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INEQUALITY OF BMI DYNAMICS: A SOCIOECONOMIC AND GENDER PERSPECTIVE

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Abstract

The aim is to understand causal effects of gender, socio-economic status, and ageing on body mass index (BMI) of individuals in three industrialized countries which are characterized by different BMI distributions.

Data comes from three large population representative panel surveys in the USA, Switzerland, and Germany including about 65 000 individuals and 254 000 measurements. Individuals report up to eleven times, measured annually (Switzerland) or bi-annually (USA and Germany). We use fixed effects models to interprete causal effects and random effects models to estimate coefficients of time invariant covariates. We find that not working increases BMI in the US and Germany, in women, and in lower educated individuals. A higher income increases BMI in men and in the US. Ageing is the driving force in all countries, in particular in Germany. Women increase their BMI faster than men, and the lower educated faster than those with a higher education. We conclude that the generally more deprived individuals (women, not working, lower educated, people from less affluent countries) suffer from a comparatively stronger BMI increase over their lifetime.

Keywords

SES and individual BMI | gender differences | age differences | fixed effects modeling | USA | Switzerland | Germany |

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1. Introduction

In the past decades, research clearly proved that obesity causes severe chronic health problems (Schienkiewitz et al. 2012) and increases the rates of ill health and disability, including cancer, diabetes, cardiovascular problems, and also psychological issues (Luppino et al. 2010, Onyike et al. 2003, Roberts et al. 2003). For this reason, the expansion of this phenomenon in the more recent cohorts (Lipps & Moreau-Gruet 2010, Reither et al. 2011, Wang et al. 2007) was named a "global obesity epidemic" by the WHO (2015). Also a number of governments started to pay more attention on obesity, worrying that its increase will lead to alarmingly rising health care costs (Hu 2008). For example, in the United States (where 67.3% of the population aged 18 or more are overweighed or obese), the annual health-care costs for obesity in 2008 were estimated at $147 billion a year (Finkelstein et al. 2009). Annual costs of medical expenditures and the value of lost productivity (such as absenteeism) attributable to obesity among full-time employees in the United States are estimated as high as $73.1 billion in 2006 (Finkelstein et al. 2010) and predictions estimate an increase of total annual costs of treating obesity-related diseases by $48–66 billion between 2010 and 2030 (Wang et al. 2011). In Germany, where the proportion of obese people is smaller, the costs of obesity were estimated at €14.1 billion in 2005 and projections by 2020 describe the total costs of obesity in excess of €25 billion (Knoll & Hauner 2008). In addition to costs, obesity causes discrimination in important areas such as work (Baum & Ford 2004, Carr & Friedman 2005, Glass et al. 2010, Judge & Cable 2011, Conley & Glauber 2007), education (Karnehed et al. 2006), marriage market (Mukhopadhyay 2008, Silventoinen et al. 2003, Conley & Glauber 2007) and healthcare (WHO 2016, Puhl & Brownell 2001).

Although obesity affects all social groups, research consistently documents socio-economic disparities in obesity or body mass index (BMI) (Conley & Glauber 2007, Wang & Zhang 2006), defining obesity as one important example of social inequality. Most importantly, the risk of obesity is negatively correlated with an individual's socio-economic status (McLaren 2007). Specifically, low education (Faeh et al. 2011, Kemptner et al. 2011, Pudrovska et al. 2014), low income and poverty (Drewnowski 2009, Sobal & Stunkard 1989) are all associated with a higher risk of obesity, at least in the developed countries (Sobal & Stunkard 1989, McLaren 2007). Among the socio-economic indicators, education has one of the strongest discrimination effects on BMI. Different reasons may explain this. First, better educated people tend to be richer which allows for the consumption of healthier food (De Irala-Estévez et al. 2000). Second they have a less sedentary lifestyle (Varo et al. 2003), are likely to exercise more and have easier access to, better process, interpret and apply

