Article

Individual and social predictors of smoking and obesity: A panel study in Germany

Ida G. Monfared [a,*], Kenneth Harttgen [b], Sebastian Vollmer [a]

[a] *Centre for Modern Indian Studies & Department of Economics, University of Göttingen, Göttingen, Germany*
[b] *ETH, Zürich, Switzerland*

ABSTRACT

This is a longitudinal study of changes in smoking behaviour as well as becoming overweight/obese (OW/OB) and the strength of their association with personal factors such as self-control, mental health, and socioeconomic status (SES) versus their connection with the behaviour of other household members. Furthermore, we investigate that in terms of roles within a household, who is more vulnerable towards the behaviour of others. We used a hybrid model that followed individual adults (person-level fixed-effect) who participated in a national representative panel survey in Germany, SOEP, between 2008 and 2016 and answered all SF-12 items (N = 6874). The count of members in a household showing the associated adverse health behaviour was the nested random-effect. Compared with other predictors, the likelihood of a person becoming OW/OB had the strongest association with the number of cohabits who were also OW/OB and it became worse as this number increased (OR 7.18, 95% CI: 2.10–24.54 and 12.44, 95% CI: 1.53–100.85, for men and women respectively, e.g. compared with being married 2.83, 95% CI: 2.28–3.53 and 1.82, 95% CI: 1.42–2.34). However, for smoking the same rapid trend was not observed. Particularly, becoming OW/OB in female (adult) children was strongly associated with the behaviour of others (compared with household head or partner). For smoking the strongest link with others was among women who were head of the household. For both behaviours, we found neither mental health nor self-control to be strong predictors. Our findings indicate that various factors do not play equal roles in changes in health behaviour and particularly for women, becoming OW/OB is strongly connected with the behaviour of others. We further discuss the potential importance of social norms that might be helpful in developing more effective policies incorporating social connections as well as norms.

Background

There is a mount of evidence confirming the negative impact of unhealthy behaviour in particular, smoking and being overweight. However, with the pattern of adverse health behaviour (HB) being varied among different socioeconomic statuses (SES), addressing health inequality remains a challenge. Smoking has remained more common and intense among men, those with lower education, and those with lower income (Heilert & Kaul, 2017). For obesity and overweight (OB/OW), the situation is rather alarming and as an example from Germany depicts (Fig. 1) within about only a decade, the prevalence of OW/OB has increased by 7.5 and 5.2 percentage points among men and women, respectively. Moving to become a global epidemic (Peralta, Ramos, Lipert, Martins, & Marques, 2018) it is predicted that in 2030 the absolute global burden of diabetes, one of the leading causes of BMI-related deaths, will increase from U.S. $1.3 trillion in 2015 to $2.2 trillion in the baseline (Bommer, Sagalova, Heesemann, Manne-Goehler, Atun, Bärnighausen, et al., 2018).

HB has been approached from various angles and through different disciplines. Given its heterogeneity, it is difficult to find a single model that can comprehensively explain HB (Noar & Zimmerman, 2005). In general, it can be said that HB is a combination of individuals' characteristic (Hagger & Chatzisarantis, 2009), their network (Powell, Wilcox, Clonan, Bissell, Preston, Peacock, et al 2015), and their SES (Mirowsky & Ross, 2003).
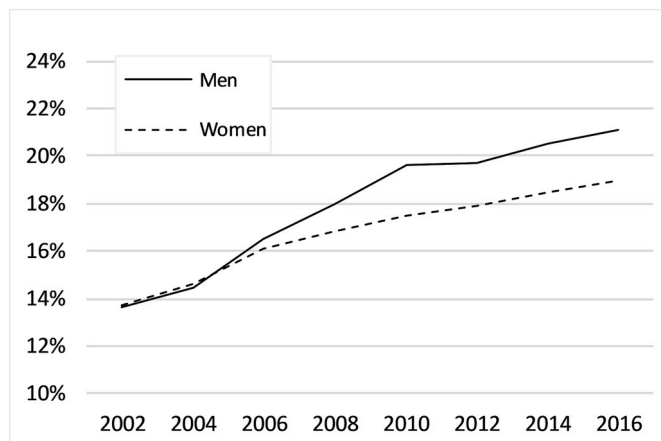

Fig. 1. Prevalence of obesity and overweight based on German Socio-Economic Panel (SOEP) weighted according to the measure provided as part of the dataset.

Scope of the present study

Umberson et al. suggest a conceptual mechanism illustrating that how through the course of life, HB might be associated with psychosocial factors and social ties (Umberson, Crosnoe, & Reczek, 2010). This model indicates that while at a person level, mental health (MH) and self-control may play a role in shaping HB, network and moreover, behaviour of cohabits could also be influential. Through testing this model, the present study contributes to the existing literature firstly by following changes in individual's smoking behaviour as well as becoming OW/OB through years and comparing the scale of impact from the behaviour of other household members with individuals' sense of control, their MH status, their marital status and their SES. Furthermore, we investigate that across different roles in a household, head, partner, and child, who is more vulnerable to the behaviour of others when the rest of factors are controlled for. Being longitudinal, our study also addresses the limitation of many present works that are based on cross-sectional observations, and thus, were unable to track change.

MH and HB

The connection between HB and Health Related Quality of Life (HRQoL) and particularly MH is well established (Charafeddine, Demarest, Cleemput, Van Oyen, & Devleesschauwer, 2017) (Coste, Quinquis, D'Almeida, & Audureau, 2014). Confirming the association between smoking and HRQoL, Wilson et al. found MH morbidity to be higher among smokers and particularly heavy smokers than non-smokers (Wilson, Parsons, & Wakefield, 1999). A study of rate of smoking in US observed that decrease of smoking among those with MH problems was significantly less than others (Lê Cook, Wayne, Kafali, Liu, Shu, & Flores, 2014). Similar to smoking, over-eating and obesity was found to be associated with HRQoL (Jia & Lubetkin, 2005) (Warkentin, Majumdar, Johnson, Agborsangaya, Rueda-Clausen, Sharma, et al., 2014) (Fontaine & Barofsky, 2001). As noted by Dallman, through evolution one of the human responses to stress is to crave and store pleasurable food. However, this was then when food was scares while now, and in developed countries in particular, comforting food is easily accessible, inexpensive in terms of time and costs, and in abundance. When such a defence mechanism against stress becomes habitual, it can easily lead into weight gain and obesity (Dallman, 2010).

Locus of control

Based on the social learning theory, locus of control (LoC) indicates the degree of which a person believes he/she has control over his/her own life (Rotter, 1966). This indicator that has an extensive base in understanding HB can vary between two poles of internal (self-control) and external (controlled by others) LoC. It was found that higher internal health LoC (HLoC) to be associated with greater likelihood of having healthier behaviour (Steptoe & Wardle, 2001). Taking into account SES, in a cross-sectional study of the UK households Wardle and Steptoe found a link between beliefs in chance HLoC and SES but no difference in internal HLoC across different social classes (Wardle & Steptoe, 2003). Grotz et al. also found that the relationship between HB and LoC to be less clear cut once SES and in particular, ethnicity and difference between groups from various cultural backgrounds are considered (Grotz, Hapke, Lampert, & Baumeister, 2011).

