.00		1.00	
One generation not married	1160/62	2.40	1.56, 3.69	2.30	1.50, 3.55	2.18	1.41, 3.36	2.02	1.31, 3.13	1.86	1.19, 2.90	1.62	1.04, 2.55
Two generations not married	91/12	5.76	2.89, 11.45	4.80	2.40, 9.60	4.54	2.26, 9.14	4.08	2.03, 8.21	3.35	1.63, 6.86	2.50	1.21, 5.19

Model 1: mutually adjusted. Model 2: model 1 + family social class 1968. Model 3: model 1 + son's educational attainment 1971–72. Model 4: model 1 + son's social class by 2002. Model 5: model 1 + son's psychiatric admission. Final model: model 1 + family social class, son's educational attainment, son's social class, son's psychiatric admission.

whereas adjustment for the mental health variable attenuated the associations between marital status and mortality risk considerably (model 5). In the full model (final model) a significantly doubled mortality risk persisted among the never married sons despite adjustment for social and mental health variables. An effect of mother's marital status was still present, hazard ratio = 1.44 (0.79 to 2.60), whereas the effect of being divorced among the sons was almost fully explained by the included covariates.

An interaction term between mother and son's marital status was not significant.

Table 3 shows the results of multivariate analyses of the accumulated measure over two generations and all cause mortality. A dose-response relation was seen for the accumulated marital status variable—that is, the more generations not married the higher the mortality (model 1). Adjustment for socioeconomic position variables in 1968 attenuated this association slightly (model 2), whereas son's own educational attainment 1971–72 and social class by 2002 explains a rather large part of the association (model 3+4), as did his mental health (model 5). Inclusion of the sample variable also slightly attenuated the estimates for the marital status variables (data not shown). The final model showed a persistent dose-response relation between accumulated marital status and mortality (final model).

Multivariate analyses of marital status accumulated over three generations showed a significantly increased mortality risk per unit increase in number of not married generations (0–3) HR = 1.31 (1.00, 1.71), data not shown.

The most prevalent causes of death in this population were violent deaths attributable to accidents and suicides as well as alcohol related deaths (37%) and around a fourth of the deaths were attributable to cardiovascular causes. However, the number of deaths was too small to allow for analyses on specific causes of death.

DISCUSSION

Our results showed that never married sons had a doubled 10 year mortality compared with the married sons, and that mother's marital status at child birth is associated with their son's mortality risk, after adjustment for covariates. Among divorced sons an insignificant 18% increased mortality risk was seen after adjustment for socioeconomic position and mental health variables. We presume this result to be attributable to lack of power, as in an earlier study on the full cohort we found a tripled mortality risk among divorced/widowed males.⁶

This study supports the hypothesis of a proximity effect as son's marital status is a stronger predictor of mortality than both maternal grandparent's and mother's marital status. The accumulated measures of marital status over two and three generations showed a statistically significant increased mortality risk with each level of accumulated generations not married, when adjusted for the above mentioned covariates.

Our analyses suggest some support for the accumulation hypothesis showing a dose-response association between the combined measure of marital status over two and three generations. However, as the effect of mother's marital status attenuates after adjustment for son's marital status, and as the effect of the accumulated measure weakens the more generations added, there is stronger support for both a proximity effect and the idea that proximal risk factors are more potent than more distal risk factors. The main causes of death in this population are psychiatric and violent, and the proximity effect may act especially strong for these outcomes. Larger scale studies and/or longer follow up periods provide the opportunity to analyse the proximity effect for other causes of death—cardiovascular and cancer—where childhood may be of importance.

What this paper adds

This paper provides results based on information on marital status over three generations as a predictor of last generation's mortality risk among younger men. The results support the hypothesis of proximity effect—that is, the last generation's marital status was the strongest predictor of mortality. Furthermore, the results suggest an accumulative effect as each of the three non-married generations added to an increased mortality risk. The effects were not explained by mental health problems or socioeconomic conditions in the last generation.