nutritional and general medical information (Sobal & Stunkard 1989, Wardle et al. 2002). Third, it is likely that a higher education level affects a person's sense of control, self-efficacy (Wardle et al. 2002, Lynch et al. 1997), and self-esteem (Judge et al. 2009). Such people are more aware of future detrimental impacts of obesity and adopt a longer-period perspective health behavior (Herzlich & Adam 1994). Despite the fact that in the USA and in European countries education was one of the best predictor of obesity, we hypothesize that working status and income reflect additional aspects, even if these factors are positively correlated with education. Indeed, the highest educational level is already achieved at comparatively young ages and remains unchanged while the obese "career" continues thereafter. Consequently, to explain the considerable individual variance across individual BMI growth patterns (Onyike et al. 2003), other SES measures must be considered in addition to education after the education is finished (Winkleby et al. 1992). Taking together, education, working status and income may provide a more complete picture of the relationship of obesity and SES (Galobardes et al. 2000), especially when analyzing BMI developments as people age.

When focusing on inequality in body weight, gender needs to be considered as well. Research has found that the various socio-economic indicators affect men and women to a different extent. For example, several studies found larger educational, occupational and income differences due to a higher body weight in women than in men. Roehling et al. (2007) and Caliendo and Lee (2013) found that obese women were 16 times more likely than men to report employment discrimination and to experience worse employment outcomes. For men, income penalties seem to be limited to those who are very obese (BMI > 35): a cutoff that Carr and Friedman (2005) describe as the point at which "obesity may become a 'master status' or a characteristic that overrides all other features of a person's identity" (p. 255). Obese men can overcome initial disadvantages with time and experience, while obese women will continue to face diminished wages over the course of a lifetime (Mason 2012). Also for this reason household income is often associated with women's BMI, but not always with men's BMI (Faeh et al. 2011, Garcia Villar & Quintana-Domeque 2009, Schmeiser 2009, Heineck 2002). This is probably due to the gender ideals, which create the expectation of heavier and taller men, compared with thinner women (Bordo 2003). Men eat heartier food in greater portions while "a girl's accession to womanhood is marked by doing without" (Bourdieu 2003), and men have the right to look at and judge women's bodies (while women do not have parallel visual access to men's bodies) (Berger 1977, Mulvey 1975). Women,

rich of historical and ideological ties to the body, are more likely than men to be evaluated according to their physical characteristics (Butler 2006).

A methodological issue is that the vast literature that investigates the relationship between SES and obesity used cross-sectional data. While this approach is adequate to get a snapshot about the population at one point in time, it cannot capture causal effects. Similarly, while studies based on repeated cross-sectional surveys are able to forecast developments of population group aggregates (e.g., Lipps & Moreau-Gruet 2010), they cannot explain them (Singer & Willett 2003). The reason is that (regression) analyses based on cross-sectional surveys most often suffer from omitted variable bias. If variables which are correlated with both the dependent and independent variables are omitted then the regression estimate will be biased. Panel data offer the possibility to use fixed effects models, which only use within-individual variance. Omitted variables, which are time invariant within individuals, are implicitly controlled in fixed effects models such that their omission does not cause biased estimates. Looking at the (few) published studies which adopt a life course perspective, we noticed that some European researchers found heterogeneous dynamics of weight gain. For example, a study from Poland (Dennis et al. 2000) reported greater increases in younger rural women, in urban men and in rural women with low education. A Finnish study (Salonen et al. 2009) found that while lower educational attainment and lower adult social class were associated with a higher BMI increase in both men and women, lower household income was associated with higher BMI in women only. Pudrovska et al. (2014) found that SES disadvantage at age 18 is related to a higher body mass index and a greater risk of obesity at age 54 in particular for women.

