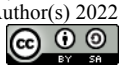
Sociology and Social Work Review Volume 6 (Issue 2)/2022 | pp. 102-120


DOI: 10.58179/SSWR6209
https://globalresearchpublishing.com/sswr/


COVID-19 and obesity. A SHARE analysis of educational and gender differences on diet and physical activity

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Abstract

Scientific evidence shows that food-related excesses, which are linked to obesity and are spreading globally both among adults and the youth, are the cause of new and widespread diseases ranging from cardiovascular disturbances to diabetes. Indeed, the body mass index (BMI) is rising rapidly in all industrialized and many developing societies.

The COVID-19 pandemic has increased the incidence of obesity, and the disease also has particularly negative impacts on obese populations, namely a greater severity of the disease and higher mortality. Obese individuals have a greater probability of suffering from other diseases that are independent risk factors for severe COVID-19, including heart disease, lung disease, and diabetes. Indeed, lack of physical activity and an unhealthy diet with too much fat and sugar constitute major and increasingly important determinants of poor health and premature death across the world.

Using SHARELIFE data, this research presents an empirical analysis of the relationship between lifestyle behaviors related to physical activity and diet, education, and health capital (physical health, mental health, self-sufficiency, and perceived health), also incorporating a gender perspective. More specifically, the aim was to illustrate whether and how the self-perceived health status of older adults (the group hit hardest by COVID-19) varies according to BMI and how it responds to changes in lifestyle behaviors, as well as whether and how these relationships are modified or altered by one's level of education and gender. People with tertiary education report a better health status than people with primary education after improving their diet and physical activities, and this effect is greater for men.

Keywords: *COVID-19; obesity; risk factor; health promotion; lifestyle*

1. Introduction. Obesity: an epidemic within the pandemic

Obesity has reached epidemic proportions on all continents, such that the World Health Organisation (WHO) coined the term "Globesity" (global obesity) to refer to the

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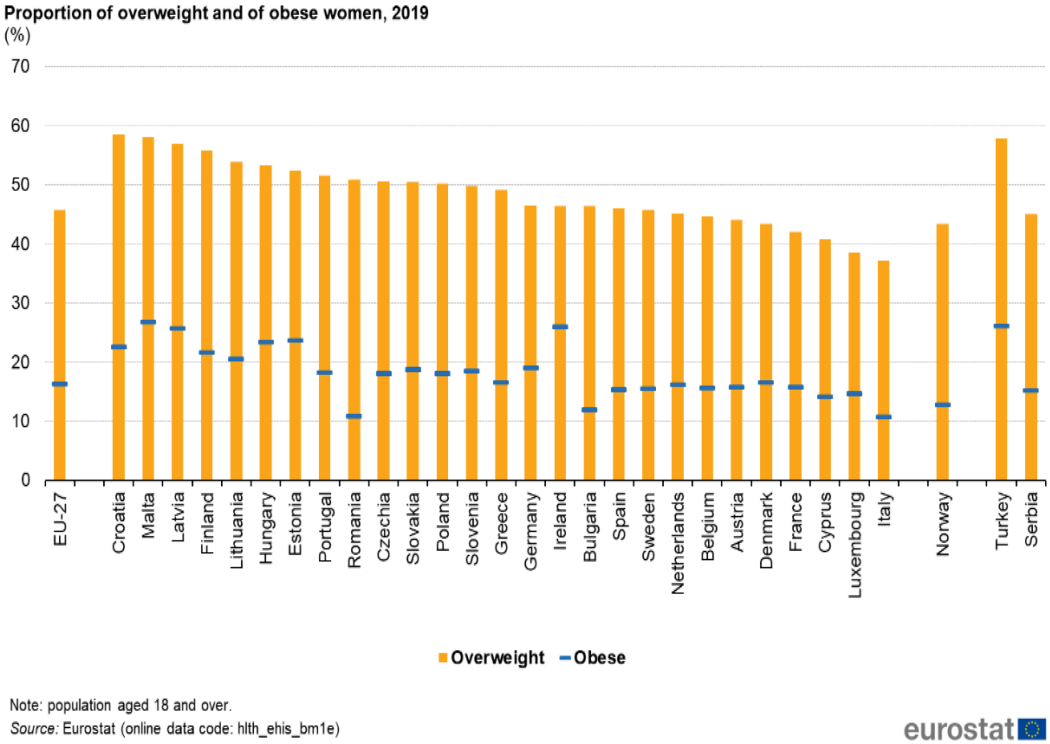
global spread of the problem. In 2016, a report estimated that the "expansion of this phenomenon in the future could lead to the emergence of nearly 700,000 new cases of cancer in the UK by 2035 and reiterated that obesity is often associated with diabetes, a disease that will affect more than 4 million (+65%) individuals in Great Britain over the decade (The Lancet, 2016). In the European Union (Eurostat, 2021), our focus of investigation, 45% of adults had a normal weight in 2019, slightly more than half (53%) were considered overweight (36% pre-obese and 17% obese) and almost 3% were underweight, according to their body mass index (BMI). According to the WHO (2014, 2022), worldwide obesity has nearly tripled since 1975. In 2016, 39% of adults aged 18 years and over were overweight and 13% were obese. In 2018, Mexico was the leader in the global rankings, with 69.5% of the population over 15 years of age being overweight or obese, followed by the USA with 69.2%, of which 34% is constituted of obese persons alone (OECD, 2020).