Methods

We used data from the German Socioeconomic Panel (SOEP), one of the largest longitudinal nationally representative household surveys ongoing since 1984 (Wagner, Frick, & Schupp, 2007). In this survey, smoking habits are measured since 2004 in every other year. To ensure that our longitudinal data is not affected by event singularity, we particularly focused on waves 2008, 2010, 2012, 2014, 2016 and after when public smoking bans across the hospitality industry were introduced by the states (Kuehnle & Wunder, 2013). A study of this ban (Anger, Kvasnicka, & Siedler, 2011) found that while it did not have an immediate effect on average population, it reduced the rate of smoking within particular groups (i.e. those who often go out to bars/restaurants). Following this ban, later studies in Germany reported fewer hospitalization for acute coronary events (Sargent, Demidenko, Malenka., Li, Gohlke & Hanewinkel, 2012) also evidence from other countries indicate that such bans might reduce smoking uptake (Pierce, White, & Emery, 2012). For OW/OB, we used the definition given by WHO that is BMI greater than or equal to 25 (WHO, 2013).

In SOEP, HRQoL was measured through SF12 (a short version of SF36) a scale widely used in Medical Outcome Studies covering eight dimensions: limitations in physical activities because of health problems, limitations in social activities because of physical or emotional problems, limitations in usual role activities because of physical health problems, bodily pain, general mental health, limitations in usual role activities because of emotional problems, vitality, and perception of general health (Ware & Sherbourne, 2006). We followed Andersen et al.'s method of z-transformation and aggregation of sub-scales into two main variables: Physical Component Summary Scale (PCS) and Mental Component Summary Scale (MCS) (Andersen, Mühlbach, Nübling, Schupp, & Wagner, 2007). This process required excluding those cases where response to all SF12 items were incomplete.

LoC was measured using 10 items asking respondents to score their perception of self-control through statements such as "*How my life goes depends on me*" on a 7-point scale ranging from 1 (*Not at all*) to 7 (*Absolutely*) where higher scores indicate a stronger self-control. This scale was included in SOEP survey in years 1999, 2005, 2010, and 2015. We took the results for 2015 as the proxy for 2014. Taking the same approach as Specht et al. (Specht, Egloff, & Schmukle, 2013) we aggregated 7 items (how my life goes depends on me; I haven't achieved what I deserve; what a person achieves depends on luck; others make the crucial decisions in my life; doubt my abilities when problems arise; opportunities are determined by the social conditions; I have little control over my life) that provided good internal consistency (Cronbach's α = 0.71 and 0.70 in 2010 and 2015, respectively).

Attention to healthy diet was measured on a scale of 1 (*Very strong*) to 4 (*Not at all*). This item was measure in four waves and was not included in 2016. Education level was aggregated in three groups, primary, secondary, and higher according to German ISCED-1997-Classification. We used the indicator of employ/unemployment in the previous year based on the evidence that the effect of unemployment on adverse HB is not immediate and there is a time lag between the two (Schunck & Rogge, 2010).

The households were grouped according to the count of other members who also showed the corresponding adverse HB (for being OW/OB 4 groups with 0, 1, 2, and 3 or more others being OW/OB and for smoking 3 groups with 0, 1, and 2 or more others being smoker). These categories were driven by the data; for OW/OB, within waves, there were maximum only 7 cases where 4 others also were OW/OB and there were no higher numbers. Therefore, these cases were grouped together with 3 others under the category "3 or more". For smoking, there were only maximum of 6 cases within waves where the number of others also smoking was 3 and there were no higher counts; hence, these were grouped with two others and categorised as "2 or more". We analysed the data using a hybrid model with logistic fixed-effect (to control for the effect of unobserved time-invariant factors at person level such as ethnicity) (Bärnighausen et al., 2017) and household grouping as a nested random-effect following equation (1):

$$\log(\frac{P_{it}}{1 - P_{it}}) = \mu_t + \beta X_{it} + \gamma Z_i \qquad (1)$$

where X_{it} is covariate matrix for the fixed-effect β (person level factors, behaviour of others, SES, time dummy) and Z_i is the covariate for the random effect γ (household behaviour groups). P_{it} is the binary probability of person i being a smoker at time t; for OW/OB, it is $P_{i(t+1)}$ that is the lead (prospective) probability by taking into account that weight gain is not a contemporaneous outcome. As well as investigating the effect size of fixed-effect/person level factors, this mixed-model allows to take into account the variation between household groups.

Considering the differences in HB between genders, we have stratified our main analysis between men and women. LoC is added to the model in a second step (model (2) in Table 2) allowing to investigate if this inclusion improves the model. Please note that for this step, we have used only two waves of 2010 and 2014. Flagging only those cases where there is a change, the number of cases reported by these models is smaller than the original sample size. Stata 14.0 was used for statistical analysis. Multi-collinearity was checked by looking at both variance inflation factor (VIF) and Spearman's ρ where correlation coefficients hardly reached 0.3.

Results

Table 1 shows the descriptive characteristics of the sample at the first (2008) and last wave (2016) highlighting the high ratio of those who were OW/OB that increase from 56% to 61% (18%–22% being obese) most of whom were in the age range of 36–65 years old. At each year, the ratio of OW/OB individuals who lived in a household where there were no other person OW/OB was around 50%. This ratio increases considerably as the number of other household members who were OW/OB grew from 1 to 2 and went even further up to 90% when there were 3 or more other members also OW/OB (Fig. 2).

For smoking, however, this pattern was somewhat different as the ratio difference is more noticeable when there is no other cohabit smoking versus one other smoker (e.g. 16% vs. 46% in 2008) and having two or more other smokers did not change this pattern noticeably (Fig. 3).

Role of MH, LoC, and SES vs. behaviour of others

Table 2 presents the odds ratio (logit mixed-effect) for becoming OW/OB_lead. This is taking the state of being OW/OB not at present but in the following wave to account for the lag of time from when a factor triggers a none-contemporaneous outcome and when the outcome, in this case OW/OB, demonstrates itself. MH and LoC were only weakly associated with OW/OB and the coefficient was only significant for men. However, for this group, incorporating LoC increased the scale of association from behaviour of others. We should remind that the model 2 in both Tables 2 and 3 includes only two waves of 2010 and 2014 and when

Table 1

Descriptive statistics of demographics and key variables ($N = 6874$).