Following the current debate in the scientific literature, in our contribution we hypothesize that different components of SES such as working status and income have specific effects on individual BMI developments, and, at the same time, separating different genders, educational levels and countries of residence contribute to better understand these effects. In our study, we investigate three developed countries with considerable obesity differences, using data from large-scale national panel surveys: the Panel Study on Income Dynamics (PSID) from the USA, the Socio-Economic Panel Survey (SOEP) from Germany, and the Swiss Household Panel (SHP). In addition to the availability of large datasets, our country choice has two reasons. First, we decided to consider relatively rich countries in which the proportion of obese people is high albeit quite different. In fact, while in the USA 33.9% of the adults are obese, in Switzerland this figure amounts to 8.2% and is one of the

lowest among the developed countries. Germany, where the proportion of obesity equals to 12.9%, is intermediate in this respect (Global Database on Body Mass Index 2015). Second, these countries have adopted various strategies to deal with this problem, with a different timing. The American government began in the 1990s to implement a wide range of policies and programs to respond to obesity that was already dramatically increasing. Most programs have addressed clinical, behavioral, or educational issues (EASO 2014). The German government has paid attention to this phenomenon in 2004 with the German Platform for Diet and Physical Activity (Vallgårda 2015). With this plan the government aimed to provide more information on the role of the diet, to promote physical activity in daily life and to improve the quality of away-from-home catering. The Swiss government has started to implement some national programs to encourage healthy lifestyles and healthy nutrition and exercise only in the late 2000s (Ackermann et al. 2015).

In a nutshell, our study sheds light on the individual BMI of men and women with a different education level in these countries and on the causal effect of age, income and working status. To the best of our knowledge this is the first analysis of causal effects from different SES measures and age on BMI of different groups in different countries, which uses data from population representative panel surveys.

2. Methods

2.1 Dependent variable: Body mass index

To measure overweight and obesity we use the body mass index (BMI = kilograms over squared height in meters). Despite the BMI is easy to measure and to report in general population surveys, it has been accused to represent an imprecise measure of fatness since it does not distinguish fat from muscle mass. As a result, BMI overestimates fatness among those who are muscular (Burkhauser & Cawkey 2008). This limitation notwithstanding, the BMI is still the most common measure to determine overweight and obesity in sociological and epidemiological literature (in the Western world: overweight = BMI $\geq$ 25 and $<$ 30; obesity = BMI $\geq$ 30).

2.2 Data

Data for this research come from the Cross National Equivalent File (CNEF), an ex-post harmonized collection of several nationally representative panel surveys (Frick et al. 2007). While the German Socio-Economic Panel (SOEP) uses mainly face-to-face CAPI (computer assisted personal interview) interviews, both the Swiss Household panel (SHP) and

the US Panel Survey on Income Dynamics (PSID) administer their surveys using CATI (computer assisted telephone interview). The SHP and the SOEP survey their respondents annually, and the PSID administers its survey every other year since 1997. We use all samples from all three surveys, i.e. the original 1999 sample plus the refreshment samples 2004 and 2013 from the SHP, the original sample including the 1997 immigrant sample from the PSID, and all samples A to K from the SOEP. Information on BMI is contained in all bi-annual years from 1999 to 2013 of the PSID and from 2002 to 2012 of the SOEP, and all years from 2004 to 2014 of the SHP. We use weighted data to both produce descriptive statistics on overweight and obesity and unweighted data for the multivariate models (Brick 2013).

For the analysis, we drop panel respondents whose BMI exceeded a value of 60. A BMI over 60 is very likely a measurement error. In addition we restricted the sample to individuals aged between 25 and 75 years. The final sample comprises 64,643 individuals reporting 254,751 person-years. Of those in the PSID (SOEP), 15% (36%) of the respondents provide valid data on their BMI in just one wave, 12% (11%) in two waves, 11% (10%) in three waves, 9% (11%) in four waves, and 29% (23%) in all eight (six) bi-annual waves. In the SHP, 41% contributed one wave (the majority of whom are members of the 2013 refreshment sample who were first asked their BMI in 2014), 7% in two waves, 6% in three, and 17% in all eleven annual waves. In table 1, we list some basic socio-demographic characteristics across the three countries in the respective first wave considered (PSID: 1999, SHP: 2004, SOEP: 2002).

