Obesity in an increasingly urban environment

The influence of socio-economic status on obesity in France and Hungary

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Abstract

Over the last decades, the world has been going through a change in nutritional patterns, defined as the nutrition transition. Throughout this transition, dietary habits and physical activity patterns have been changing, leading to an increasing number of people being overweight or obese. Obesity has developed into a global health crisis and can be called an epidemic. The nutrition transition is influenced by, among other things, socio-economic status and is taking place in an increasingly urban environment. The obesity epidemic reached Western Europe first, and later Eastern Europe, but numbers are now similar. This raises the question how socio-economic status is associated with obesity in these two parts of Europe. Linear and logistic regressions are performed to answer this question for France and Hungary, using European Social Survey data, focusing on Social Inequalities of Health, with BMI and obesity as dependent variables. It can be concluded that obesity is a complex disease that is influenced by many different factors. The regression results show the influence of socio-economic status on BMI or obesity is different in France and Hungary. In France, a high socio-economic status is associated with a lower likelihood of being obese. In Hungary, there are hints of this same association, but it cannot be concluded based on this study.

Keywords: Obesity | Nutrition transition | Socio-economic status | Urbanization | BMI

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List of abbreviations

BMI	Body Mass Index
CAD	Coronary Artery Disease
ESS	European Social Survey
ISCED	International Standard Classification of Education
OECD	Organization for Economic Co-operation and Development
SES	Socio-economic status
WHO	World Health Organization
WHR	Waist-hip ratio

1. Introduction

Over the last decades, the world has been going through a change in nutritional patterns, defined as the nutrition transition. Throughout this transition, dietary habits and physical activity patterns have been changing. The world has experienced several nutrition transitions and each of them is characterized by different economic, demographic and food processing patterns (Popkin, 1993). The recent changes in nutrition are associated with globalization (Belahsen, 2014) and lifestyle changes in an increasingly urban environment. The result of these changes is an increase in consumed fats and sugars, and together with a more sedentary lifestyle this increases the chances of someone becoming overweight or obese (Shetty, 2013). Over time, obesity has developed into one of the largest health challenges in the world (Haidar & Cosman, 2011). According to the World Health Organization (WHO) (2020), obesity has tripled since 1975. In 2016 there were 1.9 billion adults overweight, of which 650 million were obese. The problem is not limited to adults, in 2018 there also were 40 million children overweight or obese.

Being overweight or obese damages both the individual and society. For a society, overweight and obesity are accompanied by high medical costs (Schenker, 2003). To illustrate, in the United States the medical costs associated with obesity account for 20% of the health care spending (Spieker & Pyzocha, 2016). On the individual level, overweight and obesity have a negative impact on one's health (Shetty, 2013) and it lowers one's quality of life (Patel, 1983). Obesity itself is a disease, and at the same time it is associated with several other diseases and conditions (Via & Mechanick, 2014). Having a high body mass index (BMI) increases the chances of type 2 diabetes, hypertension, cancers, coronary artery disease (CAD) and strokes (Kopelman, 2007; Caballero, 2007). The changes seen in disease patterns are described by the epidemiological transition, which concerns changes in causes of death over time. The emergence of obesity fits in the age of degenerative and man-made diseases (McKeown, 2009).

The United States has been the leading country when it comes to the proportion of overweight and obese people in a population (Morrill & Chinn, 2004), but these diseases have been spreading around the globe and can now be found in every country. The European countries have not been able to stay away from this development, with an estimate of nearly 52% of adults being overweight or obese in 2014 (Eurostat, 2014). These numbers illustrate obesity is not only a medical problem but also one of public health (Rabin et al., 2007). The obesity epidemic has reached Eastern Europe later than it reached Western Europe (Webber et al., 2012), this difference is part of the 'East-West Health Gap' (Nédó & Paulik, 2012). Nowadays, the prevalence of obesity is similar in these regions (WHO, 2017). Dietary changes are related to economic growth (Drewnowski & Popkin, 1997) and the nutrition transition is associated with both globalization (Belahsen, 2014) and modernization (Fox et al., 2019). This shows obesity is not only related to diet and physical activity, but that there are more factors to consider. Important factors include culture, socio-economic status, policy, politics and chemicals (Via & Mechanick, 2014). One of these, socio-economic status (SES), is related to health outcomes in several ways. Mortality and morbidity rates present socio-economic status differences in which people with a higher SES are healthier in general. SES includes income, education, and work status, which often interrelate (Adler et al., 1994). SES differences are also present in obesity numbers, the association between these two shows the same direction as SES and health; a lower SES is associated with higher obesity numbers (Everson et al., 2002).

