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Spousal resemblance for smoking: Underlying mechanisms and effects of cohort and age☆

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ABSTRACT

Background: In this study we ask why spouses resemble each other in smoking behaviour and assess if such resemblance depends on period of data collection or age. Spousal similarity may reflect different, not mutually exclusive, processes. These include phenotypic assortment (choice of spouse is based on phenotype) or social homogamy at the time spouses first meet, and marital interaction during the relationship.
Methods: Ever and current smoking were assessed between 1991 and 2013 in surveys of the Netherlands Twin Register for 14,230 twins and 1,949 of their spouses (mean age 31.4 [SD = 14.0]), and 11,536 parents of twins (53.4 [SD = 8.6]). Phenotypic assortment and social homogamy were examined cross-sectionally by calculating the probability of agreement between twins and their spouses, twins and their co-twin's spouse and spouses of both twins as a function of zygosity. Marital interaction was tested by investigating the association between relationship duration and spousal resemblance.
Results: Between 1991 and 2013 smoking declined in all age groups for both genders. Spousal resemblance for ever and current smoking was higher when data were more recent. For ever smoking, a higher age of men was associated with lower spousal resemblance. Phenotypic assortment was supported for both smoking measures, but social homogamy could not be excluded. No effect of marital interaction was found.
Conclusions: Differences in smoking prevalence across time and age influence spousal similarity. Individuals more often choose a spouse with similar smoking behaviour (phenotypic assortment) causing higher genotypic similarity between them. Given the heritability of smoking this increases genetic risk of smoking in offspring.

1. Introduction

Many risk factors contribute to human smoking behaviour, including environmental (Freedman et al., 2012) and genetic factors (Li et al., 2003). From previous work in a Dutch sample, we know that spouses often show similar smoking behaviour (Vink et al., 2003). In fact, a systematic review of the literature on spousal resemblance for traits associated with coronary heart disease found that smoking was one of the most strongly correlated traits between spouses (Di Castelnuovo et al., 2009). High spousal correlations (0.19 to 0.55) were also reported by Kuo et al. (2007) and by Clark and Etilé (2006), who showed that the chance of a smoker having a smoking partner is approximately 50%. Boomsma et al. (1994) found that the correlation between husband and wife for 'currently smoking' ($r = 0.43$) was larger than for 'ever smoked' ($r = 0.18$).

There are different, not mutually exclusive, explanations as to how spousal resemblance arises. The three most frequently investigated mechanisms are phenotypic assortment, social homogamy and marital interaction. In case of primary, or *phenotypic assortment*, individuals tend to choose a spouse that is phenotypically

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similar (Falconer and Mackay, 1996). If a trait is heritable, phenotypic assortment is associated with a higher genotypic similarity between spouses, causing a greater phenotypic and genotypic similarity between them and their offspring (Crow and Felsenstein, 1986; Eaves, 1977; Falconer and Mackay, 1996). Alternatively, spouses may be more similar to each other due to *social homogamy* (Heath and Eaves, 1985). Then, individuals are more likely to meet and pair up because they are from similar (social) surroundings. It can also be described as a "passive" influence on mate selection, as opposed to the "active" influence which occurs with phenotypic assortment (Mascie-Taylor and Vandenberg, 1988). Under social homogamy, the genetic resemblance between parents and offspring or between siblings is not expected to increase (Falconer and Mackay, 1996). Lastly, spousal resemblance may be due to *marital interaction* reflecting that two individuals start to resemble each other because they influence each other while being in a relationship together. Here, a longer relationship is associated with more similar behaviour of spouses due to their interaction. Increasing similarity with marriage duration in cross-sectional data could also result from selection: those who are more similar to each other are more likely to remain together. Marital interaction does not have consequences regarding genetic similarity in the next generation.

As phenotypic assortment can be associated with a higher genotypic resemblance between spouses, spousal resemblance can influence the genetic resemblance between relatives. In addition, it shapes the environment to which the offspring of smoking parents is exposed. Data from twins and their spouses can inform on the underlying mechanisms of spousal resemblance (Eaves, 1979; Heath and Eaves, 1985), but studies employing this design for smoking are scarce. In a Swedish sample of 507 twin pairs and 273 twin-spouse couples, Reynolds et al. (2006) found support for phenotypic assortment for quantity of tobacco, while social homogamy explained spousal resemblance for current tobacco use (yes/no). Phenotypic assortment was demonstrated for ever regular smoking in 914 Australian twin-spouse couples (Agrawal et al., 2006), while evidence for both phenotypic assortment and social homogamy was found in a larger US-based study of 14,756 twins and 4390 spouses (Maes et al., 2006). After initial mate selection, a person's smoking status was not influenced by their spouse (Agrawal et al., 2006), arguing against marital interaction for the initiation of smoking. These studies give an indication of the factors behind spousal resemblance for smoking, but only one addressed phenotypic assortment, social homogamy and marital interaction simultaneously (Maes et al., 2006).