Table 1: Socio-demographic characteristics from the first year observed. Data PSID 1999, SHP 2004, SOEP 2002.

	PSID (USA)	SHP (Switzerland)	SOEP (Germany)
(First) Year	1999	2004	2002
N [individuals]	9 505	6 350	19 629
BMI [mean]	26.5	24.3	25.7
Man [%]	47	44	49
Age [years]	44	48	48
Black (only asked in PSID) [%]	27	0	0
Living together with a partner [%]	75	75	83
13 or more years of education [%]	46	34	30
Working full time [%]	56	46	46
Working part time [%]	23	28	23
Not working [%]	21	26	31
Equivalized household income [$/CHF/€]*10^6 [mean]	.04	.08	.03

Differences between the surveys are due to true country differences but also to surveys design differences (Frick et al. 2007) and effects from noncoverage and nonresponse. To assess possible biasing effects on BMI from nonresponse and measurement issues we validate our panel data with large cross-sectional survey data in the three countries. For Switzerland and the USA, Lipps and Moreau-Gruet (2010) showed that there are only small gender and age specific differences between the proportions of overweight and obese people in the SHP 2004 and in the Swiss Health survey (SHS) 2002 on one hand, and those in the PSID 1999 and the Behavioral Risk Factor Surveillance System (BRFSS, 1997, 2002) on the other. For the SOEP, however, comparisons between the first wave and external data are still due. In addition, we include a validation of the data from all three surveys for the most recent year considered.

We compare the BMI of the residential population 15 (16 in the PSID) years or older in the three surveys with data published by the OECD for 2013 (or the nearest year) (Luppino et al. 2010). According to the OECD, 41.0 % of the population are overweight or obese in Switzerland (self-reported), and 10.3% obese. In the SHP 2013 (using cross-sectional weights), these figures amount to respectively 39.8% overweight or obese, and 10.2% obese. This is suggestive of an only small bias in the SHP. In the USA, 63.5% of the population are overweight or obese (self-reported), and 35.3% obese. This compares with respectively 60.7% (self-reported) overweight or obese, and 26.0% obese in the PSID 2013. The differences suggest some underrepresentation among obese people in the PSID. In Germany 49.2% of the population aged 18 years or over are overweight or obese (12.9% obese) in 2003 and 52,4 (15.7% obese) in 2013. The respective figures in the SOEP 2002 are 53.1% (14.9% obese) and 56.8% (19.5% obese) in the SOEP 2012, respectively (self-reported in face-to-face interviews). The somewhat higher incidence of overweight and obesity in the SOEP is difficult to explain and also the survey mode cannot be a reason since both the SOEP and the German micro-census were conducted face-to-face.

2.3 Independent research variable 1: Education

The CNEF contains the number of years of education as one education measure. To be comparable across the three countries we resorted to only distinguish between a high and a low education, using 13 years of education (13 years and more=high) as the cut-off. The reason is that in all countries, the median number of years of education amounts to 12 years in Germany and Switzerland (13 in the US), while the mean is slightly higher and is close to 13 years in all countries.

2.4 Independent research variable 2: Income

We use disposable household net income which aggregates income from all sources and all individuals living in the household. To take account of the household composition, we equivalize this income according to the modified OECD scale: the first adult receives a weight of 1, children up to 14 years a weight of 0.3 and all other household members a weight of 0.5. Household income is then simply divided by the sum of these weights. Prices or currencies are not harmonized since the (individual) time spans are not very long and, whenever income is compared across the three countries, income is distinguished by country.

2.5 Independent research variable 3: Working status

We distinguish three working statuses: if the individual had positive wages and works at least 1,820 hours per year, then the individual was classified as full-time worker. If the individual had positive wages and worked at least 52 hours but less than 1,820 hours per year, then the individual was employed part-time. The respondent was considered not working in all other conditions, including students, housewives, unemployed and retired.