	2008		2016	
	Mean (Sd.)/%	Min - Max	Mean (Sd.)/%	Min - Max
Gender: male	47.54%		47.54%	
Age	49.77 (15.46)	18–90	57.77 (15.46)	26–98
Marital status				
Single	20.95%		14.91%	
Married/in a relationship	62.82%		64.76%	
Separated/divorced	10.26%		11.13%	
Widowed	5.98%		9.20%	
Education level				
Primary	11.15%		8.82%	
Secondary	50.40%		48.85%	
Higher	38.45%		42.34%	
Unemployed (last year)	8.9%		5.09%	
Monthly hh. income per capita (€)	1189.92 (657)	100–7000	1463.57 (729)	0–7200
MCS (0–100)	50.54 (9.62)	5.79–76.22	50.67 (9.65)	5.85–74.06
Smoker	25.97%		22.17%	
OW/OB	56.12%		60.90%	
Ratio of women who were pregnant at the time of interview	1.47%		0.75%	
Follows health conscious diet[a]				
Very strong	8.87%		–	
Strong	43.70%		–	
A little	42.35%		–	
Not at all	5.08%		–	
Count of others in hh smoking				
0	72.85%		78.57%	
1	25.29%		20.86%	
2 or more	1.86%		0.57%	
Count of others in hh OW/OB				
0	39.61%		36.36%	
1	55.50%		60.32%	
2	4.24%		2.94%	
3 or more	0.66%		0.37%	

[a] This var. was not measured in 2016.

the data for LoC were available. Smoking cessation was not found to be particularly significant for becoming OW/OB, however, smoking initiation had a revers connection in the case of both genders (the latter loses its significance once LoC is incorporated into the model). Following a health conscious diet "a little" found to have a significant relationship with OW/OB (increasing the likelihood by 56% (95% CI: 1.15–2.12) for men and 49% (95% CI: 1.18–1.88 for women). Secondary level of education had an association with becoming OW/OB for men, however, it lost its significance once LoC was included in the model. For women as the education level went higher, this likelihood declined by 44% (95% CI: 0.29–0.56). Unemployment was not found to be a significant predictor for men, however, for women, being unemployed was associated with a higher likelihood of 44% (95% CI: 1.07–1.94).

We also took into account pregnancy for women who reported being pregnant at the time of individual interviews. As presented in Table 2, we did not find a significant association between pregnancy and changes in becoming OW/OB which could probably be due to the low number of pregnancy cases in our panel data.

Being married or in a relationship had a strong association with becoming OW/OB and for men, it was to the same scale as to having two other household members also being OW/OB increasing the odds by 3 folds. For women, although being married was a significant factor, the behaviour of others had a much stronger association with becoming OW/OB and having 3 or more people in the house who were also OW/OB was associated with a 12 times higher odds.

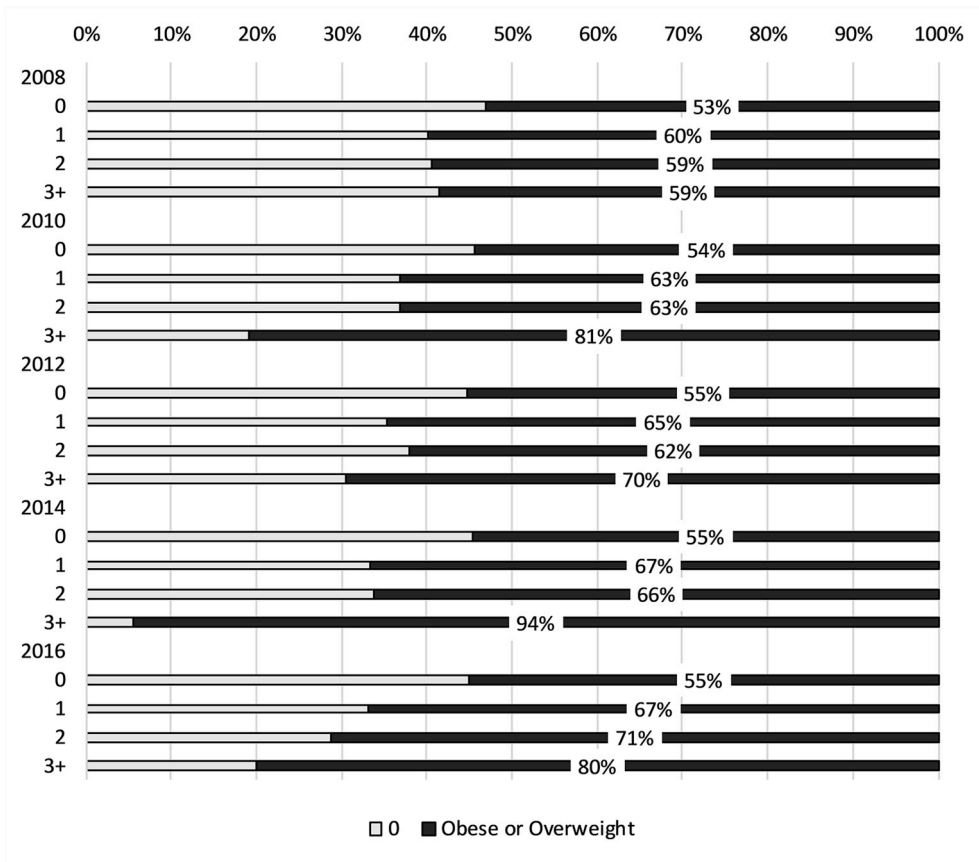The mechanism for smoking initiation seemed to be slightly different

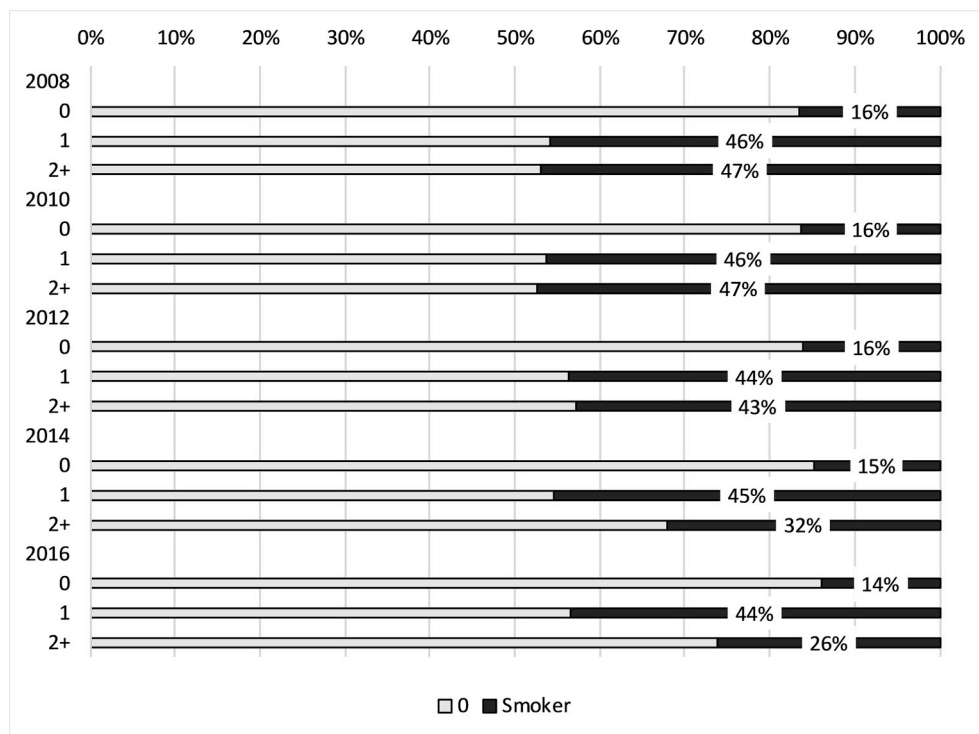**Fig. 2.** Ratio of OW/OB by count of other hh members also being OW/OB.