The neologism "globesity" first appeared in a WHO report and was used referred to the serious threat to public health caused by the excessive weight gain of human beings in Latin American countries and across the globe (PAHO, 2002). Regular physical activity reduces the risk of cardiovascular disease, some cancers, and type II (non-insulin-dependent) diabetes (WHO Regional Office, 2018). Overweight and obesity—that is, having a body mass index (BMI) of 30 or higher—is estimated to kill about 320,000 men and women across 20 countries of western Europe every year; the rate of obesity in some areas of eastern Europe is also high and has risen more than threefold since 1980 (WHO, 2018). Rates of overweight and obesity change across the life course (Gillman, 2004; Kuh et. al., 2014) and continue to grow in both adults and children (WHO, 2022): In the European Region, 59% of adults and almost 1 in 3 children (29% of boys and 27% of girls) are overweight or living with obesity. Obesity prevalence for adults in the European Region is higher than in any other WHO region except for the Americas. Overweight and obesity are among the leading causes of death and disability in the European Region, with recent estimates suggesting they cause more than 1.2 million deaths annually, corresponding to more than 13% of total mortality in the region.

Data from the third round of the European Health Interview Survey (EHIS, 2021), which was administered between 2018 and 2020 to persons aged 15 and over, revealed substantial differences in the proportion of adults who are overweight or obese based on gender, educational level and socio-economic background. Figure 1 shows the proportion of women who were overweight in 2019, according to their educational level. The proportion of women who were overweight was lower among those with higher levels of educational attainment, and this pattern holds across all EU Member States. Indeed, the difference between overweight women with a tertiary education and those with no more than a lower secondary level of education was at least 32 pp in Portugal (32.0 pp), Greece (32.6 pp) and France (34.7 pp). The differences in the proportion of men who were overweight according to educational attainment were generally much smaller than for women.

Figure 1: Proportion of women who were overweight, by educational level, 2019 (%)

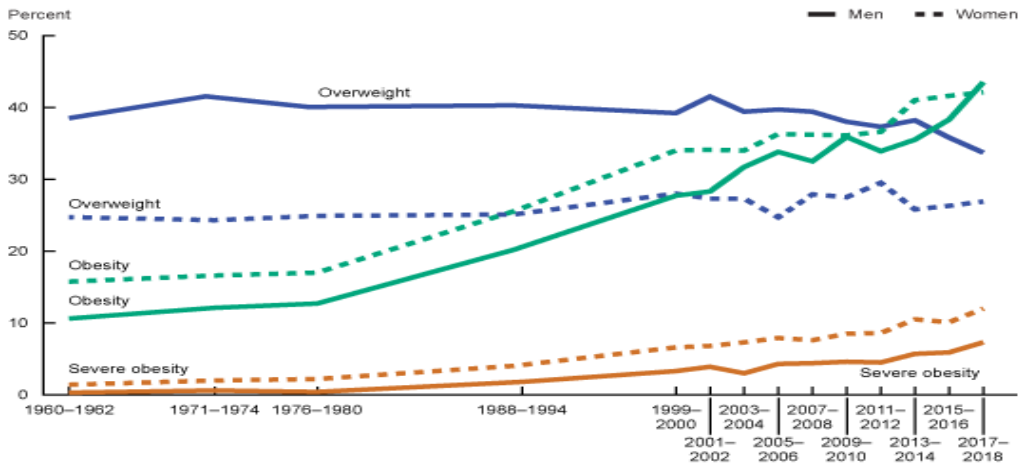


Note: population aged 18 and over.
Source: Eurostat (online data code: hlth_ehis_bm1e)