2.6 Modeling approach

To model effects of the mentioned independent variables on BMI, we use both random effects and fixed effects models. On one hand, random effects models (which use a weighted mean between the between-effects estimator and the fixed-effects estimator; see Cameron and Trivedi 2009) have more statistical power because they use between- unit variance in addition to within-unit variance. In addition they are able to estimate coefficients of time-invariant covariates such as gender. On the other hand, omitted individual heterogeneity may result in biased coefficients. Fixed-effects models (which use only within-individual variation), in turn, are unable to estimate coefficients of time-invariant covariates. However, they provide unbiased estimates of the coefficients from covariates even in the case they correlate with the time-invariant parts of the individual errors. As a consequence, the coefficients estimated from fixed-effects models capture the causal effects from such independent variables on the dependent variables.

There is some debate in the literature about pros and cons of fixed and random effects models (e.g., Clark and Linzer 2012). According to Clark and Linzer, three primary considerations should determine the choice of one or the other model: 1) the extent to which variation in the explanatory variable is primarily within-unit as opposed to across units, 2) the amount of data one has (number of units and observations per unit), and 3) the goal of the

modeling exercise (Clark and Linzer 2012:27). Given we are primarily interested in causal effects (Antonakis et al. 2010) from our covariates and that we find enough variance within units (about one fourth of the total variance for BMI, and more for the model covariates), but want to estimate coefficients from time-invariant covariates as well, we employ a random effects model in the first step, acknowledging that the coefficients may be biased. In this model we include the covariates gender, education, working status, country, income and income interacted with country, together with race (black versus others), age, age squared, and presence of a partner in the household. The income / country interaction is necessary to allow comparing the association between income and BMI across the countries since we did not control for the different purchase power. As mentioned above, coefficients from the RE model may be biased because they may include effects from other, unobserved, variables. For example, if education correlates with an unobserved variable such as lifestyle, which may also have an effect on BMI, a part of the coefficient that is ascribed to education is due to lifestyle. If such unobserved variables are constant within an individual (such as lifestyle may be constant at least for some time), they are controlled for in the fixed effects models such that they cannot cause possibly biased estimates. As a consequence, we estimate fixed effects coefficients in the second step. We use seven fixed-effect models, differentiated by countries (three models), educational level (two models) and gender (two models). In all fixed-effect models, we control for the presence of a partner in the household, age and age squared (Mason 2012). We find for all models satisfactorily high within R-squared which range between 0.04 and 0.06. Modeling results are depicted in table 2.

Table 2: Multivariate modelling coefficients (RE=random effects, FE=fixed effects).

** (**) (***)=significant on 10 (5) (1)% level.*

Data: PSID (1999-2013), SHP (2004-2014), SOEP (2002-2012), N=250 427 person-years (63 183 individuals).

BMI	RE	FE (Country)			FE (Gender)		FE (Education)	
		US	CH	Germany	Women	Men	Low educat	High educat
CH (ref: USA)	-3.026***							
D (ref: USA)	-1.573***							
Survey year	0.062***							
Man [%]	1.304***							
Age [years]	0.232***	0.311***	0.252***	0.307***	0.311***	0.273***	0.351***	0.258***
Age squared [years]	-0.002***	-0.002***	-0.002***	-0.002***	-0.002***	-0.002***	-0.002***	-0.002***
Black (only asked in PSID) [%]	2.445***							
Living together with a partner [%]	0.241***	0.244***	0.256***	0.407***	0.303***	0.315***	0.359***	0.254***
13 or more years of education [%]	-0.614***							
Working part time (ref: full time) [%]	-0.021	0.024	-0.032	0.016	0.0510***	-0.026	0.041*	-0.023
Not working (ref: full time) [%]	0.075***	0.079**	0.007	0.0826***	0.108***	0.048*	0.157***	-0.049*
Equivalized household income [$]	-0.127	0.327*	-0.075	0.104	-0.071	0.455***	0.237	0.195
CH x Equivalized HH income [CHF]	-0.216							
D x Equivalized HH income [€]	-1.253***							
Intercept	-103.200***	18.600***	16.360***	15.610***	15.420***	18.470***	15.16***	17.760***
R^2 (within)	.047	0.039	0.057	0.060	0.052	0.039	0.052	0.043
R^2 (between)	.119							