Obesity and the obesity epidemic have both been studied frequently, and much has been written about both topics. The United States has been the focus point of many, but since obesity can now be found all around the world, obesity in Europe has increasingly been the focus of several studies. Obesity in Europe has been researched from different points of view, one of them being the difference between Eastern and Western Europe. Even though the topic has been studied by many, this thesis contributes to the literature by focusing on only two countries, both in a different part of Europe and both demonstrating high obesity numbers. To my knowledge, no other studies have focused on these two specific countries with including the factors that are included in this thesis. Besides this academical contribution, this study also makes a societal contribution. Battling the public health problem that obesity is, is important for both individuals and society; to increase one's health and life satisfaction, and to alleviate the society from the high medical costs that obesity provokes. This study contributes to this by uncovering which factors are related to obesity, which can help to manage policies better.

Taking all this into consideration, leads to the question how socio-economic status is associated with obesity in Eastern and Western Europe. To study this association, the relationship between SES and obesity is explored for France and Hungary, which belong to either Western or Eastern Europe. Obesity numbers are similar in these two countries; 26,4% in Hungary and 21,6% in France in 2016 (WHO, 2017). Both countries classify as high-income countries, with gross national income per capita being 2.8 times higher in France than in Hungary (The World Bank, n.d.). Taking all this into consideration leads to the following research question: how are socio-economic status indicators associated with obesity in France and Hungary? To answer this question, several sub questions are formulated:

1. Which socio-economic status indicators influence obesity?
2. How do socio-economic status indicators influence obesity?
3. How does obesity differ in France and Hungary in rural and urban areas?
4. How do socio-economic status indicators and their relationship with obesity differ for France and Hungary?

This thesis is structured as follows. First, in the theoretical framework the nutrition transition is further explained, followed by a literature review focusing on obesity and its association with different socio-economic status factors, concluded by several hypotheses. Next, the method section describes the data and methods used. This is followed by the results, conclusion, discussion and recommendations.

2. Theoretical Framework

2.1 Nutrition transition

The nutrition transition describes changes in dietary patterns, which are connected to several other factors, including social, demographic and health factors. Modern societies have been shifting towards what is known as the Western diet, consisting of more fats, sugar, refined foods, and fewer fibres than people used to eat. The world has known five different nutrition patterns, which have changed throughout history. All these different patterns are characterized by their own specific economic, demographic, and food processing patterns (Popkin, 1993). Not only are different times characterized by different nutrition patterns, there are also differences between different socio-economic classes and their nutrition patterns (Ameye & Swinnen, 2019). Nutrition patterns have thus changed several times, but the change has accelerated during the last centuries, with different speed throughout the world. The change can be explained by changes in several domains, which are income, level of education, urban-rural residence, and lower costs of energy dense foods (Popkin, 2001). The last three nutrition transitions are shown in figure 1.

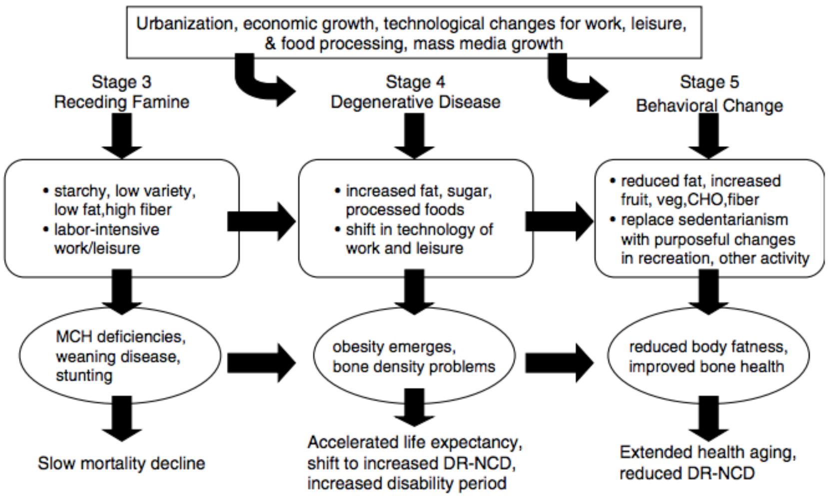

Figure 1. Stage 3, 4 and 5 of the nutrition transition (Popkin & Gordon-Larsen, 2004)