eurostat

Although the focus of this paper is on the European region, obesity and childhood obesity are a major health concern in the United States as well (Fryar et al., 2021; National Center for Health Statistics, 2022). The US obesity rate, shown in Figure 2, is generally high, and some states show rates above 40% (Mississippi's rate is about 41%). In the United States we also find interesting gender differences: Severe obesity is higher for women than men, while overweight is more common in men than women.

Figure 2. Age-adjusted trends in overweight, obesity, and severe obesity among men and women aged 20–74 in the United States, 1960 to 2018



Source: National Center for Health Statistics, National Health Examination Survey and National Health and Nutrition Examination Surveys, 2021

Therefore, overweight and obesity is a phenomenon that overcomes the economic division of rich countries/poor countries and requires a response from all health systems, particularly in light of the high costs associated with the treatment of diseases related to obesity, which, in countries with advanced economies, requires resources between 2% and 8% of health expenditure (Specchia et al., 2015).

2. Coronavirus 2019 and obesity: a vicious circle

Coronavirus disease 2019 (COVID-19) is a disease caused by a novel coronavirus called severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). On 30 January 2020, the WHO declared the outbreak of this disease to be a global pandemic.

Older patients with comorbidities such as chronic pulmonary disease, heart disease, kidney disease, diabetes, and hypertension are vulnerable to a more severe course of the disease and show higher mortality rates. Obese patients are also at increased risk of exacerbations from viral respiratory infections and are potentially more vulnerable to COVID-19, in addition to being more contagious than lean patients (Albashir, 2020). The comorbidities associated with obesity have been found to be correlated with a severe clinical course of COVID-19 and increased mortality, and a high BMI has been shown to be correlated with hospitalization, the need for mechanical ventilation, and non-survival (Dana et al., 2021; Xie et al., 2021). Furthermore, according to many studies (e.g., Kyrou et al., 2020; Williamson et al., 2020; Wu and McGoogan, 2020; Zhou et al., 2020), obesity can progressively cause and/or exacerbate a variety of comorbidities, including hypertension, type 2 diabetes, dyslipidemia, cardiovascular and lung disease, depending on the degree of obesity. Therefore, obesity can potentially contribute to increased morbidity and mortality among COVID-19 patients.

Several studies (Albashir, 2020; Funk et al., 2021; Karaca-Mandic et al., 2021) have reported that obesity increases susceptibility to SARS-CoV-2 infection and the risk of developing a severe form of the disease. If we look at the global scenario of the pandemic, obesity appears to be one of the factors that, at the population level, aggravates the burden of COVID-19. This is confirmed by a study in which it emerged that countries where the share of overweight persons in the population is high also have the highest mortality rates for COVID-19 (Wang et al., 2021). The research cross-referenced data on the BMI of populations from the WHO Global Health Observatory with data on COVID-19 from worldometers.info. The results show that the overweight [BMI (kg/m^2) ≥25] population in a country is significantly associated with the number of deaths per million population (adjusted R^2: 0.20; $P < 0.0001$), with countries with a larger proportion of overweight individuals experiencing a greater number of deaths from COVID-19. As shown by a multi-country study conducted in Europe (Funk et al., 2021), underlying obesity-related conditions significantly increase the odds of dying after contracting COVID-19. The results suggest that patients with obesity die almost 5.0 times more than cases with no underlying conditions and 3.0 times more than cancer patients. Even in the early days of the pandemic, when the coronavirus was still a mystery illness raging in Wuhan, China, the profile of the typical patient at greatest risk was clear: they were older, but more importantly they were fragile, suffering from multiple existing conditions such as obesity, diabetes, or cardiovascular problems.