3. Results

3.1 Random effects model

From the random effects model (RE) we find that men have a higher BMI than women, black people a higher BMI that other races, and the Americans have the highest BMI, followed by German and Swiss people. Furthermore, higher educated people report a lower BMI. This finding confirms the thesis of the protective effect a higher education may have against excessive body weight. At the same time, we find that unemployed and inactive people are heavier than those who are working, as confirmed by other studies (e.g. Caliendo & Lee 2013). In addition, income has no association with BMI in the US and in Switzerland (the sum of the overall income and income x Switzerland is insignificant), and a negative in Germany only (the sum of the overall income and income x Germany is negative). However, as explained in the previous part, it is important to consider gender in addition to country differences for this relationship, since household income seems to be associated with women's BMI, but not always with men's BMI (Garcia Villar & Quintana-Domeque 2009, Schmeiser 2009, Heineck 2002).

3.2 Fixed effects models

3.2.1 Countries (FE(US), FE(CH), FE(Germany))

We find a number of differences between the countries considered. Specifically, (currently) not working increases the BMI of individuals in the US and in Germany, but not in Switzerland. Despite there are not many studies on the relationship between the number of working hours and BMI, we hypothesize that being at home increases the level of stress for people otherwise being active, and, at the same time, is associated with more sedentary activities. As it is well known from cross-sectional studies both these aspects contribute to an increased risk of obesity (Brown et al. 2003). Studies in the US have shown a strong association between television viewing and overweight/obesity in adults and in children (Jeffrey & French 1998, Tucker & Friedman 1989). An Australian study found that body mass index was associated with hours of television watched (Salmon et al. 2000) and data from UK suggest that increasing levels of sedentariness have played a major role in the development of obesity (Prentice & Jebb 1995). The absence of statistical significance in Switzerland could be linked to the Swiss labor market condition, where the level of

unemployment is very low and presumably the duration of unemployment short, and often, times of inactivity are a choice, in particular for part-time working women.

Also the second indicator of our interest, equivalized household income, exhibits country differences. In the US, higher economic resources cause higher BMI, whilst in Germany and Switzerland we do not find income differences. Studies that have examined the association between income and obesity in the US have often been unable to account for the potential endogeneity and reverse causality between income and body weight (Conley & Glauber 2007, Cawley 2004). Indeed, income may directly affect weight through its effect on consumption and expenditure of calories: people may use the additional income to purchase additional calories for home consumption or substitute restaurant meals that are generally more calorie-dense than food consumed at home. At the same time, higher income does not necessarily imply an increased calorie intake, since excessive obesity has a negative influence on the quality of life and substituting inexpensive with more expensive, but potentially healthier food is also possible. Also, with higher income, individuals may have access to healthier activities or more opportunities to care about their health (Grossman 1999).

Finally, the presence of a partner in the household has a positive effects in all countries (The & Gordon-Larsen 2009), as well as age. However the BMI - age curve is steeper and more convex in the US and flatter in Switzerland. Regarding the relevance of the effects of the different variables, we deduce from the t-values that age has a very strong effect, compared with the other independent variables. To get a sense of this effect in the different countries, in the US, people increase their BMI by about 0.20 BMI points per year at age 25, and this yearly increase drops to almost 0 at age 70. Also in Germany, people start increasing their BMI by about 0.20 BMI points per year at age 25, but this yearly increase remains positive at 0.04 at age 70. Finally, Swiss people increase their BMI slightly less, by about 0.17 per year at age 25, and this yearly increase drops to about 0.02 at age 70.

3.2.2 Gender (FE(women), FE(men))

In the literature on BMI, the differences between genders often appear important. In our models, working status has a much stronger effect for women than for men: working part time (rather than full time) has a positive effect on BMI for women only and not working a positive effect for both genders, which is however much higher for women. These results are in line with previous findings, which underline the negative association between BMI and full-time work for women. For example, Brown et al. (2003) reports that women who worked full-time or part-time had fewer chances of being obese (compared, in this case, with men).

