Original Research Article

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Relationship transitions and change in health behavior: a twelve-year longitudinal study with four phases

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Abstract

Rationale: Extensive scientific evidence shows an association between involvement in social relationships and healthy lifestyle. Prospective studies with many participants and long follow-ups are needed to study the dynamics and change in social factors within individuals over time.

Objective: Our aim was to determine whether a change in relationship status (single, married, divorced, widow, cohabiting) is followed by a change in health behavior (smoking, alcohol consumption, physical activity, and body mass index).

Methods: We used data from 81,925 healthy adults participating in the prospective longitudinal Finnish Public Sector Study in the period 2000–2013. We analyzed 327,700 person-observations from four data collection phases. Missing data were multiply imputed. A within-individual methodology was used to minimize the possibility of selection effects affecting the interpretation.

Results: All four health behaviors showed associations with relationship status. The effects were very similar and in the same direction in women and men, although there were gender differences in the magnitudes of the effects. The end of a relationship was followed by a decrease in body mass index, increased odds of being a smoker, increase in physical activity, and increase in alcohol consumption (widowed men). The effects were reverse when forming a new relationship.

Conclusion: A change in relationship status is associated with a change in health behavior. The association is not explained by socioeconomic status, subjective health status, or anxiety level. People leaving or losing a relationship are at increased risk of unhealthy behavior (smoking and alcohol consumption), but at the same time they have a lower BMI and show higher physical activity compared to the time they were in a relationship. It is not clear if the cumulative health effect of these health behavior changes is positive or negative.

Keywords: Finland; smoking; alcohol; physical activity; BMI; within individual; marriage; divorce

Introduction

Extensive research has shown that people living in a relationship have lower mortality rates than divorced or single people (Elovainio et al., 2017; Frisch & Simonsen, 2013; Holt-Lunstad et al., 2010; Kiecolt-Glaser & Newton, 2001; Koskinen et al., 2007; Lund et al., 2004; Martikainen et al., 2005; Rendall et al., 2011). Different behavioral, psychosocial, and physiological pathways are likely to explain these findings (Umberson & Montez, 2010). At least five possible mechanisms have been proposed for this phenomenon: social selection, social protection (or social causation), social obligation or norms, social crisis, and the marriage market (i.e. certain behaviors are preferred over others in an ideal wife / husband candidate) (Averett et al., 2008; Williams & Umberson, 2004).

According to the *selection* view, persons with an elevated risk of death due to individual qualities such as unhealthy behavior, low socioeconomic status (SES), or poor health are less likely to enter a relationship and more likely to divorce or separate (Martikainen et al., 2005). In this view, 1) healthy behaving individuals are considered better marriage partners, 2) the association between relationship status and health is not causal, and 3) the relationship-forming process is seen to favor the healthy.

The *social protection* hypothesis assumes that a relationship in itself is a protective factor due to, for example, increased economic security and social support, which help in maintaining a healthy lifestyle and dealing with stress, leading to lower mortality (Cohen, 2004; Lund et al., 2004; Waldron et al., 1996). Social protection is mostly a direct form of social control where the actions of a person are intended to affect another person (Umberson, 1992). Social support from the significant other can be divided into instrumental support (material aid, such as financial support), informational support (advice and guidance when facing problems), and emotional support (e.g., empathy, caring and trust) (Cohen, 2004; Umberson et al., 2010). Also, as people in a relationship have more material resources than when they are single, it may be easier to make and maintain

healthy and possibly more expensive life choices. Protection may also come in the form of spousal supervision, suggestions to go to see a doctor when needed, and discouragement to engage in risky or unhealthy behavior (Averett et al., 2008).

The *social obligation* view suggests that in a relationship, people eat more regularly, choose healthier meals, and due to positive social pressure, follow the health enhancing norms that society tries to promote (Averett et al., 2008; Umberson et al., 2010). Social obligation is an indirect form of social control: a person has internalized certain health norms and self-regulates one's behavior accordingly (Umberson, 1992). A person is probably more likely to work towards quitting smoking if he/she thinks that smoking is a negative form of behavior (Christakis & Fowler, 2008). The hopes and expectations of other people may also be important. Even if a person thinks that there is nothing wrong with smoking, he/she may smoke less around non-smokers who do not want to inhale smoke or who dislike smoking in general. However, it is also possible that social obligations towards the spouse, children, home, and family take away cognitive resources from upholding healthy behavior which may lead to unhealthier behavior (Umberson, 1992).

The *social crisis* hypothesis implies that the observed associations are not explained by the protective aspects of a relationship but by the negative and stressful effects of losing an important relationship such as a divorce (Williams & Umberson, 2004). No benefit would be the normal situation and compromised well-being would be an abnormal temporary situation following a negative social life event.

Finally, the *marriage market* hypothesis suggests that in a relationship people may quit maintaining healthy behavior because maintaining it requires much effort and by being in a relationship they have already achieved their goal in the market. The flipside of the phenomenon is returning to healthy behavior after the end of a relationship to increase one's market value (Averett et al., 2008).It is important to understand that these four explanations are not mutually exclusive, as it is possible that both causation and selection play a role in the link between relationship status and

different outcome measures. Different mechanisms may interact and this interaction may explain the phenomenon better than any single mechanism (Rendall et al., 2011; Umberson & Montez, 2010). For example, it is entirely possible that alcoholics do not form relationships as often as others and that, at the same time, people without a drinking problem will drink even less in a relationship.