The recent changes in dietary patterns have been attributed to economic growth and are regarded as a by-product thereof. The Western diet was tied to high income levels for a long time, but this dependence has decreased, and poorer countries now also have access to foods characterizing this diet, consisting of food high in fat and sugar. Industrialized countries now spend money to reverse this transition, while industrializing countries spend money for their traditional meals to be replaced by food with more calories and fats (Drewnowski & Popkin, 1997).

The factors that Popkin (2001) names as explanations for dietary changes together constitute a big part of one's socio-economic status. First, income is a very influential factor influencing diet, and therefore body weight. The type of relationship between income and obesity differs per country, but in high income countries that experience a more advanced nutrition transition, the relationship seems negative. Second, education shows the same relationship, in countries where the nutrition transition is more advanced, the higher educated demonstrate lower obesity numbers. Last, urban residents have very different dietary and physical activity patterns than rural residents. The different components of socio-economic status affect biological factors, these biological factors at their turn determine body weight (Popkin et al., 1995).

The nutrition transition is closely related to the epidemiological and demographic transitions. The epidemiological transition concerns change in causes of death over time. The main message of the model is that infectious diseases are replaced by degenerative and man-made diseases. This replacement is due to improved living conditions and medical improvement, which resulted in lower infant mortality and higher life expectancy (Popkin, 1993). The result of the transition is an increase of chronic, degenerative diseases that develop in an ageing population, this includes cardiovascular disease, stroke and cancers (Agyei-Mensah & Aikins, 2010). The demographic transition describes changes in mortality and fertility patterns over time (Popkin, 1993).

Furthermore, important concepts related to the nutrition transition are globalization and modernization, as will be explained in the following paragraphs.

2.2 Globalization

The nutrition transition is associated with globalization (Belahsen, 2014). Globalization is a broad concept that covers many different domains, including, but not limited to, economic integration, knowledge transmission and policies crossing borders (Al-Rodhan & Stoudmann, 2006). The main element of globalization concerns increasing connectivity or connectedness (Robertson & White, 2007). This connectedness increases the dependence around the world (Fox et al., 2019).

Globalization affects lifestyles by the movement of, among other things, technology and goods. These effects are linked with changes in diet and activity patterns. These changes are explained by different components of globalization, including global food production, marketing and the distribution sector (Popkin, 2006). Changes in the global food system result in cultural globalization or Westernization, which concerns the spread of Western lifestyles (Fox et al., 2019). Lower-income countries can now consume the same type of foods that are consumed in high-income countries for many years already (Popkin, 2006). These types of food are replacing traditional meals (Fox et al., 2019). The food supply is changed by globalization in terms of quantity, type, cost and demand for food (Hawkes, 2007). The global distribution sector can transport all products, including obesogenic products, available throughout the world. As a result, a wide variety of different types of food can now be found in many different places (Fox et al., 2019). To illustrate, the fast food sector and soft drink industry, originating from the United States, have spread throughout the world. Products of soft drink company Coca-Cola are sold in more than 200 countries (Popkin, 2006), leading to the emergence of the term 'Coca-Colonization' (Hawkes, 2007). Globalization has led to the spread of modern mass media, which affects physical activity behaviour but also increased marketing of food. Besides commercials directly promoting certain types of food, mass media often projects Western lifestyles, which at their turn influence people (Popkin, 2006).

2.3 Modernization

Globalization in relation to increasing weight describes influences external to a country, looking at internal influences on weight gain can add more insight to this phenomenon. The process of modernization includes changes in nutrition and health improvements, next to changes in economic, social, cultural and political domains. Without exposure to Western lifestyles, increasingly rich middle classes may ask for a change in nutrition, including unhealthy food. Besides health improvements, modernization also leads to an increase of unhealthy lifestyles, caused by several factors. These factors include increasing income, women's empowerment and democratization. In addition, modernization promotes industrialization and urbanization, which both influence body weight and thus BMI (Fox et al., 2019). Industrialization is a process that transforms the economy of a country where physical labor gets replaced by other sources of energy and where international trade increases (Szreter, 2004). The industrialization of food means that the production of food products in factories increases. The Western diet consists mainly of products produced in factories (Kramer, 2017). Food industrialization is one way how industrialization affects health, industrialization also impacts health in another way, which is by the development of dense settlements in a trading network (Szreter, 2004). Urbanization influences body weight due to a different nutrition pattern seen in an urban environment, including food with more fats, but it also influences the amount of physical activity in someone's daily life (Fox et al., 2019).