Fig. 3. Ratio of being smoker by count of other hh members also being smoker.

Table 2
Mixed-effect logit OR for OW/OB_lead1.

OW/OB_lead1	Men		Women	
	(1)	(2)	(1)	(2)
MCS	1.01**	1.01***	1.00	1.00
	(1.00–1.01)	(1.01–1.02)	(1.00–1.01)	(1.00–1.01)
LoC		0.90**		0.98
		(0.83–0.98)		(0.91–1.06)
Count of others OW/OB = 0	ref.	ref.	ref.	ref.
Count of others OW/OB = 1	1.77***	1.82***	1.92***	1.90***
	(1.60–1.96)	(1.57–2.11)	(1.73–2.13)	(1.64–2.21)
Count of others OW/OB = 2	2.29***	2.09***	2.38***	2.28***
	(1.73–3.03)	(1.39–3.14)	(1.84–3.09)	(1.56–3.33)
Count of others OW/OB = 3+	3.07***	7.18***	10.77***	12.44**
	(1.68–5.60)	(2.10–24.54)	(3.17–36.65)	(1.53–100.85)
Smoking cessation	1.20	1.19	1.08	0.91
	(0.87–1.64)	(0.80–1.77)	(0.78–1.49)	(0.60–1.38)
Smoking initiation	0.81***	0.89	0.80***	0.87
	(0.72–0.91)	(0.75–1.05)	(0.71–0.90)	(0.74–1.03)
Follows a healthy diet: very strong	ref	ref.	ref.	ref.
Follows a healthy diet: strong	1.02	1.07	1.17**	1.05
	(0.83–1.25)	(0.79–1.46)	(1.00–1.36)	(0.84–1.31)
Follows a healthy diet: a little	1.54***	1.56***	1.69***	1.49***
	(1.25–1.89)	(1.15–2.12)	(1.44–1.99)	(1.18–1.88)
Follows a healthy diet: not at all	1.20	1.06	1.14	0.94
	(0.91–1.57)	(0.71–1.59)	(0.81–1.60)	(0.57–1.56)
Pregnant at the time of the survey	n/a	n/a	1.02	1.00
			(0.64–1.63)	(0.47–2.11)
Marital status: single	ref.	ref.	ref.	ref.
Marital status: separated/divorced	3.71***	3.67***	1.95***	1.79**
	(2.68–5.13)	(2.23–6.03)	(1.47–2.59)	(1.15–2.79)
Marital status: married/in a relationship	3.00***	2.83***	2.08***	1.82***
	(2.60–3.46)	(2.28–3.53)	(1.77–2.45)	(1.42–2.34)
Marital status: widowed	4.54***	4.42***	3.33***	2.87***
	(2.25–9.15)	(1.64–11.94)	(2.32–4.78)	(1.68–4.89)
Monthly hh income per capita	1.00	1.00	1.00***	1.00***
	(1.00–1.00)	(1.00–1.00)	(1.00–1.00)	(1.00–1.00)
Education level: primary	ref.	ref.	ref.	ref.
Education level: secondary	1.39***	1.30	0.84**	0.79**
	(1.14–1.70)	(0.95–1.78)	(0.72–0.98)	(0.63–1.00)
Education level: higher	1.04	0.99	0.60***	0.56***
	(0.85–1.28)	(0.71–1.37)	(0.51–0.71)	(0.44–0.71)
Unemployed last year	1.02	1.03	1.43***	1.44**
	(0.83–1.24)	(0.76–1.40)	(1.18–1.74)	(1.07–1.94)
Constant	0.36***	0.41**	0.37***	0.63
	(0.24–0.55)	(0.21–0.81)	(0.26–0.53)	(0.35–1.11)
Observations	8468	3997	8162	3807
Number of groups	4	4	4	4
Dummy year included	✓	✓	✓	✓

CI in parentheses; ***p < 0.01, **p < 0.05, *p < 0.1.

from the one that led into weight gain (Table 3). In this case, a decline in MH status although in a small scale played a significant role for both men and women while LoC did not seem to be important. Divorce or separation was associated with an increased likelihood of becoming a smoker significantly and for women, the odds almost doubled. Being unemployed was associated with an increased chance of becoming a smoker by 106% (95% CI: 1.53–2.77) and 78% (95% CI: 1.29–2.45) for men and women, respectively. For men, education had a reverse association with smoking as expected. However, for women, having a secondary level of education was related an increased likelihood of becoming a smoker by around 29% yet having higher level of education reduces this likelihood for both genders noticeably. Here, a large association was found to be with having one other person in the household who also smoked with an increased odds by a factor of 4 and this scale did not noticeably change when there were two or more other smokers in the house. Moreover, following a healthy diet (which could be a proxy indicator for caring for own health) had a significant relationship with smoking initiation particularly for men.

Who is more vulnerable in a household?

In order to find out that within a household how members with different roles were relatively affected by the behaviour of others, we have excluded the cases where between years, individual's role in the household changes within time. Also, our model indicated that marital status being a significant factor, however, as the number of cases where the marital status of (adult) children in the household changed between years was quite low, the cases where marital status changed in time were excluded. As the primary aim here was to compare the magnitude of association with the others' behaviour across roles, this process which practically kept marital status at constant, did not affect the overall approach.

While overall having at least one other person being OW/OB was significantly associated with an individual's tendency to become OW/OB, this connection was stronger for those who indicated their role in the household to be child in comparison with head or partner (Fig. 4). This became particularly extreme for women where the ratio of odds increases by a factor of 31 (it should be noted that here, the term child is

Table 3
Mixed-effect logit OR for Smoking.

Smoking	Men		Women	
	(1)	(2)	(1)	(2)
MCS	0.99***	0.99	0.99***	0.99
	(0.99–1.00)	(0.99–1.00)	(0.99–1.00)	(0.99–1.00)
LoC		1.06		1.02
		(0.97–1.16)		(0.93–1.13)
Count of others smoking = 0	ref.	ref.	ref.	ref.
Count of others smoking = 1	3.89***	4.05***	4.39***	4.56***
	(3.47–4.37)	(3.41–4.79)	(3.90–4.93)	(3.83–5.42)
Count of others smoking = 2+	3.28***	4.10***	3.42***	2.91***
	(2.19–4.91)	(2.19–7.67)	(2.26–5.17)	(1.56–5.42)
Follows a healthy diet: very strong	ref	ref.	ref.	ref.
Follows a healthy diet: strong	1.48**	1.44	1.42***	1.33*
	(1.09–1.99)	(0.92–2.25)	(1.14–1.77)	(0.95–1.85)
Follows a healthy diet: a little	2.64***	2.41***	1.95***	1.90***
	(1.97–3.54)	(1.56–3.73)	(1.56–2.44)	(1.35–2.67)
Follows a healthy diet: not at all	4.89***	5.46***	3.37***	2.97***
	(3.49–6.87)	(3.30–9.04)	(2.29–4.98)	(1.67–5.31)
Marital status: single	ref.	ref.	ref.	ref.
Marital status: separated/divorced	1.76***	1.79**	1.95***	2.12***
	(1.29–2.40)	(1.11–2.87)	(1.44–2.65)	(1.31–3.42)
Marital status: married/in a relationship	1.05	1.06	0.90	0.88
	(0.90–1.23)	(0.83–1.34)	(0.75–1.09)	(0.66–1.18)
Marital status: widowed	0.74	0.90	0.75	0.65
	(0.37–1.45)	(0.36–2.28)	(0.49–1.15)	(0.34–1.23)
Monthly hh income per capita	1.00***	1.00	1.00**	1.00
	(1.00–1.00)	(1.00–1.00)	(1.00–1.00)	(1.00–1.00)
Education level: primary	ref.	ref.	ref.	ref.
Education level: secondary	0.63***	0.55***	1.38***	1.29*
	(0.51–0.77)	(0.41–0.75)	(1.14–1.66)	(0.97–1.71)
Education level: higher	0.39***	0.34***	0.85	0.76*
	(0.31–0.48)	(0.24–0.47)	(0.69–1.05)	(0.55–1.04)
Unemployed last year	1.82***	2.06***	1.78***	1.78***
	(1.50–2.22)	(1.53–2.77)	(1.44–2.19)	(1.29–2.45)
Constant	0.32***	0.25***	0.11***	0.11***
	(0.20–0.52)	(0.12–0.54)	(0.07–0.17)	(0.05–0.23)
Observations	8511	4023	8330	3877
Number of groups	3	3	3	3
Dummy year included	✓	✓	✓	✓