Our study concentrates on the association between relationship status and health behavior. Health behavior is one of the most important pathways between relationship status and serious health outcomes, including mortality (Mokdad et al., 2004; Stringhini et al., 2010). We use alcohol consumption, body mass index, physical activity, and smoking as health behavior variables because they are some of the most important factors explaining premature mortality and disability (World Health Organization, 2009). The most reliable way of testing this association would be a randomized control trial, but as it is not possible to randomly assign people to different relationship statuses we use observational data to examine within-individual variation over time. We examined whether a change in relationship status predicts changes in health behavior (smoking, body mass index (BMI), alcohol consumption, physical activity) using longitudinal data with four study phases that took place four years apart. Many previous studies have concentrated on single health behaviors. More studies examining several health behaviors in the same study are needed. It is also very much possible that the type of a relationship transition matters. Becoming a widow after a marriage may have different implications than becoming divorced even though losing a relationship is in the center of them both. We included the categories of single, married, cohabiting, divorced / separated, and widowed, and all plausible transitions between these categories.

According to previous research, the end of a relationship reduces BMI and a new relationship increases BMI (Averett et al., 2008; Eng et al., 2005; Jeffery & Rick, 2002; Lee et al., 2005; Mata et al., 2015; Sobal et al., 2003; Syrda, 2017; The & Gordon-Larsen, 2009). The end of a relationship has been found to increase alcohol consumption and being in a relationship seems to

decrease it (Dinescu et al., 2016; Eng et al., 2005; Power et al., 1999). Forming a relationship seems to decrease smoking frequency and ending a relationship seems to increase smoking frequency (Christakis & Fowler, 2008; Eng et al., 2005; Lee et al., 2005; McDermott et al., 2009). In a new relationship physical activity has been found to decrease, and the end of a relationship seems to increase physical activity (Eng et al., 2005; Engberg et al., 2012; Lee et al., 2005; Mata et al., 2015). The very limited previous research suggests that relationship transition type may not always be an important factor. For example, a divorce and being widowed seem to produce very similar results (Eng et al., 2005; Lee et al., 2005). More research is needed to fill the knowledge gaps in different relationship transitions. We introduce a wider set of different transitions than in previous studies. Our study included four measurement waves, which is more than in most previous studies. The direction of the aforementioned effects has been similar in men and women. If men have shown an increase or decrease in healthy behavior after a change in relationship status, women have shown a change in the same direction or no change at all. Therefore, possible sex differences in the present study are expected to be in the magnitude of the effects and not in the direction of the effects. There is reason to expect that the effect sizes are bigger for men. In a relationship, women have been shown to control men's behavior more than vice versa (Raitasalo & Holmila, 2005). Also, since women have traditionally been more often responsible for different household chores than men, men may experience the positive sides of a relationship without these stressful negative effects (Umberson & Montez, 2010). In addition, men's emotional needs are usually mostly met by their spouses, whereas women rely much more on their female friends (Vandervoort, 2000). Therefore, forming or ending a relationship could affect men more than women.

Method

Participants

Participants were from the prospective longitudinal Finnish Public Sector study (FPS). The first data collection phase (survey) was conducted in 1997–1998. Additional repeated survey data with 2- to 4-year measurement intervals cover the period from 1997 to 2014. The FPS study consists of all Finnish public-sector employees in 10 towns. All current employees and previous study participants were invited at each study wave. Informed consent was obtained from all individual participants included in the study. The ethics committees of Helsinki University Hospital and the Finnish Institute of Occupational Health approved the study protocol.

The present study contains data from four consecutive study phases with 4-year intervals in 1) the period 2000–02 (*n*=32,299, response rate 67%), 2) the period 2004–05 (*n*=32,197, response rate 65%), the period 2008–09(*n*=38,838 response rate 71%), and the period 2012–13(*n*=39,250, response rate 69%). 43% of all the participants participated all four study waves. The time between the study waves slightly varied due to the different time period of the data collection in individual study phases (e.g., two years in 2000-02). In our sample, all participants had data from one or more study phases. As health behavior is a target for several life style changing interventions among the diseased, individual participant observations with objectively measured diabetes, asthma, hypertension, coronary heart disease, arthritis or cancer were removed to tackle this possible source of bias. This led to the removal of 1,944(1,526 women, 418 men) participants. There were 81,925 (65,850 women, 16,075 men) participants who had data of the relationship status or at least one health behavior in at least one of the four measurements. Of these, 24% participated in one study wave, 21% in two study waves, 18% in three study waves, and 19% in all four study waves. Non-responders in the FPS study were more likely to be male, younger, and manual workers (Clark et al., 2015). Attrition effects were evaluated by comparing the participants with only one study phase to the participants with all four study phases. Those with only one study phase were more likely men (21.5% vs. 17.3%), more likely manual workers (36.4% vs. 35.1%), and less likely married (53.2% vs. 59.9%). They also had higher BMI (25.6 vs. 24.5), were more likely smokers (18.1% vs.

15.8%), had lower probability of mental ill-being (23.9% vs. 25.5%), and were less likely subjectively healthy (75.8% vs. 78.5%). Although significant due to a large sample size, these differences were rather small in magnitude. Missing values were multiply imputed in the final sample of 81,925 participants (see details below). This process led to a complete dataset of 327,700 observations and four study waves for each participant. Figure 1 shows the flow chart of the study sample.