On the other hand, early data show that the pandemic has contributed—in adults as well as children—to weight gain linked to stress, reduced activity, and comfort eating. One poll from Public Health England (2021) found that over 40 percent of adults put on weight during lockdowns, with an average gain of 3 kilos. Even more concerning, pandemic weight gain seems to be worse in children. NHS Digital (2021) has reported that obesity rates among 4- and 5-year-olds rose from 9.9 percent in 2019–2020 to 14.4 percent in 2020–2021. Among pupils aged 10 and 11, obesity prevalence increased from 21 percent to 25.5 percent over the same period.

Returning to the United States, one study showed that among a cohort of 432,302 persons aged 2–19 years, the rate of BMI increase approximately doubled during the pandemic compared to a pre-pandemic period (Lange et al., 2021). Persons with pre-pandemic overweight or obesity and younger school-aged children experienced the largest increases.

3. The danger of extra kilos for COVID-19

The biology of obesity includes impaired immunity, chronic inflammation, and blood that is prone to clotting, all of which can worsen COVID-19. The physical pathologies that render people with obesity vulnerable to severe COVID-19 begin with the follow mechanism: fat in the abdomen pushes up on the diaphragm, causing this large muscle lying below the chest cavity to impinge on the lungs and restrict airflow. This reduced lung volume leads to a collapse of airways in the lower lobes of the lungs, where more blood arrives for oxygenation compared to the upper lobes. Consequently, people with obesity are more likely than people of a normal weight to have other diseases that are independent risk factors for severe COVID-19, including heart disease, lung disease, and diabetes (Dana et al., 2021; Funk et al., 2021; Karaca-Mandic et al., 2021; Xie et al., 2021).

Even on its own, “BMI remains a strong independent risk factor” for severe COVID-19, according to several studies that adjust for age, sex, social class, diabetes, and

heart conditions (Patel et al., 2020; Karaca-Mandic et al., 2021; Mankowski et al., 2021; Rostila et al., 2021; Sze et al., 2020). In addition, according to a large body of literature (among others, see Muennig et al., 2006; Price-Haywood et al., 2020; Mankowski et al., 2021; Sundaram et al., 2021) people with obesity may delay seeking medical care due to fear of being stigmatized, increasing their likelihood of severe disease or death.

4. The social determinants of health: education and lifestyle

The social determinants of health are defined as the structural determinants and conditions of daily life responsible for a major part of health inequities between and within countries (WHO, 2009:1). They include the distribution of power, income, goods, and services, and the circumstances of people's lives, such as access to health care, schools and education, conditions of work and leisure, and the state of their housing and environment. The term "social determinants" is thus shorthand for the social, political, economic, environmental, and cultural factors that greatly affect one's health status.

In 2005, the WHO instituted the Commission on Social Determinants of Health (CSDH), with the goal of providing guidance to Member States and WHO programs by gathering evidence on the social determinants of and ways to overcome health inequities. In 2008, the CSDH published its final report, "Closing the gap in a generation. Health equity through action on the social determinants of health". The WHO has now adopted the results of this scientific work, about three decades after a series of prominent studies that started to question the dominant biomedical paradigm and reductionist view, according to which better medical care alone can generate major gains in population health.

Indeed, from the 1970s to the end of the 1990s, several studies gave support to the relevance of the social determinants of health. Following Antonovsky (1967), in 1974 and 1979 Lalonde and McKeown developed for the first time the concept of health determinants, arguing that there are a large number of influences on health apart from traditional public health and medical services and that these influences should be considered in framing health policy and any efforts to improve population health. In 1980, the Black Report in the UK (Gray, 1982) sparked debates and inspired a series of national inquiries into health inequities in other countries such as the Netherlands, Spain, and Sweden (Colgrove, 2002). The pervasive effects of social gradients on health were then progressively clarified (Marmot et al., 1978; Whitehall and Dahlgren, 1991; Evans et al., 1994).

Black and his colleagues (1980) and others argued that social conditions shape health inequities and that reducing the health gap between privileged and disadvantaged social groups would require ambitious interventions in areas such as education, housing, and social welfare, in addition to improved clinical care. But it was only in the 2000s, and above all after 2008, that health equity and the social determinants of health were embraced as explicit policy concerns by a growing number of countries across several continents.