CI in parentheses; ***p < 0.01, **p < 0.05, *p < 0.1.

how individuals identified their role in the household and they are young adults mostly aged between 17 and 35 and single). In 2016, the ratio of OW/OB (adult) children living in a house where the head of the household was also OW/OB was 15%, almost three times higher than living in the house where the partner was OW/OB (5%) and in the majority of cases, both head and partner were OW/OB (42%) ($N = 116$).

On the contrary, comparing the odds of an individual becoming a smoker between groups with different roles showed that although this factor was still significant for all groups, the connection was less strong

for (adult) children (Fig. 5). In this group in 2016 ($N = 117$), of those who were smokers, the majority (56%) lived in a house where there were no other person smoking indicating that the influence on this particular group is not strongly linked to the behaviour of cohabits when it comes to smoking. It should be noted that breaking down the analysis into subgroup by gender and role inevitably reduced the count of cases per groups, hence, the statistical results were taken with cautions.
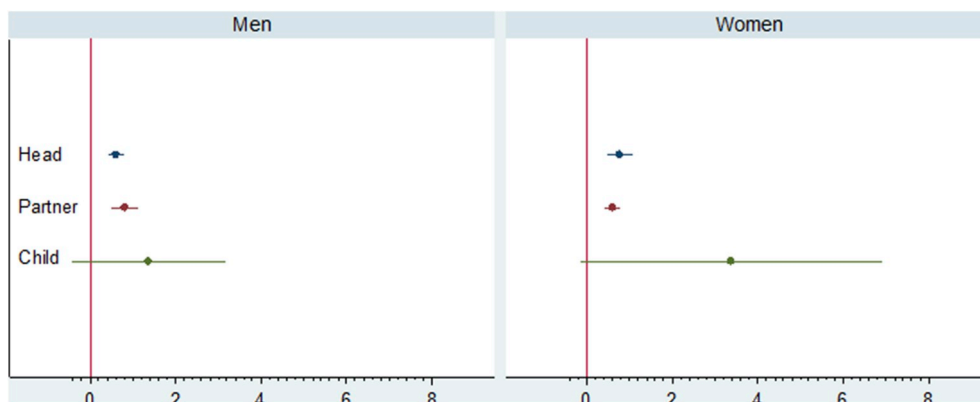

Fig. 4. Log-odds (95% CI) of becoming OW/OB when there is at least one other member in the hh who were also OW/OB by role in the household.
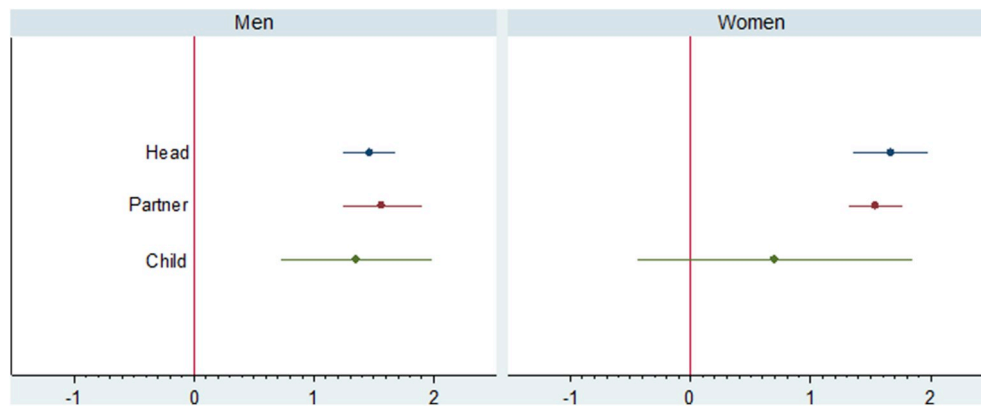
Fig. 5. Log-odds (95% CI) of becoming a smoker when there is at least one other member in the hh who were also smoker by role in the household.

Discussion

A comprehensive illustration of reasons behind the recent sharp rise in the prevalence of obesity and overweight in Germany is yet not available. Similar to the US and other developed countries, as well as change in cultural norms, the growing availability and ease of access to low-cost highly-calorific foods (Cutler, Glaeser, & Shapiro, 2003) alongside the increase in prevalence of sedentary life-style could be some of the contributors to this issue. In terms of the relationship between OB/OW, SES, and sedentary life-style, our findings are in line with the observations from a cross-sectional study in Germany in 2010 (Wallmann-Sperlich, Bucksch, Hansen, Schantz, & Froboese, 2013) that found the level of education for men to be positively associated with sitting time and they sat longer hours than women (5 vs. 4 h per day). On the contrary for women, we found that higher levels of education reduced the likelihood of becoming OW/OB.

We did not find self-control to play particularly an important role. This could be due to the point that here, self-control was measured through global LoC and not HLoC. However, other studies that used HLoC also found it to be a weak predictor of HB (Norman, Bennett, Smith, & Murphy, 1998). A possible explanation might be found through the theory of planned behaviour itself as perceived control works in parallel with subjective norms and attitude as a determinant of intentions (Armitage & Conner, 1999). Where there is a shift in norms, then self-control could lose its importance in determining HB. On the opposite path, self-control might be important when it comes to being motivated in moving away from an adverse HB e.g. for weight loss (Holt, Clark, & Kreuter, 2001). Moreover, other aspects of self-control, such, as 'trait' self-control might be more important when it comes to e.g. impulse eating (Hagger, Gucciardi, Turrell, & Hamilton, 2019) where low-cost high calorific foods are easy to access.