<INSERT FIGURE 1 ABOUT HERE>

Relationship Status

Information on relationship status was obtained from self-report questionnaires with one question. There were five possible categories: single, married, cohabiting, divorced or separated, and widowed. All five options were used in the analyses when exploring a possible change in relationship status.

Health Behavior

Health behavior was mapped using the following self-reported indicators: height and weight (with which Body Mass Index (BMI = weight in kg/ height in meters^2) was calculated), smoking status (one item: current smoker, ex-smoker, never smoker), alcohol consumption (How much do you consume of the following alcoholic drinks on average: beer per week (none, less than a bottle, 1-4bottles, 5-12 bottles, 13-24 bottles, 25-47 bottles, over 48 bottles); wine or other mild drinks per week (none, less than a glass, 1-4 glasses, 1-2.5 bottles, 3-4.5 bottles, 5-9 bottles, over 10 bottles); spirits per month (none, less than half a bottle, 0.5-1.5 bottles, 2-3.5 bottles, 4-9 bottles, 10-19 bottles, over 20 bottles?) The volume of beer, wine, and spirits consumed was calculated as grams of absolute alcohol per week); and physical activity (average weekly intensity and duration of exercise; all activities were assigned metabolic equivalent task values (MET), which were multiplied by the hours spent at each intensity level, and the result was one measure of MET hours

of physical activity per day). Questions to assess physical activity were 1) walking, 2) high intensity walking, 3) jogging, 4) running, and the answering options a) not at all, b) less than 0.5 hours a week, c) an hour a week, d) 2-3 hours a week, e) 4 hours or more. Alcohol consumption, BMI, and physical activity were analyzed as continuous variables. Smoking was analyzed as a 0 / 1 (current smoking reported) dummy variable.

Covariates

Information on sex, age in years (continuous), and occupational status (upper-grade non-manual, lower-grade non-manual, manual workers) was obtained from the employers' records and from national registers. Occupational status was based on the International Standard Classification of Occupations-88 (ISCO-88) and the Occupational Title Classification of Statistics Finland. Occupational status was used only in the imputation models because, due to its high stability over time, it was redundant in the fixed effects analyses. Mental ill-being was defined as at least four symptoms (coded as yes/no) on the 12-item General Health Questionnaire (Holi et al., 2003). The six-item Trait Anxiety Inventory (Marteau & Bekker, 1992) was used to measure symptoms of anxiety (continuous). Subjective health was measured with one item on a 5-point Likert scale, which we dichotomized as good (good or reasonably good) / bad (average, reasonably bad or bad) dummy variable (Idler & Benyamini, 1997; Lundberg & Manderbacka, 1996; Manderbacka et al., 1998). Dummy-coded study year variables were included in all the analyses to control for possible period effects.

Statistical Analyses

Relationship status was the independent variable and health behavior the dependent variable in all the analyses (four separate analyses per one relationship status option for different behaviors).We chose to use random-intercept multilevel modeling (observations nested within-individuals) as the analysis method to take into account the nonindependence of repeated

measurements of the same persons over time (Curran & Bauer, 2011). We used the fixed effects (within-individual effect) estimator of *xtreg* and *xtlogit* procedures (STATA version 13.1). Data were analyzed in a long form, that is, one row represented an individual observation and one person had 4 rows in the dataset. With repeated measurements, the between- and within-individual components can be estimated separately with the linear regression model $y_{it} = \alpha + \beta_{0i} + \beta_W(x_{it} - \bar{x}_i) + \beta_B\bar{x}_i + \varepsilon_{it}$, where α is the overall intercept, β_{0i} is the participant-specific intercept, x_{it} is the exposure variable for the *i*th participant at the *t*th measurement time of the participant, $\bar{x}_i$ is the mean value of the exposure variable averaged across all measurement times separately within each participant, and ε_{it} is the error term. Then the regression coefficient β_W gives the within-person (or fixed-effect) estimate and β_B gives the between-person estimate. Robust estimation with clustering was used in all models to calculate robust standard errors and confidence intervals. The advantage of fixed effects methodology is that it ignores all time-invariant variables and only explores within-individual variation (Press, 2007). Thus, it is an ideal tool in longitudinal data where there are many repeated measurements. It is also built to accommodate situations where participants have gaps in their data, that is, they have participated in only some but not all of the study waves. The fixed effects estimator is also very robust to missing data (Young & Johnson, 2015). And answers to the questions like "if people move from single to married status, does their health behavior change," although a large fixed effects coefficient is not a proof of causality or the direction of a possible causal effect. The main function of the fixed effects estimator in the present study is to provide evidence of possible within-individual covariation between health behavior and relationship status.

Of the covariates, measurements of age, mental ill-being, anxiety, and subjective health were carried out at each study phase. Mental ill-being and anxiety were chosen because mental health and the state of mind strongly affect behavior and health behavior has been shown to function as a source of pleasure and relaxation that help regulate negative mood (Pampel et al., 2010). Subjective

health was used because health concerns have been shown to affect health behavior (Pampel et al., 2010). An objectively healthy person can feel unwell so we wanted to add subjective health. Occupational status was not used as a covariate with the fixed effects estimator because it is highly stable over time and fixed effects considers only change over time. BMI, physical activity, and alcohol consumption were analyzed in separate models. A logistic regression model was used to analyze smoking status.