The CSDH (2008) indicates education and lifestyle choices—including physical activity and diet—as examples of social determinants that can influence health in positive

and negative ways. Many studies show how social determinants such as education, physical activity, and healthy food choices influence obesity (Hillger, 2008; Devau et al., 2011; WHO, 2014; Hahn and Truman, 2015; Chung et al., 2016; Chumpunuch and Jaraeprapal, 2022; Jääskeläinen et al., 2022).

5. Objectives

As described in the previous paragraphs, an epidemic of obesity has been developing in virtually all countries over the last 30 years, and a lack of physical activity together with unhealthy diets with too much fat and sugar constitute major and increasingly important determinants of poor health and premature death across the world (Kawachi, 1999; CSDH, 2008; Kino et al., 2018; Raghupathi and Raghupathi, 2020). Moreover, the studies and research mentioned in the previous paragraphs provide us with evidence that the current COVID-19 epidemic has affected some social groups more than others. Indeed, obese patients are at increased risk for and are potentially more vulnerable to COVID-19, and they are more contagious than lean patients (Albashir, 2020). The comorbidities associated with obesity have been found to be correlated with a more severe clinical course of COVID-19 and increased mortality, and high BMI has been shown to be correlated with hospitalization, the need for mechanical ventilation, and non-survival (Dana et al., 2021; Xie. et al., 2021).

On the other hand, we have scientific evidence of the higher likelihood of ageing successfully (after a 10-year follow up) among people who have maintained high levels of physical activity, and in older adults (with a college education) with healthy habits (normal weight, not smoking, regular physical activity), the development of disability is delayed and mortality is reduced compared to those with less healthy behaviors (Chakravarty et al., 2012; Gopinath et al., 2018). Indeed, regular physical activity reduces the risk of cardiovascular disease, some cancers, and type II (non-insulin-dependent) diabetes (WHO Regional Office, 2018).

Physical activity levels are influenced by cultural values (Lynch, 2003; Darnton-Hill et al., 2004; WHO, 2018), gender (Marmot et al., 2012), and education: In most countries, girls, women, older adults, lower socioeconomic groups and those with low levels of education have fewer opportunities to access safe, affordable and appropriate programs and places in which to be physically active (Ross and Wu, 1995; Kawachi, 1999; Kino et al., 2018; Clemente and Pereiro, 2020; Raghupathi and Raghupathi, 2020). Thus, adults with higher educational levels tend to be healthier compared to their less educated peers (Evans et al., 1994; WHO, 2014; de Breij et al., 2020).

This paper sheds light on the nature and strength of the correlation between education and obesity by empirically analyzing the relationship between lifestyle behaviors related to physical activity and diet and one's education and health capital (physical health, mental health, self-sufficiency, and perceived health), using SHARELIFE data and incorporating a gender perspective. More specifically, the aim is to illustrate whether and how the self-perceived heath status of older adults (the group hit hardest by COVID-19) varies according to BMI and whether it responds to changes in lifestyle behaviors, as well as how these relationships vary according to education level and gender.

6. Data and methodology

This research uses data from the first[b] (SHARE) and third (SHARELIFE) waves of the Survey of Health, Ageing and Retirement in Europe. The first wave interviewed more than 30,000 respondents aged 50 or older across eleven European countries (Austria, Belgium, Denmark, France, Germany, Greece, Italy, Netherlands, Spain, Sweden, Switzerland; Börsch-Supan et al., 2005; Börsch-Supan and Jürges, 2005). The third[c] collected life histories (marital history, accommodation, childhood circumstances, financial assets, work history, and health and health care) of men and women aged 50 and over (Börsch-Supan et al., 2011; Börsch-Supan et al., 2013).

SHARE data was linked to SHARELIFE data to include variables regarding changes in behavioral patterns that were collected only once (Börsch-Supan and Jürges, 2005; Börsch-Supan et al., 2008; Schröder, 2011).[d] The final sample (n=16,546) includes only individuals who declared their general health status (ordinal dependent variable).

Ordinal logistic regression models were used to analyze the roles played by the main variables of interest (gender, educational attainment, BMI, and changes in lifestyle behaviors, namely improved diet and increased physical activity) and control variables (well-known determinants of subjective health status: individual characteristics, current health, and habits).