3. Literature review

3.1 Defining obesity

The World Health Organization (WHO) defines obesity as “abnormal or excessive fat accumulation that presents a risk to health”. A much-used measure of obesity, or nutrition status in general, is body mass index. This is a number that is measured using height (meter) and weight (kilogram) in the following way: BMI = weight / height^2. BMI values can be divided in different nutritional statuses, seen in table 1. The cut-off points as seen in table 1 can be used for adults, when it comes to children it is necessary to also include age (WHO, 2020).

Table 1. Nutritional status (WHO, 2020)

BMI	Nutritional status
< 18.5	Underweight
18.5 – 24.9	Normal weight
25.0 – 29.9	Pre-obesity
30.0 – 34.9	Obesity class I
35.0 – 39.9	Obesity class II
40 >	Obesity class III

While BMI is widely used to define overweight or obesity, there are also other measures that can be used. First, weight-for-height, which is often used in children below the age of two (Roy et al., 2016). Second, waist-hip ratio (WHR), which identifies what is called centralized obesity. For men, a ratio above .90 is classified as obese, for women this is .85. Having a high WHR comes with a high risk of obesity related complications (Srivastava et al., 2016). A third measure is waist circumference, and body fat percentage is the last measure (Ghesmaty Sangachin et al., 2018). These last three methods inform about body fat distribution, while BMI does not (Cawley & Burkhauser, 2006).

Body fat percentage can be measured in different ways, it can be done relatively easy by using skinfold thickness or using bioelectrical impedance (Ghesmaty Sangachin et al., 2018).

Using BMI to determine nutritional status has advantages and disadvantages. Its biggest advantage is that it is very easy to use, because only height and weight are needed. Using BMI also has disadvantages. First, it does not provide information about body composition because BMI does not include information about which body parts contain too much fat (Nuttall, 2015) since the calculation does not take muscle mass into account (Cawley & Burkhauser, 2006). Several studies (Mullie et al., 2008; Deurenberg et al., 2001, cited by Ghesmaty Sangachin et al., 2018) have shown that the nutrition status classification of BMI does not always hold when measuring body fat. Second, the cut off points used for different nutritional statuses are not straightforward all round the world, but rather that there are differences according to ethnicity (Deurenberg-Yap & Deurenberg, 2003). Nevertheless, due to the ease of using BMI, and the availability of height and weight to calculate BMI, it is still widely used to determine nutritional status.

3.2 History of obesity

Populations around the world have been struggling scarcity for a long time. In prehistoric societies, pestilence and famine threatened populations. Stored body fat functioned as a reserve during these times (Bellisari, 2008). Those who could store the most energy from the small amount of food available were the ones who stayed alive (Eknoyan, 2006). Malnutrition as the norm has persisted during many centuries (Eknoyan, 2006), while at the same time populations dealt with poverty and communicable diseases. These problems were seen as obstacles for economic growth, and needed to be solved (Caballero, 2007). Due to the second agricultural revolution, food supply increased in the 18th century. People grew in height and weight and stayed alive longer, which promoted economic growth (Eknoyan, 2006). Sugar and fat were added to food, to improve the health of the working class (Caballero, 2007). As a result, the prevalence of obesity increased and in the first part of the 20th century, life insurance companies were concerned about body weight. Nowadays, there are more people overweight or obese than there are people undernourished (Caballero, 2007), and obesity has been identified as an epidemic in developed countries (Popkin & Doak, 2009).