We accounted for missing data by using multiple imputation by chained equations, which generated five imputed datasets (White et al., 2011). The imputation model included occupational status, all covariates, all health behavior variables, and relationship status. Imputation was conducted in wide form, that is, each participant had only one row, and BMI in year 2000 was coded in a different variable than BMI in year 2004. Imputed data were included in the analyses by using the *mi estimate* prefix in Stata. Given the mix of different characteristics that differed between the two groups (see above) with no clear direction of potential bias (e.g., lower likelihood of mental health issues in non-responders, non-responders were more likely to be men), the missing-at-random principle was likely not very seriously violated. Therefore, we conducted our analyses with imputed data; moreover, we also evaluated whether results depended on this decision.

To test whether reverse-causation bias (ie, the effect of health behavior on relationship status) affected our results, we conducted a sensitivity analysis using logistic regression in the imputed dataset. Health behavior was the independent and relationship status the dependent variable. We tested whether those in a relationship in year 2000 ended their relationship in 2004, 2008, or 2012 as a function of health behavior in year 2000 using all the same covariates as in the main analyses.

Results

A summary of the characteristics of the study population appears in Table 1. Participant ages ranged from 18 to 77 years across the study phases. The mean age was 45 years. Most of the

participants were women (80%), which reflects the sex distribution among all Finnish public-sector employees (78% women in 2009). Table 2 shows distribution of relationship status and changes in relationship status over the four study phases. 12.6% were single, 58.8% married, 15.7% cohabiting, 10.8% divorced or separated and 2.0% widowed.

< INSERT TABLE 1 ABOUT HERE>

<INSERT TABLE 2 ABOUT HERE>

We tested the possible interaction effects of sex × relationship status on each of the four health behaviors using a fixed effects model, with relationship status, age, sex, and one interaction term as the predictors. Only physical activity had no significant interactions. Thus, analyses were conducted separately for men and women if the interaction term was significant. Otherwise, men and women were combined.

Fixed Effects of Relationship Transitions

Tables 3 and 4 show the results of adjusted within-individual (fixed) changes in relationship status in four health behaviors. These analyses used longitudinal data only. Relationship status and health behavior were assessed at the same wave, that is, a cross-lagged setup was not used. Compared to single people, married people had higher BMI, lower level of alcohol consumption (only in women), lower level of physical activity, and lower probability of smoking (only in women). Comparing single to cohabiting showed very similar results as from single to married, although the magnitudes of the effects were consistently lower. Comparing cohabiting to married followed a similar logic and showed several significant associations which were consistently weaker than when comparing being single to being married. Comparing married to divorced gave results that very much were the mirror image of the single-married comparison although the magnitude of the effects was slightly smaller except that for smoking. If a health behavior showed a positive association when getting married, it showed a negative association in a divorce. Comparing

cohabiting to separated showed results in the same direction as married-divorced comparison. Comparing married to being widowed showed decrease in BMI and increase in alcohol consumption (for men) when widowed. Comparing cohabiting to being widowed showed a decrease in BMI when being widowed. The largest effect for BMI was found when being widowed was compared against being married (adjusted *b* = -0.55, 95% *CI:* -0.71,-0.40). The largest effect for alcohol consumption was found when being widowed was compared against being married (for men) (adjusted *b* = 36.26, 95% *CI:* 5.70, 66.83). The largest effect for physical activity was found when cohabiting was compared against being single (adjusted *b* = -0.38, 95% *CI:* -0.56, -0.19). The largest effect for smoking was found when being divorced or separated was compared against being married (in men) (adjusted *OR* = 2.22, 95% *CI:* 1.43, 3.44). The effect size for women was very similar in magnitude (adjusted *OR* = 2.15, 95% *CI:* 1.76, 2.62).

< INSERT TABLE 3 ABOUT HERE>

<INSERT TABLE 4 ABOUT HERE>

Gender Interaction Effects in Fixed Effects

For both men and women, entering a relationship was associated with an increased BMI as the fixed effects in Tables 3 and 4 show. Ending a relationship was associated with a decrease in BMI in both men and women. Similarly, entering a relationship was associated with decreased physical activity in both men and women, and ending a relationship was associated with an increase in physical activity. Entering a relationship was associated with lower odds of smoking only in women. Ending a relationship was associated with higher odds of smoking in both men and women. Alcohol consumption showed a decreasing trend in men and women when entering a relationship although the association was weak. Ending a relationship showed no associations with alcohol consumption with the exception of being widowed in men. All the significant gender interactions came from the magnitude differences of the effects. There were no differences in the direction of

the effects. One of the most notable interactions was found in alcohol consumption. A transition from being married to widowed was associated with an increase of 36.26 grams of alcohol per week in men but women showed no effect. Interaction effects in BMI were significant but small. Physical activity showed some interaction effects but these were rather small in magnitude. In smoking, women showed 5 significant effects against men's two. This may be a result of not having enough men in the analyses and the rarity of a change in smoking status since the trends of the associations in men were very similar to those in women.

Exploring the Possibility of Reverse Causality

According to logistic regressions conducted in the imputed dataset, baseline BMI or physical activity did not predict a breakup in the following study waves. Alcohol consumption showed a very marginal effect (adjusted *OR* = 1.01, 95% *CI:* 1.01, 1.02). Smoking status, however, had a larger effect (adjusted *OR* = 1.52, 95% *CI:* 1.37, 1.67). Additional adjustment for occupational status lowered this smoking status effect only little (adjusted *OR* = 1.45, 95% *CI:* 1.31, 1.60).