The estimates computed are the odds ratios for all independent variables included in model specifications and interaction terms, with robust standard errors. Model goodness of fit was assessed using the pseudo-R^2 and log pseudolikelihood. Model estimations respect the proportional odds assumption of ordinal logistic regression (Brand tests were performed).

Four estimations are presented in Table 3: the first two including changed diet and the last two including physical activity as the behavioral change. The first and third estimations (Model 1 and Model 3) test the relationship between self-declared health status, the main variables of interest, and other health determinants (controls), plus an interaction term to identify how the effects on an individual's self-declared health status differ across levels of education and BMI. The second and fourth estimations (Models 2 and 4) test whether the relationship between self-declared health status and having made lifestyle changes (improved diet or increased physical activity) depends on gender and level of education.

[b] The main questionnaire collects information on 20 modules related to the health, socioeconomic status, and social networks of all respondents.

[c] The third wave was carried out between 2008 and 2009. SHARELIFE collected the life histories of individuals aged 50 and over living in the countries of the baseline study plus two transition countries (Czech Republic and Poland). The questionnaire includes retrospective information on several spheres of respondents' lives: marital history, accommodation, childhood circumstances, financial assets, work history, and health and health care.

[d] Table 1 presents variables included in multivariate analyses.

Table 1. Information regarding dependent and independent variables used in the empirical analyses

Variable	Definition and source
Dependent	
Self-declared health status	Scale of 1 to 5, from poor (1) to excellent (5). SHARELIFE Wave 3.
Independent	
Main variables of interest	
Gender	Dummy. Coded 1 if respondent is female and 0 if male. SHARE Wave 1.
Educational attainment	Categorical. Its coding follows ISCED1997. Coded 1 if respondents' level of education is primary or less, 2 if they achieved lower secondary education, 3 for upper secondary education and 4 for having completed tertiary education. SHARE Wave 1.
BMI	Quantitative. Body Mass Index. SHARE Wave 1.
Change in diet	Dummy. Coded 1 if respondents have changed their diet during their life course and 0 otherwise. SHARELIFE Wave3.
Increased physical activity	Dummy. Coded 1 if respondents have increased their diet levels of physical activity during their life courses and 0 otherwise. SHARELIFE Wave 3.
Controls	
Age	Age at 2009. SHARE Wave 1.
Household income	Quantitative. Net household income. SHARELIFE Wave 3.
Marital status	Categorical. Coded 1 if respondent is living with a the partner, 2 if they were never married, 3 if they are separated or divorced, and 4 if they are widowed. SHARE Wave 1.
Household size	Quantitative. Number of persons living in the household. SHARELIFE Wave 3.
Ethnicity	Dummy. Coded 1 for respondents born in the country of interview and 0 otherwise. SHARE Wave 1.
Social activities	Scale of 1 to 6. Cumulative indicator of the number of activities (from at least one to all) in which the respondent has been recently involved (voluntary/charity work, provided help, completed a course, sport/social/club, religious organization, political org.). SHARE Wave 1.
Limited in usual activities	Dummy. Coded 1 if individuals have long-term limitations in usual activities due to a health problem, 0 otherwise. SHARE Wave 1.
2+ chronic illness	Dummy. Coded 1 if respondents suffer from two or more chronic illness, 0 otherwise. SHARE Wave 1.
Currently smoking	Dummy. Coded 1 if the respondent is currently a smoker and 0 otherwise. SHARE Wave 1.

Table 2 shows descriptive statistics for the variables included in the empirical analyses. The mean value of the dependent self-declared health status variable is 2.8; almost 38% of respondents report being in fair health. The mean age of the sample is 69 years old and 55.6% are women. The variables regarding socioeconomic status (educational attainment and income) indicate that 18.6% of respondents achieved tertiary education, and the mean net annual household income is near 30,000 euro. Regarding the current health and habits of people in the sample, around 40% are limited in their daily activities and have two or more chronic illnesses. Almost 20% were smokers at the time of

the survey, and the mean BMI is 25.9 (which is considered overweight).[e] Around 13% of respondents have increased their level of physical activity and changed their diet (to a healthier one) at least once in their life.