Being overweight or obese was not seen as a problem until the ancient Greeks identified an association with disease, they believed obesity led to infertility and early death. To deal with (excess) food intake and health, the ancient Egyptians choose vomiting or fasting, Pythagoras focused on moderation, and Iccus added physical exercise to this (Haslam, 2007). Despite awareness about the relation between obesity and disease, carrying extra weight was considered healthy and seen as a useful reserve when one would get sick. This changed in the first half of the 20th century when excess fat was considered as a health problem (Eknoyan, 2006). Throughout the years, knowledge about obesity and health increased and this topic was given more attention in medical literature (Haslam, 2007)

An increase in body weight of individuals is often caused by an energy imbalance, where more energy goes in than out. Energy intake consists of food and drinks, as mentioned before, sugar and fat in food have increased (Caballero, 2007). People are consuming more energy dense food than before, which is a trend that goes together with a demographic transition and a nutrition transition. The nutrition transition is a result of economic growth. Economic growth leads to higher income, population become more urban and the diets change. The increase in income results in an increase of average calories consumed (Drewnowski, 2000).

3.3 Obesity and disease

Obesity is considered to be an important contributor to the global burden of disease (Visscher & Seidell, 2001). Not only is obesity itself a disease, several other diseases are associated with being obese: type 2 diabetes, hypertension, cancers, coronary artery disease (CAD) and strokes, are only a few to mention (Kopelman, 2007; Caballero, 2007). In addition, the weight that obese people carry with them has an impact on their body movements. People experience osteoarthritic and pain, most common in the knee, hip and spine, which hinders their range of motion. Obesity is associated with reduced muscle strength, known as sarcopenic obesity, which contributes to an increased risk of disability (Capodaglio et al., 2010). The diseases obesity is associated with are diseases very common in modern society. According to Jung (1997) the relationship between BMI and mortality follows a J shaped curve, where the mortality risk increases very rapidly above BMI values of 30, which is the cut-off point for obesity. Obesity is not only associated with diseases, but also with death. The risk of death increases with more weight, death can then be an indirect result of obesity via several diseases, but death can also be attributed directly to obesity (Jung, 1997).

The cumulative disadvantage theory describes how early (dis)advantage is an important contributor to how people age. Health and health resources early in life are important for health later in life. The health consequences of obesity often take time to develop, which can last up to 50 years. Long-term obesity is related to disability, even when people lose weight and become non-obese, the health problems due to obesity did not disappear (Ferraro & Kelley-Moore, 2003). There are two chains of risk associated with obesity, a chain of risk describes adversity early in life leads to negative outcomes later in life (Ferraro et al., 2003). Concerning obesity, the first chain of risk focuses on obesity during early life, the second chain of risk focuses on BMI variation in adult life. The risk of staying obese in life is greatest for obese adolescence, and not so much for younger children being obese. For obese adults, the chance they stay obese is greater than the chance they lose weight (Ferraro et al., 2003). Another consequence of obesity is premature death, the greatest mortality risks associated with obesity are cardiovascular disease and cancers (Abdelaal et al., 2017). Years lost due to obesity can be as much as 7 years for women and 6 years for men (Peeters et al., 2003).

3.4 Obesity and urbanization

The prevalence of obesity is different in different regions in a country, these differences vary between developed and developing countries. Within a country, obesity can often be found more in lower socio-economic status areas, or areas with undesired environmental conditions. In Western countries, rural areas show a higher obesity prevalence (Peytremann-Bridevaux et al., 2007). Studies exploring overweight or obesity prevalence in Western countries show different patterns. Peytremann-Bridevaux et al. (2007) found no difference between urban and rural areas in their study focused on 10 different European countries, in their study they exclusively looked at citizens aged 50-79. Morland et al. (2006) found obesity and overweight prevalence to be lower in areas where supermarkets are present, while the presence of convenience stores is associated with higher overweight and obesity numbers. Supermarkets are present more in wealthier areas (Drewnowski et al., 2012) and they offer more healthy foods. The availability of supermarkets is associated with healthier diets (Morland et al., 2006). Popkin (2001) states that the diets of urban and rural residents are very different from each other. Urban residents eat more grains, food with more fat, more animal products, more sugar and more processed or food prepared outside of the house. These differences are more pronounced in developing countries, because there is a more developed food distribution and market system in developed countries, making these "urban" foods available in rural areas too. Still, there are differences between urban and rural regions in developed countries as well, mostly due to eating away from home and influences of mass media and how people respond to this. Transportation and marketing are more developed in urban areas. This results in a wide variety of food available throughout the whole year, and more marketing activities in the processed food sector. In addition, urban residents often have lifestyles and jobs that cause time to prepare food themselves to be limited (Popkin, 2001). Kushi (2006) also stresses the importance of the environment on both physical activity and food availability. In some areas, mostly in the United States, there is little room for walking and biking, and cars are the main mode of transportation. Restaurants or fast food chains offer larger portion sizes than people eat at home, and more food is consumed in these places. Urban residents eat away from home more often than rural residents do (Popkin, 2001). Environments that offer many high caloric foods, such as fast food, can trigger people into eating this. People are triggered by food cues, which are a result of advertisement and availability of unhealthy foods. These areas have been identified as obesogenic food environments, which are associated with increased food consumption and weight gain (Hallam et al., 2016).