Comparing the Results of the Imputed and the Non-imputed Datasets

The direction and magnitude of the effects were very similar in the imputed and the non-imputed datasets. Most notable differences were in the gender interaction effects. There were more significant interactions in the non-imputed than in the imputed dataset. For example, physical activity showed no significant gender interactions in the imputed dataset but there were two interactions in the non-imputed dataset. Thus, attrition effects appeared to have caused some bias to the complete data gender estimates, which multiple imputation helped to correct.

Discussion

Our findings suggest that changes in relationship status are associated with changes in health behavior. BMI increased, alcohol consumption decreased, physical activity decreased, and

probability of smoking decreased when a person entered a relationship. The direction of these effects was very similar in men and women. There were, however, differences in the magnitude of these changes between men and women. Getting married or moving to cohabit was associated with women's lower odds of smoking but not men's odds. When there was a transition into not having a relationship, BMI decreased, physical activity increased, and odds for smoking increased. Interestingly, end of a relationship was associated with alcohol consumption only in widowed men and the size of this effect was quite large. Plausible explanations for these associations are that either the association between a relationship status transition and health behavior is causal (with a possibility of reverse causality) or there are common unknown factors that cause change both in relationship status and health behavior. Previous research suggests that relationship transitions play an important role in smoking status and that selection effects are more pronounced in alcohol consumption, BMI, and physical exercise (Dinescu et al., 2016; Osler et al., 2008).

Through health education, such as that in Finland, the general social norm is against heavy alcohol consumption, smoking, overweight, and physical inactivity and probably explains our results to some extent by attenuating the effect sizes. Health education may offer an alternate source of motivation for healthy behavior. It is possible that health education changes social norms and that these norms affect a person even without an intimate relationship. Finnish society as a whole encourages healthy behavior, and it is possible that this effect goes beyond individual social relationships.

Probably most people living in modern Western societies acknowledge that non-smoking, moderate alcohol consumption, plenty of physical exercise, and a BMI under 25 is the healthiest lifestyle. However, being aware of this fact does not necessarily lead to living according to it. Previous research suggests that smoking status is highly stable, alcohol consumption moderately stable, and physical activity and BMI somewhat less stable over time (Bauman et al., 2012; Mulder et al., 1998b; Paavola et al., 2004). Living in a committed social relationship has been linked to a

healthier lifestyle (Benzies et al., 2008). Social selection, social protection, social obligation, and the marriage market have been proposed as the mechanisms behind this link (Averett et al., 2008).

Previously, smokers have been shown to be more often those not living in a relationship, and being in a relationship has been suggested to help in quitting smoking, with our results supporting this finding (Lee et al., 2005; McDermott et al., 2009). The effect was of similar size in men and women. Most of those initiating smoking after the end of a relationship were ex-smokers (about 84%). Nevertheless, a possible change in smoking status has important health consequences, and the proportion of never-smokers initiating smoking was surprisingly high. The marriage market is not a plausible explanation for these findings, since smoking is rarely seen as a desirable characteristic in a partner and, still, those without a relationship smoked more. Social selection is a possible mechanism since single people are more likely to smoke (Osler et al., 2008). Social protection is a very plausible mechanism, since ending a relationship was associated with initiating smoking. Social obligation is also a possible mechanism. The dangers of passive smoking and the many other negative effects probably pressure a person to quit smoking when in a relationship to reduce social tension (Christakis & Fowler, 2008).

According to previous evidence, being in a relationship is associated with decreased physical activity while ending a relationship is associated with increases in it (Engberg et al., 2012; Lee et al., 2005). Our results support these findings. In this case, the marriage market is a possible explanatory mechanism. Physical fitness is seen as a desirable trait, which motivates a single person to exercise. Social selection may play a role as has previously been found (Osler et al., 2008). Social protection does not apply here because a relationship has a negative effect on physical activity. Competing social obligations are a very plausible explanation, since physical activity requires time, effort, and commitment. As many daily activities in a person's family life compete for the same resources, the physical activity level may be low even if physical activity is seen as being positive and one is encouraged to increase it.

There is plenty of existing evidence that being in a relationship is associated with weight gain, and that the end of a relationship is associated with weight loss (Eng et al., 2005; Jeffery & Rick, 2002; Lee et al., 2005). We found very similar results that support these previous findings. The marriage market could be one of the explanatory mechanisms, since weight is seen as an important factor in partner selection. Social selection is also a possible mechanism as has previously been suggested (Osler et al., 2008). Competing obligations is a promising explanatory candidate. Eating together and other family obligations requiring cognitive attention may make it difficult to focus on not eating too much. An additional previous finding is that the effect of a relationship on weight is suggested to be short-term only (Umberson et al., 2009). Eating behavior is strongly influenced by both positive and negative emotions, which can lead to both weight gain and loss (Macht, 2008). Thus, social, and emotional factors seem to influence weight without a clear direction or simple long-term effects.