Although MH was found to be significantly associated with becoming a smoker for both genders and with becoming OW/OB for men, this connection was relatively weak. In the case of sever obesity, a multinational cross-sectional study found that the relationship between obesity and depressive disorders to be significant yet not large (OR 1.2) (Scott, Bruffaerts, Simon, Alonso, Angermeyer, Ormel, et al., 2007). In comparison to MH, our study indicate that unemployment to have a stronger association with becoming a smoker and for women, it was related to becoming OW/OB. Graham argued that unemployment alongside education and other social factors like marriage can shape a notion of identity within which certain behaviours are recognized as norms (Graham, 2012). Not following a healthy diet might also be part of this self-recognition where being a smoker becomes an indicator of caring less about own health (Laaksonen, Prättälä, & Karisto, 2001). The association between low nutrients intake and being a smoker has already been reported by a number of studies (Dallongeville, Marécaux, Fruchart, & Amouyel, 1998) (Raatz, Jahns, Johnson, Scheett, Carriquiry,

Lemieux, et al., 2017). Aside from MH and LoC, future studies focusing on self-identification, social norm, valuing own health, and also living environment could help to shed further light on the interlink between smoking and healthy diet.

Here, household income was not found to be a key predictor. This makes the case of Germany rather interesting as perhaps the availability of social protection for unemployed took the element of income out of the equation. In the same line, while having a higher level of education could improve one's knowledge about the negative side-effects of smoking, it could also be the change in self-identity that leads to the change in smoking behaviour.

Our results indicate that across the conceptual mechanism suggested by Umberson et al. (Umberson et al., 2010) the connection between HB and MH and also self-control is weaker than the association of HB with SES that possibly shapes norms. The notion of norm might also explain why being married/in a relationship has such a strong impact on reducing the likelihood of smoking while increases the odds of becoming OW/OB by a minimum factor of about 2 even when the behaviour of others/cohabits is accounted for. As suggested by other studies, this could be due to developing shared dietary habits that are heavier in calorie intake with a simultaneous change towards adapting a less physically active lifestyle (Dinour, Leung, Tripicchio, Khan, & Yeh, 2012). Through a study across nine European countries, married men were found to be more aware of healthier food choices yet they significantly exercised less than those who were never married (Mata, Frank, & Hertwig, 2015). Moreover, it has been noted that among singles, the motivation for maintaining a healthier/more attractive body image could be stronger than other groups. Our analysis showed that compared with being married/in a relationship, divorce/separation and becoming widowed did not increase the odds of becoming OW/OB significantly indicating that the weight gain transition from being single to other marital status at a person level could have a long-term consequence (Mata, Richter, Schneider, & Hertwig, 2018). In this route, further studies that would monitor the shift in life-style and diet in details alongside norms and group-identity through life-course are needed.

The effect of network on HB is well documented (Fletcher, 2010). We found a dramatic increase in odds of becoming OW/OB particularly for women as the count of OW/OB cohabits moved from 2 to 3 or more and this probability was far much higher for female (adult) children than those who were head or partner in the household. It can be argued that the gender difference could be due to the difference in amount of physical activities among young men and women. Unfortunately through SOEP, physical activity is measured in odd years thus this factor was not originally included in our model (later noted as one of the limitations). Nevertheless, we ran a test by taking the figures from proxy years (2011 for 2010 and 2015 for 2014). Although including the frequency of sport/exercise found to have a significant association, remarkably, it did not change our model effect estimates considerably

and if anything, for women it increased the magnitude of the association with having 3 or more OW/OB cohabits (OR for men changed from 7.18 to 7.07, CI 95%: 2.06–24.28 vs. women 12.44 changed into 13.65, CI 95%: 1.68–111.24). An alternative explanation here could be the social influence as suggested by Higgs that perhaps women are more vulnerable towards the behaviour of others due to probably having more empathetic tendencies and greater interest in facilitating positive social bonds (Higgs, 2015). In this vein, a study of connection between obesity and personality traits found that across two waves of measurements, out of "Big-Five" personality traits, only agreeableness to be significant and negatively associated with obesity. However, the study did not find gender difference to be significant when these connections were stratified (Bagnjuk, König, & Hajek, 2019).

Compared with other role types in a household, the likelihood of becoming a smoker was higher among women whose role was head when there were also one more other person smoking. After the threshold of one, having more smokers in the household did not make a noticeable difference. Becoming a smoker for (adult) children had a weaker connection with the behaviour of cohabits when compared with head or partner members. Our study did not expand the cover of network beyond the household, however, our findings indicate support for the existing suggestion that in terms of smoking, young adults are more affected by the behaviour of their friends and peers rather than by the behaviour of their parents and cohabits (West, Sweeting, & Ecob, 1999) which is in contrast with the mechanism behind OW/OB. This perhaps reflects the fact that eating is more of a shared activity among cohabits, thus, group behaviour is more dominant than individual's choice.

Our research is one of the few longitudinal studies that covers a sample of varied age groups. In comparison with middle-aged and older, we found that changes in HB in young adults had a stronger connection with the behaviour of their cohabits in terms of becoming OW/OB. While having more than one other smoker did not make a noticeable change in the scale of association with the behaviour of others, moving from two to three or more other cohabits being OW/OB increased the odds cumulatively. This combined with the particular vulnerability of young adults could perhaps partly explain the mechanism through which the prevalence of OW/OB grows. Future studies that could follow this pattern through units from household to neighbourhood, to region, and across a country will help to gain an insight towards the mechanism behind this growth.

Advantages and limitations

While most of the existing studies in this field are cross-sectional, we used a balanced panel that allowed following individuals within their households. Through incorporating both person- and household-level factors, our findings support the existing literature that we are probably more affected by our social connections than our individual trades. Our further focus on roles in the household indicates that the mechanism behind smoking and becoming OW/OB are rather different and gender in particular plays an important role. Our study has a number of limitations that should also be noted. Self-reported variables such as weight and height are often susceptible to respondent error. However, as our analysis was fixed at the person level, this error was mitigated by the same person provided responses at different points in time. We should also note that we used a balanced panel data (subsample of SOEP data), hence, our data did not essentially remain the population representative. In terms of the relationship between MH status and HB as an outcome, it is also possible to consider a reverse association between the two. This connection, however, is conceptual and in practice, it is difficult to eliminate this two-way relationship. As mentioned above, it was not possible to include the amount of exercise here due to the difference in years of measurement. Nonetheless, our test of using proxy years did not noticeably change the magnitude of association across various factors from the present findings. In the notion of links between household

members, genetic susceptibility and hereditary connections between parents and children/siblings might also play a role as they can have both physical and psychological impacts (Farooqi, 2018). However, the present rate of growing prevalence of OW/OB across the globe indicates that the mechanism behind it has certain routes in changes in modern lifestyle and environment (Goodarzi, 2018). While our fixed-effect approach controls for non-measured time-invariant factors, we cannot dismiss the potential effect from time varying confounders that are not included in our model, thus, we cannot infer any causality. As such factors are connections with friends as well as the effects from neighbouring environment that require further studies in the future.

Conclusion

The recent global increase in the prevalence of OW/OB could be due to an overall shift in food industry as well as changes in lifestyle and social norms. Our study of changes in smoking initiation and weight gain that followed individuals over time did not find a particular link between these and self-control or MH. It was argued that an individual's level of education, marital status, and employment status shapes his/her social-identity within which a certain HB might be more of a norm. Moreover, we found a strong connection between changes in HB of an individual with the behaviour of his/her cohabits. However, this network mechanism was different for smoking and weight gain, between genders, and between members with different roles in a household. For OW/OB, the increase in the count of others also being OW/OB increased the odds drastically and changes in HB of female (adult) children had by far the strongest association with the behaviour of others. These findings indicate that policies aiming to reduce adverse HB might be more successful if they focus on groups rather than individuals and intervention programs need to be considerate of diversity in social classes and norms within a society.