Joleka et al. (2009) performed a study in Finland, to determine whether obesity different between urban and rural regions were due to social selection or social causation. Their study found that both these mechanisms were relevant, which meant that people in rural areas were heavier and heavier people moved towards rural areas. Airaksinen et al. (2016) found evidence for social causation in their study on the effect of neighbourhoods on health behaviours. Their study showed people in urban areas were more likely to smoke and to drink alcohol, no difference was found in rural and urban areas concerning physical exercise.

3.5 Socio-economic status and obesity

One's socio-economic status influences one's health, differences in SES are present in mortality and morbidity rates. Socio-economic status includes income, obesity, work status, and the area people live in (Adler et al., 1994). Just as health status, obesity numbers also show differences with socio-economic status (Everson et al., 2002). The relationship between obesity and the different components of socio-economic status is discussed next.

3.5.1 Obesity and income

The relationship between obesity and income is not straightforward. There are studies that report a positive relationship (Su et al., 2011; Ameye & Swinnen, 2019), where other studies have reported a negative relationship (Nikolaou & Nikolaou, 2008; Ameye & Swinnen, 2019). The direction of this relationship seems to depend on context, and it changes throughout the nutrition transition. In low-income countries, the relation between obesity and income is positive. More money gives people the opportunity to buy more and different types of food (Ameye & Swinnen, 2019). Agricultural innovations have lowered the price of food, which resulted in an increase of food supply. This contributes to the increase in bodyweight (García Villar & Quintana-Domeque, 2009). A shift can be seen toward Western diets, and at the same time, people move less. In developing countries, being bigger is often associated with a better economic position and is thus perceived as positive and as a sign of wealth (Ameye & Swinnen, 2019).

Where in developing countries, the richest are the most obese, in developed countries it are the least well-off in society that show the highest obesity numbers. The relationship between income and obesity changes from being positive to being negative with increasing income (Ameye & Swinnen, 2019). Several explanations have been raised for the differences between countries. First, the attitude towards obesity in high income countries is different than in low income countries, due to different cultural and social preferences (Ameye & Swinnen, 2019). In high income countries, obese or overweight people are often stigmatized (Klos & Sobal, 2013). Second, supermarkets offer a variety of food in high income countries, giving people the opportunity to buy more diverse healthy food options. Nédó and Paulik (2012) state that those with a lower SES follow a less healthy diet, and they eat monotonous diets with little variation. Those with a higher SES show a higher intake of fruits and vegetables. Third, in high income countries there are more opportunities to manage bodyweight, due to a better educational and health care system, compared to low income countries (Ameye & Swinnen, 2019).

In addition to differences between countries, there are also differences within countries. In high income countries, obesity is more prevalent in the lower class. Which is a result of the high economic classes being more aware of their health and having more resources to deal with this, in terms of time and money. Important to consider are food deserts, which relates to the supply of and access to healthy food. The lower classes often live in food deserts, where healthy food is not available to them (Ameye & Swinnen, 2019).

When looking at differences within a country it is necessary to take income inequality into account. This claim is supported by Wilkinson (1997) who writes about the importance of relative instead of absolute standards when looking at mortality in developed countries. His claim is supported by three points:

- Relative income within countries is related more to mortality than differences in absolute income;
- In countries with smaller income differences the mortality rates are lowest;
- The long-term increase in life expectancy is unrelated to long term economic growth rates.

Health is a topic very sensitive to socioeconomic situations. When differences between people grow bigger, health becomes worse (Wilkinson, 1997). Su et al. (2012) have studied the effect of income inequality on obesity prevalence in OECD countries. They identify a pattern where income inequality leads to higher increases of obesity prevalence, but this only holds in extreme cases with high obesity prevalence and high-income inequality. Nikolaou and Nikolaou (2008) studied income related inequality and obesity in the European Union. They found that lower social classes are most affected by income inequality, which is especially true for women and for the middle aged.