Table 2. Descriptive statistics of dependent and independent variables included in the empirical analyses

Variable	Mean or %	Std. Dev.
Dependent variable		
Self-declared health status	2.8	1.0
Independent variables of interest		
Female	55.6	
Educational attainment		
Primary or less	34.4	
Lower secondary	17.5	
Upper secondary	29.5	
Tertiary education	18.6	
BMI	25.9	5.6
Increased physical activity	13.5	
Changed diet	13.2	
Controls		
Age at 2009	68.9	10.6
Household net income	30,806.2	35,276.7
Marital status		
Living with partner	72.9	
Never married	5.3	
Separated/divorced	7.2	
Widowed	14.6	
Household size	2.2	1.0
Born abroad	11.9	1.295
Social activities	1.3	1.6
Limited in usual activities	41.1	
2+ chronic illness	41.0	
Currently smoking	19.3	
N	***16,546***	

Source: Own elaboration, SHARE (Waves 1 & 3)

[e] BMI classification ranges are underweight (under 18.5 kg/m^2), normal weight (18.5 to 24.9 kg/m^2), overweight (25 to 29.9 kg/m^2), and obese (30 kg/m^2 or more).

7. Results: linking self-perceived health to education, obesity, and lifestyle behaviors

This section is dedicated to empirically illustrating the reliability of education, obesity, and lifestyle behaviors as important determinants of self-declared health among adults over 50 years of age. Table 3 presents 4 model specifications: two for each behavioral change included (changed diet: Model 1 and Model 2; increased physical activity: Model 3 and Model 4).

For all model specifications, the relationship between self-perceived health status and BMI is highly significant and negative; thus, adults over 50 who are overweight tend to declare a poorer health status than those of normal weight. Another important determinant of self-reported health is the level of education achieved. In fact, the odds of declaring a better level of health increase as the level of education increases. As is widely acknowledged in the literature on the subject, among older adults the share of overweight and obese individuals is also negatively related to education level—that is, the share diminishes as the level of education increases (Shaw and Spokane, 2008; Chung et al., 2016; Gopinath et al., 2018; Jääskeläinen et al., 2022). In this sense, it is interesting to note the moderating effect that BMI has on the relationship between self-perceived health status and education. Interaction terms (Models 1 and 3) show that this negative association gets stronger for individuals over 50 as their BMI increases. Thus, the odds of reporting a very good health status are lower for adults with lower educational levels but reaches even lower values if they are overweight or obese.

The effect of adopting a healthier diet on one's health status varies according to gender and level of education (Model 2). A diet change has a stronger impact on the self-perceived health status of men compared to women, and on those with higher levels of education. Moreover, among adults who have changed their diet, the level of self-declared health is significantly lower if they are overweight or obese with respect to those considered to be of a normal weight.

Models 3 and 4 in Table 3 examine changes in behavior in terms of increasing one's level of physical activity (PA). There is a positive relationship between having increased one's levels of physical activity and self-perceived health status. Adults who increased their level of physical activity declared having a better health status than those who did not engage in such a lifestyle change.

Considering differences according to the level of education achieved, it is found that the probability of reporting a very good health status increases with the educational level achieved, which is in line with previous research. Average marginal effects from ordinal regression models indicate that adults with tertiary education are almost 7% more likely to report a very good health status than those with primary education or less.

Again, the probability of declaring a positive health status varies significantly according to BMI, decreasing as BMI increases. Overweight and obese adults are less likely than those of normal weight to report a very good health status.

Table 3. Results from ordinal regression models regarding self-declared health status and changes in lifestyle behaviors

	Changed diet		**Increased PA**	
	M1	**M2**	**3**	**4**
Variables of interest				
Female	0.912***	0.884***	0.903***	0.911***
Lower secondary	2.296***	1.327***	2.315***	1.304***