Ethics approval and consent to participate

In our study we used secondary data, German Socioeconomic Panel (SOEP), therefore, no ethics approval or participant consent was required. We accessed SOEP data through contract and with permission of DIW Berlin.

Consent for publication

Not applicable.

Availability of data and material

Data accessibility is restricted and regulated by DIW Berlin terms and conditions. For any queries regarding this study data accessibility, please contact the corresponding author Ida Monfared (ida.gohardoust monfared@uni-goettingen.de).

Declaration of competing interest

The authors declare that they have no financial or non-financial competing interests.

CRediT authorship contribution statement

Ida G. Monfared: Conceptualization, Formal analysis, Writing - review & editing, Writing - original draft, Methodology, Visualization. **Kenneth Harttgen:** Conceptualization, Writing - review & editing, Validation. **Sebastian Vollmer:** Conceptualization, Writing - review &

editing, Supervision.

Acknowledgments

Abbreviations

HB	Health Behaviour
OW/OB	Overweight or Obese
GSOEP	German Socioeconomic Panel
LoC	Locus of Control
MCS	Mental Component Summary Scale
MH	Mental Health
HRQoL	Health Related Quality of Life.

References

Andersen, H. H., Mühlbach, A., Nübling, M., Schupp, J., & Wagner, G. G. (2007). Computation of standard values for physical and mental health scale scores using the SOEP version of SF-12v2. *Schmollers Jahrbuch, 127*(February), 171–182.

Anger, S., Kvasnicka, M., & Siedler, T. (2011). One last puff? Public smoking bans and smoking behavior. *Journal of Health Economics, 30*(3), 591–601. https://doi.org/10.1016/j.jhealeco.2011.03.003.

Armitage, C. J., & Conner, M. (1999). The theory of planned behaviour: Assessment of predictive validity and "perceived control. *British Journal of Social Psychology, 38*(1), 35–54. https://doi.org/10.1348/014466699164022.

Bagnjuk, J., König, H.-H., & Hajek, A. (2019). Personality traits and obesity. *International Journal of Environmental Research and Public Health, 16*(15), 2675. https://doi.org/10.3390/ijerph16152675.

Bärnighausen, T., Oldenburg, C., Tugwell, P., Bommer, C., Ebert, C., Barreto, M., et al. (2017). Quasi-experimental study designs series—paper 7: Assessing the assumptions. *Journal of Clinical Epidemiology, 89*, 53–66. https://doi.org/10.1016/j.jclinepi.2017.02.017.

Bommer, C., Sagalova, V., Heesemann, E., Manne-Goehler, J., Atun, R., Bärnighausen, T., et al. (2018). Global economic burden of diabetes in adults: Projections from 2015 to 2030. *Diabetes Care, 41*(5), 963–970. https://doi.org/10.2337/dc17-1962/-/DC1.

Charafeddine, R., Demarest, S., Cleemput, I., Van Oyen, H., & Devleesschauwer, B. (2017). Gender and educational differences in the association between smoking and health-related quality of life in Belgium. *Preventive Medicine, 105*, 280–286. https://doi.org/10.1016/j.ypmed.2017.09.016.

Coste, J., Quinquis, L., D'Almeida, S., & Audureau, E. (2014). Smoking and health-related quality of life in the general population. independent relationships and large differences according to patterns and quantity of smoking and to gender. *PloS One, 9*(3). https://doi.org/10.1371/journal.pone.0091562.

Cutler, D. M., Glaeser, E. L., & Shapiro, J. M. (2003). Why have Americans become more obese? *The Journal of Economic Perspectives, 17*(3), 93–118. https://doi.org/10.2139/ssrn.373121.

Dallman, M. F. (2010). Stress-induced obesity and the emotional nervous system. *Trends in Endocrinology and Metabolism*. https://doi.org/10.1016/j.tem.2009.10.004.

Dallongeville, J., Marécaux, N., Fruchart, J.-C., & Amouyel, P. (1998). Cigarette smoking is associated with unhealthy patterns of nutrient intake: A meta-analysis. *Journal of Nutrition, 128*(9), 1450–1457. https://doi.org/10.1093/jn/128.9.1450.

Dinour, L., Leung, M. M., Tripicchio, G., Khan, S., & Yeh, M. C. (2012). The association between marital transitions, body mass index, and weight: A review of the literature. *Journal of Obesity*. https://doi.org/10.1155/2012/294974.

Farooqi, S. (2018). Genetics of obesity. In T. A. Wadden & G. A. Bray (Eds.), *Handbook of obesity treatment* (2nd ed., pp. 64–74). New York: The Guilford Press. Second.

Fletcher, J. M. (2010). Social networks and health outcomes. In *The new palgrave dictionary of economics* (Vol. 34). https://doi.org/10.1057/9780230226203.3834.

Fontaine, K. R., & Barofsky, I. (2001). Obesity and health-related quality of life. *Obesity Reviews, 2*(3), 173–182. https://doi.org/10.1046/j.1467-789x.2001.00032.x.

Goodarzi, M. O. (2018). Genetics of obesity: What genetic association studies have taught us about the biology of obesity and its complications. *The Lancet Diabetes and Endocrinology, 6*(3), 223–236. https://doi.org/10.1016/S2213-8587(17)30200-0.

Graham, H. (2012). Smoking, stigma and social class. *Journal of Social Policy, 41*(1), 83–99. https://doi.org/10.1017/S004727941100033X.

Grotz, M., Hapke, U., Lampert, T., & Baumeister, H. (2011). Health locus of control and health behaviour: Results from a nationally representative survey. *Psychology Health & Medicine, 16*(2), 129–140. https://doi.org/10.1080/13548506.2010.521570.

Hagger, M. S., & Chatzisarantis, N. L. D. (2009). Integrating the theory of planned behaviour and self-determination theory in health behaviour: A meta-analysis. *British Journal of Health Psychology, 14*(2), 275–302. https://doi.org/10.1348/135910708X373959.

Hagger, M. S., Gucciardi, D. F., Turrell, A. S., & Hamilton, K. (2019). Self-control and health-related behaviour: The role of implicit self-control, trait self-control, and lay beliefs in self-control. *British Journal of Health Psychology, 24*(4), 764–786. https://doi.org/10.1111/bjhp.12378.

Heilert, D., & Kaul, A. (2017). Smoking behaviour in Germany evidence from the SOEP. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3051717.

Higgs, S. (2015). *Social norms and their influence on eating behaviours*. Appetite. https://doi.org/10.1016/j.appet.2014.10.021.

Holt, C. L., Clark, E. M., & Kreuter, M. W. (2001). Weight locus of control and weight-related attitudes and behaviors in an overweight population. *Addictive Behaviors, 26*(3), 329–340. https://doi.org/10.1016/S0306-4603(00)00108-8.