Alcohol consumption, in turn, has been shown to be associated with a decrease in a committed relationship and an increase after the end of a relationship (Dinescu et al., 2016; Eng et al., 2005; Power et al., 1999; Raitasalo & Holmila, 2005). Our results support these findings. The marriage market is not able to explain this result, since increased alcohol consumption is not a preferred spousal attribute, unless single people go to bars looking for a new relationship. We found that within individual alcohol consumption effects were rather small which suggests that possible differences between married versus not-married are due to selection effects as has been suggested (Osler et al., 2008). A good explanatory candidate is social protection, since alcohol consumption is lower in a relationship. A relationship offers alternative ways to cope with difficulties, and talking to one's own partner usually is a relaxed situation with no subjective need for alcohol. Social obligations are another possible explanatory mechanism. Plentiful alcohol consumption is often seen as negative inside a family. There is a strong social norm not to drink much alcohol around children or one's spouse (Sudhinaraset et al., 2016).

As it is not possible to conduct experimental studies on the effects of relationships on health behavior, we used longitudinal data and a fixed-effects methodology to remove bias from possible time-invariant confounders. That makes causal argumentation more justified, although time-variant factors could cause bias in the results. The practical significance of our results is heightened by the fact that health behavior is, on average, reasonably stable over time (Mulder et al., 1998a). Therefore, identifying factors associated with changes in health behavior is of special interest. The results highlight the need for interventions that buffer the negative effects of the end of a relationship or living without one. In mostly publicly funded health care systems such as in Finland, these interventions can mainly be said to be the responsibility of the public sector.

Our results showed that smoking is less common in a committed relationship, and that a change in relationship status is linked with a change in smoking status. This is in line with the finding that modern-day smokers tend to be socially isolated and have a smaller social network than non-smokers (Christakis & Fowler, 2008). Many social contacts with non-smokers tend to encourage quitting smoking, and having few social contacts in general tends to discourage quitting. Our results suggest that being widowed is linked with increased alcohol consumption in men and this association is rather strong. Other transitions were only weakly associated with alcohol consumption. It seems that the level of alcohol consumption is rather stable regardless of relationship status. The end of a relationship was associated with decreased BMI and increased physical activity. It is possible that finding a new partner motivates this change or that when social obligations related to a relationship are removed, people have again time and energy to pursue the goals of being thin and in shape.

Strengths and Limitations

The main strength of this study was the availability of longitudinal data with several repeated phases that allowed us to use fixed effects as the analysis method. We were able to remove objectively diseased participants, which made the results concerning health behavior more reliable. The time interval between follow-ups was several years, but as relationship status was very stable between the follow-ups it is unlikely that very many changes in the relationship status went unobserved in the study. The health behaviors used in this study are widely studied and allow for the replication of our results.

The response rate was about 43% in three successive study waves, and the response rate in one study wave was about 69%. Multiply imputed missing data made it possible to use all possible information in the within individual analyses. Since the sample consisted of healthy employed individuals, it is probably not possible to generalize the results to the unemployed and people with diseases. Doing so would require a new study. The results can probably be generalized to other public sector workers and to a mostly healthy population. Comparison of the imputed and the non-imputed databases suggested that the results based on the imputed database were likely to be more conservative than the results based on the non-imputed database.

Unfortunately, we did not have information on the health behavior of partners or spouses. Having a spouse with unhealthy behavior may be a source of considerable strain, which may make it harder to adopt or uphold healthy behavior (Koball et al., 2010). A spouse with a healthy lifestyle, however, may be a source of support and motivation in changing one's own unhealthy behavior. In addition, we did not have data on the subjective quality of the relationship. A badly functioning relationship is a source of stress, whereas a well-functioning relationship is a source of mental well-being and motivation (Holt-Lunstad et al., 2010). The unavailability of data on these factors was likely to cause an attenuation of the actual effect sizes, since a good and healthy relationship probably causes positive behavioral changes and bad relationship negative changes.

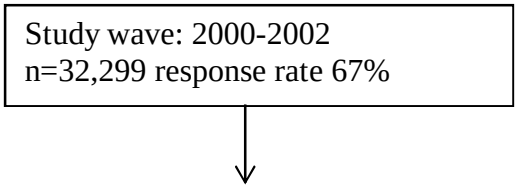
We were unable to pinpoint the exact time point for a relationship change. It is possible that the effects on health behavior vary with time. For example, it is possible that people consume much more alcohol when a breakup is recent and that this effect is weaker after 6 months or a year. Thus, the interval of four years between the measurements is a limitation. The possibility of reverse causality is also a limitation. For example, it is possible that a change in smoking frequency affects one's relationship status or that there is third factor, such as stress, which affects both smoking frequency and relationship status.

Conclusions

To conclude, we have shown that relationship status is a factor that is associated with health behavior. We showed the associations in several different relationship transition combinations. The effects were very similar in men and women, although there were some differences in the magnitudes of the effects. The end of a relationship was associated with increased smoking, increased alcohol consumption especially in widowed men, and increased physical activity, and decreased BMI. From a public health perspective, it is important to acknowledge that people in a relationship have challenges in weight management and getting enough exercise, while people without a committed relationship are at increased risk of using more alcohol and smoking more. It is not clear if the cumulative health effects of these health behavior changes are positive or negative.

Conflict of Interest

The authors declare that they have no conflict of interest.