Since smoking behaviour is often measured as a dichotomous variable (current smoking yes/no or ever smoking yes/no), resemblance between spouses will depend on smoking prevalence (Falconer and Mackay, 1996). In the Netherlands, smoking prevalence has dropped considerably in the past decades, partly due to nationwide (media) campaigns and tobacco control policies (Nagelhout et al., 2012; Schaap et al., 2008). This decrease has been observed in countries worldwide (Centers for Disease Control and Prevention (CDC) 2009; Giskes et al., 2005). Age is also associated with smoking behaviour, such that ever smoking initially increases with age (Kuo et al., 2007) while older age groups show lower rates of current smoking (Midlöv et al., 2014). Age differences can be due to effects of age itself or differences in birth cohort. Trends across time and age and their effect on spousal similarity must be assessed when studying spousal resemblance for smoking.

The current study explores trends in ever and current smoking in a large sample of 27,715 Dutch twins, spouses of twins and parents of twins, and investigates spousal resemblance for ever and current smoking conditional on period of data collection (1991–1997, 2000–2004, 2009–2013) and age. Phenotypic assortment, social homogamy and marital interaction are investigated as causes of spousal resemblance.

2. Materials and methods

2.1. Subjects

This study is part of ongoing longitudinal survey studies of the Netherlands Twin Register (NTR) (Willemsen et al., 2013). The NTR consists of adolescent and adult twins and their family members who have completed surveys since 1991. For the current study, cross-sectional data on smoking behaviour were available for 27,715 individuals (40.5% male, originating from 10,905 families), consisting of 14,230 twins and 1,949 spouses of twins (mean age 31.3 [SD 13.9]) as well as 11,536 parents of twins (mean age of 53.4 [SD 8.6]). Fig. 1 depicts a flowchart of all included subjects and corresponding analyses.

Data were retrieved from surveys completed in 1991, 1993, 1995, 1997, 2000, 2002, 2004, 2009, 2011 and 2013. Three research cohorts based on time of data collection were created: 1991–1997, 2000–2004 and 2009–2013. Surveys were sent at the family level to the 1991–1997 cohort, while participants were approached individually in the 2000–2004 and 2009–2013 cohorts. If smoking data were available from more than one survey, preference was given to the survey that was completed by most members of a family to increase the number of complete pairs of relatives available for analysis. Recently collected data were preferred over earlier data to ensure the inclusion of as many spouses of twins as possible. Spouses of twins were not invited to participate until the 2000-survey, with recruitment continuing till the year 2013. In total, 1949 spouses were included for 14,553 twins (13.4%). This rather low percentage of participating spouses is not due to twins being in a steady relationship less often. This was shown by a previous study comparing twins with siblings (Middeldorp et al., 2005) and was confirmed by self-reported data on marital status in 9247 twins indicating that the proportion of twins with a spouse was 61.7%. In the final data set, 16.1% of smoking data came from surveys sent in 1991 to 1997, 28.9% from 2000 to 2004 and 55.0% from 2009 to 2013.

Spousal pairs were excluded from analysis when the duration of relationship that spouses reported differed for more than 2 years between them, since this could indicate that the spouses are separated and report on the relationship duration with a new romantic partner (see Fig. 1). Only parents of twins aged 17+ were invited to participate in NTR surveys. Parents who stated to be in a steady relationship for <17 years were excluded since these were presumably reporting on the relationship duration with a new romantic partner. The final number of pairs with complete data on smoking was 5,537 for twin pairs, 1,734 for twin-spouse pairs, 1,346 for pairs consisting of twins and their co-twin's spouse, 325 for pairs consisting of spouses of both twins and 3,725 for parents of twins (father–mother) pairs.

2.2. Measures

Participants were classified as current smokers, former smokers or never smokers, based on the questions "Have you ever smoked?" ("No", "A few times just to try", and "Yes") and "How often do you smoke now?" ("I don't smoke regularly", "I've quit smoking", "Once a week or less", "A few times a week", and "Once a day or more"). Those who said "Yes" to the first question and subsequently stated to smoke once a week or more were classified as current smokers. Answering "I've quit smoking" to the second question resulted in a classification as former smoker. In case of contradictory answers, or when answers to one of the two main questions were missing, additional questions were used to determine classification. Additional questions were, for example, "How many cigarettes a day/a week do you smoke on average?" (for smokers; when a valid answer was given, current smoking was assumed) or "At what age