Taking the possibility of reverse causality into account, Caliendo and Lee (2013) found that obese women experience worse (or at best similar) employment conditions than normal weight women.

Furthermore, a higher income has positive effects on BMI for men only. Some previous studies conducted in the US contradict our result (Schmeiser 2009), showing that income significantly raises the BMI in women, but does not have appreciable effect for men. In Switzerland, while income seems to have an only small overall effect and there are insignificant differences between women and men, obese women had significantly lower wages than normal weight women (Faeh et al. 2011).

While effects from having a partner are similar across the genders, women increase their BMI slightly faster than men: women by 0.21 per year at age 25 and still by 0.04 per year at age 70, and men by 0.18 per year at age 25 and by 0.03 per year at age 70. This shows that women increase their BMI stronger than men during their lifetime. Interestingly, holding the other variables constant and using the weight difference between the genders from the RE model, women weight almost as much as men by the age of 70.

3.2.3 Education (FE(low edu), FE(high edu))

Looking at the differences between high and low educated people, similar to differences between men and women, working times have much stronger effects on BMI for the lower educated. Working part time and in particular not working has a positive effect for the lower educated while it has a small negative effect for the higher educated. At the same time income has no effect, irrespective of the education level. The age curve is steeper for the lower educated: the lower educated increase their BMI by 0.23 per year at age 25 and still by 0.03 per year at age 70, while the high educated increase their BMI by 0.17 per year at age 25 and by 0.02 per year at age 70. This shows that - similar to women when compared with men - the lower educated people suffer from a higher BMI increase during all their lifetime.

4. Discussion

This article investigated the role of different indicators of socioeconomic status (SES) as well as gender and ageing on the individual body mass index (BMI) in industrialized societies, by analyzing panel data of individuals from the USA, Germany, and Switzerland. We employ longitudinal models which allow for descriptive interpretations across countries, gender, and education levels (random effects models) on one hand, and for causal analyses of

effects from changed working hours, a changed income, and from individual aging (fixed effects models) on the other, distinguished by country, gender and education levels.

Reducing the working time or even stopping to work has generally BMI increasing effects, especially for lower educated or women. A higher income has positive effects in the US and for men. More interestingly, groups who are generally disadvantaged in a number of fields such as women and lower educated people suffer more from an increased BMI over their lifetime than their respective counterparts.

Despite the determinants of obesity describe a complex puzzle, there are some strategies that can be considered to prevent or to protect from obesity. For example, an improved education might be a cornerstone strategy to avoid obesity. Furthermore, preventive measures should be activated in particular at the family level (starting with parents) and should be tailored in order to implement sustained lifestyle changes (Brophy et al. 2009). Finally, it might be a good idea to take into account that, together with the enhancement of health policies, the obesity problem can be dealt with the improvement of working and material conditions (Wardle et al. 2002). These measures should empower individuals with low socio-economic status to adopt a lifestyle that allows them to maintain a healthy body weight.

Our study has a number of limitations. In terms of data quality, all surveys suffer from initial non-response and panel attrition that are usually both positively correlated with lower SES status (Stoop 2005, Voorpostel & Lipps 2011). Second, the height and weight data used are self-reported, with the data from the SOEP as the only face-to-face survey being likely to be more valid. Nevertheless, given our focus lies in causal effects from individual changes rather than studying different levels between individuals, errors should be minor such that we believe that these issues do not compromise our findings.

Despite these limitations, our study aims to reflect on the adverse effects of obesity and it adds innovative analyses methods of obesity to the sociological literature. Based on the previous studies and on our own results we argue that it is important to increase public awareness of the penalties which obese people suffer in the different spheres of individual's life, especially when they age. Because obesity is not a protected status under federal law, promoting legal protection of overweight and obese people from unfair treatment is crucial.

5. Compliance with Ethical Standards

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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