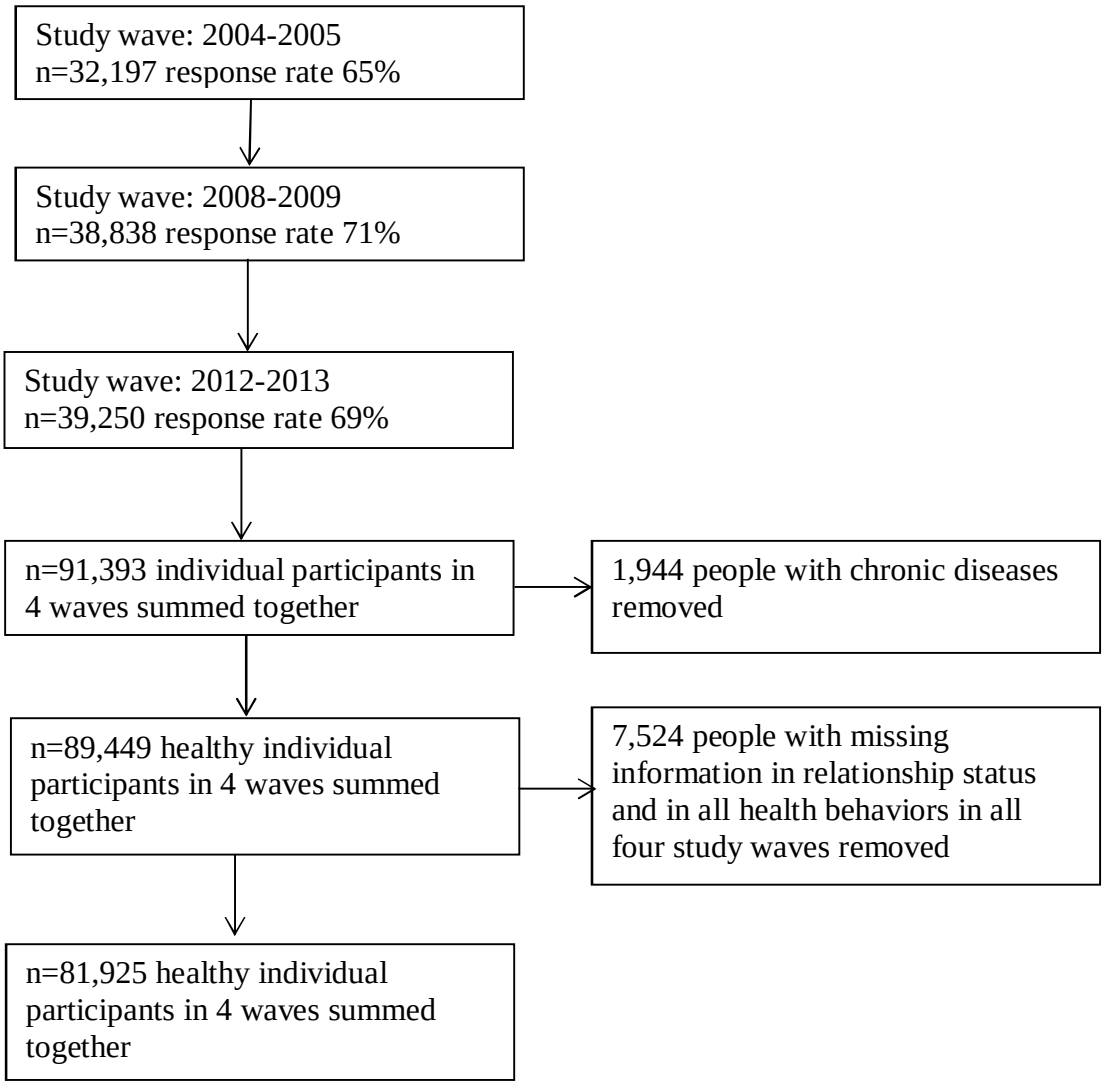


Figure 1: Flow chart of the participants. Imputation was performed in the final sample of 81,925 participants. All employees were asked to participate during each study wave.

Table 1. Characteristics of the study population

	Single (*n*=41,365)	Married (*n*=192,797)	Cohabiting (*n*=51,376)	Divorced or separated (*n* =35,497)	Widow (*n*=6,665)
Women, *n*(%)	33,571(81.2)	152,480(79.1)	40,614(79.1)	30,573(86.1)	6,162(92.5
Mean age, years (*SD*)	38.9(12.0)	47.1(10.7)	38.7(11.6)	49.7(10.4)	58.1(8.5)
Manual workers, *n*(%)	14,588(35.3)	62,649(32.5)	19,219(37.4)	14,443(40.7)	3,129(47.0
Mental ill-being [a], *n*(%)	10,542(25.5)	41,652(21.6)	12,062(23.5)	9,880(27.8)	1,741(26.1
Mean anxiety (*SD*)	2.0(.56)	1.9(.55)	1.9(.55)	2.0(.59)	1.9(.59)
Subjectively unhealthy [b], *n*(%)	8,362(20.2)	42,579(22.1)	9,192(17.9)	9,515(26.8)	2,271(34.1
Physical activity, *MET h /day (SD)*	4.4(3.8)	3.9(3.4)	4.4(3.7)	3.9(3.5)	3.4(3.2)
Smokers, *n*(%)	9,144(22.1)	23,678(12.3)	11,740(22.9)	8,639(24.3)	1,189(17.8
Alcohol use, *grams/week (SD)*	63.0(108.3)	61.4(99.8)	68.0(106.5)	63.5(104.1)	60.8(117.1
Body mass index, kg/m^2	25.0(4.6)	25.4(4.2)	24.9(4.3)	25.4(4.3)	26.2(4.4)

[a] At least 4 symptoms on the 12-item General Health Questionnaire

[b] Options 1-3 of one question on a 5-point Likert scale

Values based on the first imputed dataset

Table 2. Number of observations in relationship status categories and changes in relationship status