Only a small proportion of the total population experienced single marital status in two or three generations. From a mechanistic point of view it is however still interesting that the cumulative pattern is present. It is difficult to separate the effects of accumulation and proximity. As Hallqvist *et al* suggest in their study, the hypotheses are interrelated in such a way that they cannot be empirically disentangled within a simple life course model and the effects may operate together.²³

This study suggests that even early deaths are influenced by marital history in one and several generations as has been shown in earlier studies for mortality risk later in life.^{14 24}

We worked with three rather different measures of marital status that might have influenced our results. For the maternal grandparents we had information on the experience of a divorce for a long period of life, for the mothers we had information on marital status at childbirth and for the son we had information on marital history until the age of 39 years. As an important part of the divorces among the mothers presumably will take place later than at childbirth inclusion of information on later marital history might have given stronger effect to this generation's marital status but these data were not available. In an earlier study of mortality and marital history in one generation we found support for the accumulation hypothesis as accumulated years divorced and number of marital break ups was found to be strong predictors of mortality. In that study we also found some support for the proximity effect as the latest marital status explained a substantial part of the effect of the accumulated measures.⁶

In this study the associations between marital status and mortality risk were partly explained by subject's own education and social class and mental health. Inclusion of mental health attenuated the association between the marital status measures and mortality. Furthermore, an association between mental health and marital status was hardly changed after adjustment for family and son's own socioeconomic status. Together these results lend some support for the theory of health selection as a potential explanation of the differences in mortality risk between married and not married.

Policy implications

- To introduce better family counselling in families in high risk of divorce.
- To better economic conditions for one parent families as it seems to increase health problems in the offspring generation.

In earlier periods, it may have been stigmatising for a pregnant woman to be unmarried or divorced. Modin¹⁵ suggests that such a stigma could lead to later severe health consequences for herself and her children. We find similar results in a generation born some 30–40 years later than the Swedish cohort. In Denmark, the 1950s were the heydays of the family—married couples with children—and only a minority of children was born outside marriage.²⁵ Our results speak in favour of persisting disadvantaged circumstances for unmarried men born of unmarried mothers in this period. Nowadays, divorce and being a single mother has become much more common and perhaps less stigmatising. However, single mothers are among the poorest in the EU²⁶ and it is still health damaging to live in single parent families.²⁷ Therefore, macro-social changes from 1950s until today do not seem to have changed the unfavourable conditions for children of single mothers decisively. However, own and previous generations' marital status may be seen as different constructs, and further cumulative effects within one generation and between several generations may not mean the same thing. Although the meaning of "not being married" have changed over generations towards a higher degree of acceptance, a strong effect of single marital status persists in last generation in our study. If single marital status had had the same meaning today as in the mother's and grandparent's generation, we would have expected even stronger effects of this exposure.

This study is based on a large cohort with information on both social and health related variables over three generations with complete follow up of mortality. It gives a unique possibility to study both the proximity and accumulation hypotheses of the effect of marital status on mortality risk over several generations. Furthermore, information on all covariates except maternal grandparents' experience of a divorce was based on objective data. The excluded population that did not participate in the school survey were more often sons of unmarried mothers and had more often fathers with unknown occupation. Had these people been included in our analyses the association between marital status over two and three generations would presumably be even stronger. The people ($n = 128$) excluded because of missing information on the included variables were few (5%) and the missing values were not systematically distributed.

It is a potential weakness of the study that we have no information on women, as the associations between marital status and mortality risk may look different among women.

Because of lack of power we had to dichotomise the variable for mother's marital status well aware that divorced, widowed and never married individuals may have different social circumstances.

In this population of men it is quite common to cohabit with a partner without being formally married. The resulting misclassification will lead to an underestimation of the real effects of being not married. We have earlier shown that being married and cohabiting with a partner has about the same health protective effect.⁴

The combination of the different groups of unmarried (never married, divorced, widowed) in the analyses may have led to an underestimation of the cumulative effect as the effect on last generation's mortality of being divorced was fully explained by the social and health variables.

We had no information on son's physical health, which might cause selection out of marriage. However, in this rather young cohort the most common disease to cause selections out of marriage is probably mental illnesses in the offspring. We did adjust for the most severe cases by including a measure of admission to psychiatric hospital.

Unfortunately, we did not have access to measures of health behaviours among our study participants and we were

therefore not able to exclude the possibility that unhealthy behaviours cluster among the not married. In an earlier study of 50, 60, and 70 year old Danish women and men, adjustment for health behaviours (smoking, diet, and physical activity) did not change the strong association between cohabitation status and mortality risk.⁴

In conclusion, we found a significant effect of son's own marital status on early deaths that persisted after adjustment for social and mental health variables. Mother's marital status was also associated with son's mortality risk after adjustment for covariates, but the estimate was lower than for son's own marital status. The results support the proximity hypothesis. Furthermore, the accumulated measures of marital status over both two and three generations showed significant effects in a dose-response pattern.

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