Jia, H., & Lubetkin, E. I. (2005). The impact of obesity on health-related quality-of-life in the general adult US population. *Journal of Public Health, 27*(2), 156–164. https://doi.org/10.1093/pubmed/fdi025.

Kuehnle, D., & Wunder, C. (2013). The effects of smoking bans on self-assessed health: Evidence from Germany. *SOEP Papers on Multidisciplinary Panel Data Research, 586*(3), 1–30. Retrieved from http://ideas.repec.org/p/diw/diwsop/diw_sp586.html.

Laaksonen, M., Prättälä, R., & Karisto, A. (2001). Patterns of unhealthy behaviour in Finland. *The European Journal of Public Health, 11*(3), 294–300. https://doi.org/10.1093/eurpub/11.3.294.

Lê Cook, B., Wayne, G. F., Kafali, E. N., Liu, Z., Shu, C., & Flores, M. (2014). Trends in smoking among adults with mental illness and association between mental health treatment and smoking cessation. *JAMA - Journal of the American Medical Association, 311*(2), 172–182. https://doi.org/10.1001/jama.2013.284985.

Mata, J., Frank, R., & Hertwig, R. (2015). Higher body mass index, less exercise, but healthier eating in married adults: Nine representative surveys across Europe. *Social Science & Medicine, 138*, 119–127. https://doi.org/10.1016/j.socscimed.2015.06.001.

Mata, J., Richter, D., Schneider, T., & Hertwig, R. (2018). How cohabitation, marriage, separation, and divorce influence BMI: A prospective panel study. *Health Psychology, 37*(10), 948–958. https://doi.org/10.1037/hea0000654.

Mirowsky, J., & Ross, C. E. (2003). *Education, social status, and health*. New York: Routledge.

Noar, S. M., & Zimmerman, R. S. (2005). Health Behavior Theory and cumulative knowledge regarding health behaviors: Are we moving in the right direction? *Health Education Research*. https://doi.org/10.1093/her/cyg113.

Norman, P., Bennett, P., Smith, C., & Murphy, S. (1998). Health locus of control and health behaviour. *Journal of Health Psychology, 3*(2), 171–180. https://doi.org/10.1177/135910539800300202.

Peralta, M., Ramos, M., Lipert, A., Martins, J., & Marques, A. (2018). Prevalence and trends of overweight and obesity in older adults from 10 European countries from 2005 to 2013. *Scandinavian Journal of Public Health, 46*(5), 522–529. https://doi.org/10.1177/1403494818764810.

Pierce, J. P., White, V. M., & Emery, S. L. (2012). What public health strategies are needed to reduce smoking initiation? *Tobacco Control, 21*(2), 258–264. https://doi.org/10.1136/tobaccocontrol-2011-050359.

Powell, K., Wilcox, J., Clonan, A., Bissell, P., Preston, L., Peacock, M., et al. (2015). The role of social networks in the development of overweight and obesity among adults: A scoping review. *BMC Public Health, 15*(996). https://doi.org/10.1186/s12889-015-2314-0.

Raatz, S. K., Jahns, L., Johnson, L. A. K., Scheett, A., Carriquiry, A., Lemieux, A., et al. (2017). Smokers report lower intake of key nutrients than nonsmokers, yet both fall short of meeting recommended intakes. *Nutrition Research, 45*, 30–37. https://doi.org/10.1016/j.nutres.2017.07.010.

Rotter, J. B. (1966). Generalized expectancies for internal versus external control of reinforcement. *Psychological Monographs: General and Applied, 80*(1), 1–28. https://doi.org/10.1037/h0092976.

Sargent, J. D., Demidenko, E., Malenka, D. J., Li, Z., Gohlke, H., & Hanewinkel, R. (2012). Smoking restrictions and hospitalization for acute coronary events in Germany. *Clinical Research in Cardiology, 101*(3), 227–235. https://doi.org/10.1007/s00392-011-0385-1.

Schunck, R., & Rogge, B. G. (2010). Unemployment and its association with health-relevant actions: Investigating the role of time perspective with German census data. *International Journal of Public Health, 55*(4), 271–278. https://doi.org/10.1007/s00038-009-0075-1.

Scott, K. M., Bruffaerts, R., Simon, G. E., Alonso, J., Angermeyer, M., Ormel, J., et al. (2007). Obesity and mental disorders in the general population: Results from the world mental health surveys. *International Journal of Obesity, 32*(1), 192–200. https://doi.org/10.1038/sj.ijo.0803701.

Specht, J., Egloff, B., & Schmukle, S. C. (2013). Everything under control? The effects of age, gender, and education on trajectories of perceived control in a nationally representative German sample. *Developmental Psychology, 49*(2), 353–364. https://doi.org/10.1037/a0028243.

Steptoe, A., & Wardle, J. (2001). Locus of control and health behaviour revisited: A multivariate analysis of young adults from 18 countries. *British Journal of Psychology, 92*(4), 659–672. https://doi.org/10.1348/000712601162400.

Umberson, D., Crosnoe, R., & Reczek, C. (2010). Social relationships and health behavior across the life course. *Annual Review of Sociology, 36*, 139–157. https://doi.org/10.1146/annurev-soc-070308-120011.

Wagner, G. G., Frick, J. R., & Schupp, J. (2007). *The German socio-economic panel study (SOEP) - evolution, scope and enhancements. Ssrn.* https://doi.org/10.2139/ssrn.1028709.

Wallmann-Sperlich, B., Bucksch, J., Hansen, S., Schantz, P., & Froboese, I. (2013). Sitting time in Germany: An analysis of socio-demographic and environmental correlates. *BMC Public Health, 13*(1). https://doi.org/10.1186/1471-2458-13-196.

Wardle, J., & Steptoe, A. (2003). Socioeconomic differences in attitudes and beliefs about healthy lifestyles. *Journal of Epidemiology & Community Health, 57*(6), 440–443. https://doi.org/10.1136/jech.57.6.440.

Ware, J. E., & Sherbourne, C. D. (2006). The MOS 36-ltem short-form health survey (SF-36). *Medical Care, 30*(6), 473–483. https://doi.org/10.1097/00005650-199206000-00002.

Warkentin, L. M., Majumdar, S. R., Johnson, J. A., Agborsangaya, C. B., Rueda-Clausen, C. F., Sharma, A. M., et al. (2014). Predictors of health-related quality of life in 500 severely obese patients. *Obesity, 22*(5), 1367–1372. https://doi.org/10.1002/oby.20694.

West, P., Sweeting, H., & Ecob, R. (1999). Family and friends' influences on the uptake of regular smoking from mid-adolescence to early adulthood. *Addiction, 94*(9), 1397–1411. https://doi.org/10.1046/j.1360-0443.1999.949139711.x.

WHO. (2013). *WHO Obesity factsheet No. 311*. Geneva: World Health Organization. http://www.who.int/mediacentre/factsheets/fs311/en/.

Wilson, D., Parsons, J., & Wakefield, M. (1999). The health-related quality-of-life of never smokers, ex-smokers, and light, moderate, and heavy smokers. *Preventive Medicine, 29*(3), 139–144. https://doi.org/10.1006/pmed.1999.0523.