	Single	Married	Cohabiting	Divorced / separated	Wido
Single	41,365	5,690	883	excl	excl
Married	10,501	192,797	15,450	1,722	51
Cohabiting	1,301	11,427	51,376	5,011	133
Divorced / separated	excl	4,721	5,797	35,497	excl
Widow	excl	690	308	excl	6,665

Includes data from 4 study phases in years 2000-2012

Data from the first imputed dataset with 327,700 observations and 81,925 individuals
excl = this transition not included in the analyses

Transitions are read column first, row second. For example, from married to widow 690 transitions

Table 3. The adjusted associations of different relationship transitions with BMI and alcohol consumption

	Body mass index	Alcohol consumption
	Fixed effects	Fixed effects
Relationship transitions Before --> After	Adjusted[a] n / observations b (95% CI)	Adjusted[a] n / observations b (95% CI)
Single --> Married Men (or combined)	14,551/47,919 .25(.07,.42)	71,048/233,819 -4.54(-6.61,-2.47)
Single --> Married Women	56,472/185,740 .28(.13,.43)	no gender interaction
Single --> Cohabiting Men (or combined)	44,553/92,444 .17(.10,.23)	44,553/92,444 -3.65(-7.53,.24)
Single --> Cohabiting Women	no gender interaction	no gender interaction
Cohabiting --> Married Men (or combined)	14,857/51008 .12(.04,.21)	73,088/243,448 -3.74(-5.26,-2.22)
Cohabiting --> Married Women	58,203/192,459 .12(.05,.19)	no gender interaction
Married --> Divorced or separated Men (or combined)	74,230/228,144 -.33(-.42,-.24)	74,230/228,144 3.27(-.57,7.11)
Married --> Divorced or separated Women	no gender interaction	no gender interaction
Married --> Widow Men(or combined)	67,805/198,616 -.55(-.71,-.40)	13,671/40,728 36.26(5.70,66.83)
Married --> Widow Women	no gender interaction	54,113/158,084 .09(-7.28,7.46)
Cohabiting --> Divorced or separated Men(or combined)	37,779/86,927 -.24(-.29,-.20)	7,131/15,588 5.24(-.21,10.69)
Cohabiting --> Divorced or separated Women	no gender interaction	30,554/71,144 -.24(-4.02,3.54)
Cohabiting --> Widow Men(or combined)	31,917/57,861 -.49(-.72,-.27)	31,917/57,861 -1.29(-10.32,7.74)

Cohabiting --> Widow	Women	no gender interaction	no gender interaction

Row for men includes the combined effect for men+women if the gender interaction was not significant
Relationship transitions coded as 0/1 dummy variables
BMI, and alcohol consumption analyzed as continuous dependent variables in separate models.
b-values for BMI are BMI points (kg / $m^{2)}$.
b-values for alcohol consumption are grams of alcohol per week
[a] Adjusted for age, mental ill-being, anxiety, study year, and subjective health
Results based on a complete imputed dataset

Table 4. The adjusted associations of different relationship transitions with physical activity and smoking

	Physical activity	Smoking
	Fixed effects	Fixed effects
Relationship transitions	Adjusted[a] n / observations b (95% CI)	Adjusted[a] n / observations OR(95% CI)
Single --> Married Men (or combined)	71,048/233,819 -.34(-.40,-.28)	1,870/6,821 .70(.45,1.07)
Single --> Married Women	no gender interaction	5,293/19,184 .62(.52,.75)
Single --> Cohabiting Men (or combined)	44,553/92,444 -.38(-.56,-.19)	783/2,370 1.0(.59,1.68)
Single --> Cohabiting Women	no gender interaction	2,525/7,754 .71(.51,.99)
Cohabiting --> Married Men (or combined)	73,088/243,448 -.10(-.20,.01)	2,102/7,729 .73(.54,.98)
Cohabiting --> Married Women	no gender interaction	5,826/20,970 .69(.56,.86)
Married --> Divorced or separated Men (or combined)	74,230/228,144 .26(.10,.41)	1,746/5,998 2.22(1.43,3.44)
Married --> Divorced or separated Women	no gender interaction	5,404/18,376 2.15(1.76,2.62)
Married --> Widow Men(or combined)	67,805/198,616 .05(-.19,.29)	1,470/5,049 .58(.12,2.75)
Married --> Widow Women	no gender interaction	4,126/13,809 1.23(.53,2.85)
Cohabiting --> Divorced or separated Men(or combined)	37,779/86,927 .22(.11,.33)	706/2,180 1.51(.95,2.42)
Cohabiting --> Divorced or separated Women	no gender interaction	2,718/8,798 1.54(1.25,1.91)
Cohabiting --> Widow Men(or combined)	31,917/57,861 .21(-.18,.59)	463/1,295 1.19(.20,7.07)

Cohabiting --> Widow Women	no gender interaction	1,474/4,122 1.27(.48,3.35)

Row for men includes the combined effect for men+women if the gender interaction was not significant
Relationship transitions coded as 0/1 dummy variables
Physical activity analyzed as continuous dependent variable.
Smoking is a 0/1 categorical variable.
b-value for physical activity is MET hours / day.
Smoking estimates are odds ratios.
[a] Adjusted for age, mental ill-being, anxiety, study year, and subjective health
Results based on a complete imputed dataset

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