Upper secondary	2.696***	1.348***	2.648***	1.377***
Tertiary education	4.431***	1.829***	4.248***	1.866***
BMI	0.989***	0.976***	0.988***	0.975***
Changed diet	0.812***	0.632***	-	-
Increased physical activity	-	-	1.185***	1.132*
Control variables				
Age at 2009	0.970***	0.969***	0.971***	0.971***
Household income (net)	1.000***	1.000***	1.000***	1.000***
Never married	0.762***	0.752***	0.772***	0.768***
Separated/divorced	0.917	0.912	0.907	0.904*
Widowed	0.896**	0.888**	0.900**	0.894**
Household size	0.931***	0.928***	0.938***	0.936***
Born abroad	0.782***	0.781***	0.786***	0.784***
Social activities	1.129***	1.129***	1.122***	1.122***
Limited in usual activities	0.294***	0.294***	0.291***	0.291***
2+ chronic diseases	0.467***	0.465***	0.461***	0.459***
Currently smoking	0.763***	0.764***	0.781***	0.783***
Interactions				
*Education*BMI*				
Lower secondary*BMI	0.980**	-	0.461***	-
Upper secondary*BMI	0.977***	-	0.781***	-
Tertiary education*BMI	0.969***	-	0.945***	-
*Gender*Changed diet/increased PA*				
Female*Changed diet/increased PA		1.173**		1.072
*Education*Changed diet/increased PA*				
Lower secondary*Changed diet/increased PA		1.042		1.072
Upper secondary*Changed diet/increased PA		1.345***		1.110
Tertiary education*Changed diet/increased PA		1.265**		1.001
Observations	*16,546*	*16,546*	*16,559*	*16,559*
Pseudo-R^2	*0.103*	*0.103*	*0.103*	*0.102*
Log likelihood	*-21,653*	*-21,654*	*-21,659*	*-21,669*

*** p<0.01, ** p<0.05, * p<0.1

Results also confirm the role played by determinants already identified by the specialized literature on the subject. Females and foreigners display lower levels of health compared to males (as in Hosseinpoor et al., 2012; Boerma et al., 2016) and natives (similar to Moullan and Jusot, 2014; Sand and Gruber, 2018). The importance of socioeconomic and cultural status as major health determinants is supported by the positive

link observed between household income and self-perceived health status and relationships as cultural capital (marriage and cohabitation). The protective effects of living with a partner has also been identified here (in line with Brockmann and Klein, 2004; Huijts and Kraaykamp, 2011). In addition, older adults who never married report a poorer health status than those living with partners and being involved in a higher number of social activities increases the odds of reporting a better state of health (Adams et al., 2011; Santini et al., 2020).

Concluding remarks

Health inequalities are linked to the general conditions of both the population and the welfare systems (The Marmot Review Team, 2010). Human biology is certainly important for health, but an extensive review of studies and epidemiological evidence reveals that several factors influence health—so-called health determinants—and that that individual behaviors and social, cultural, economic, and environmental conditions have a strong impact on health.

The WHO has been raising the alarm for at least two decades, talking about globesity and an obesogenic society, that is, a society that promotes a diet that is too high in calories and fat and a very sedentary lifestyle. The influence of "social and environmental" factors can certainly be argued to be at play, both in terms of the speed with which the obesity epidemic has expanded since the beginning of the millennium and changes in diet and lifestyle (in the sense of physical activity): These are factors that are not completely under the control of individuals and are largely conditioned by the social, economic, and cultural context in which they live.

Using SHARE data, this study provides evidence regarding the relationship between lifestyle behaviors related to physical activity and diet, education, and health capital (physical health, mental health, self-sufficiency, and perceived health), also incorporating a gender perspective. The results confirm that one's level of education is indeed a predictor of health-related lifestyle factors (Kawachi, 1999; Kino et al., 2018; Clemente and García-Pereiro, 2020; Raghupathi and Raghupathi, 2020) and that a substantial educational gradient characterizes the relationship between BMI, switching to a healthier diet, and feeling healthier. The positive effect of education on health behaviors is greater for respondents who have achieved higher levels of education, and in particular men, which aligns with the results of previous studies. Individuals with a higher educational level may tend to have greater knowledge of the benefits of a healthy diet and exercise and/or a greater ability to obtain, process, interpret, and apply nutritional and medical information more generally. Therefore, education must be understood as a key determinant in the construction of people's lifestyles or habits, with gender also playing a role.

Given the overall health impact of these risk factors of food and physical activities, promoting healthier diets and more exercise is of paramount importance, including from a health equity perspective. As education repeatedly reveals itself to be an important social determinant of health, the implementation of education improvement programs will also help improve people's health and promote health equity, particularly if they are implemented taking into account the gender gap in health outcomes. This is made even more evident and has become more urgent in light of the impacts of the COVID-19 pandemic.

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Received 11 August 2022, accepted 14 December 2022