3.5.2 Obesity and education

Education is associated with health behaviour; the higher educated are less likely to smoke, drink a lot, or weigh too much, while they are more likely to be more physically active and make more use of the healthcare system (Devaux et al., 2011). The relationship between obesity and education is negative. Individuals who are more educated, are slimmer than those with a lower educational level. There are several explanations for this relationship. First, education comes with skills, these work in direct and indirect ways (Atella & Kopinska, 2014). People have better access to information and are more able to handle this (Devaux et al., 2011). They have a sense of control over their life and have the ability to solve problems. Second, people are aware of the risks involved when making lifestyle choices, they understand the consequences of their behaviour. This concerns food and drinks, as well as physical activity. Third, people are able to develop meaningful relationships, giving them the opportunity to become successful which benefits one's health. Those with more social support invest more in their health (Atella & Kopinska, 2014).

Just as with income, it is not only the absolute level of education that is important but also the level of education compared to that of others. If the difference in level of education is bigger, the lower the risk of becoming obese is for the higher educated. This is due to different levels of perceived stress, coping mechanisms and the ability to maintain a healthy weight (Devaux et al., 2011). The importance of relative level of education is also found by Magnusson et al. (2014) and Devaux and Sassi (2013). The importance of relative level of education is more pronounced among women than among men, where women in disadvantaged socio-economic groups are more likely to have a higher BMI (Devaux & Sassi, 2013).

3.5.3 Obesity and gender

In the current obesity epidemic there are differences in the prevalence of obesity between men and women, and these differences vary between countries. Overall, women are more often obese than men are, but this does not hold for all countries. In developing countries women are more often obese, but in developed countries men are more often obese (Kanter & Caballero, 2012). This is confirmed by Ameye and Swinnen (2019), who explain the gender differences by income differences, cultural aspects, employment sector, urbanization. They add that in developed countries, women are often more concerned with healthy behaviour and diets. Kanter and Caballero (2012) acknowledge this, but they add that women do consume more sugar than men do. In some countries being bigger can be a sign of fertility, healthfulness or prosperity, which can be true for both men and women (Kanter & Caballero, 2012). In developed countries, both men and women have mostly sedentary occupations, resulting in little physical activity for both. In developing countries, the sedentary patterns of women are changing, reducing physical activity, which makes them more vulnerable to weight gain (Kanter & Caballero, 2012).

One of the attributors to weight gain is food craving, which is associated with weight gain over time and a high BMI during life. There are different kind of cravings, one is cue-induced craving, which is stimulated by environmental or external triggers. When living in an environment with many of these triggers, unhealthy food is more often consumed, and some people are more sensitive to such triggers than others are. Cravings are different among men and women, these differences are shown in the food that is craved for, the intensity and frequency of craving, and the ability to regulate these cravings. Hormones are important contributors to these differences, and men and women show varying hormone levels, and these levels change with age (Hallam et al., 2016). In agreement with Kanter and Caballero (2012) and Ameye and Swinnen (2019), Hallam et al. (2016) also state that women crave sweet foods, while men more often crave savoury foods and different types of sweet than women do.

3.5.4 Obesity and marital status

Marital status is associated with health status, it is related to both mortality and morbidity (Sobal et al., 1992). Married people are healthier, both physically and mentally. This association is stronger for men than for women. Obesity can be seen as a health threat, and thus more research has been done to explore the relationship between marital status and obesity. The statement that married people are healthier, does not seem to be the case when looking at obesity. Married people have a higher risk of being heavy, compared to those who are not married. Gender and age are important to take in consideration. When people age they tend to focus more on a healthy lifestyle (Sobal & Hanson, 2011). Several associations between marital status and gender have been found. Sobal and Hanson (2011) state that married men are heavier than not married men, and that married women were less often obese than not married women. Which is in line with the research of Klos and Sobal (2013), who found that married men tend to be more obese or overweight than married women.

The association between marital status and obesity has not only to do with health, it is also a matter of appearance. People that are obese are often stigmatized, which is also the case in romantic relationships. People that are not in a relationship and who are dating, are less likely to be overweight, which is due to the importance of being attractive. After entering a marriage, people often tend to gain weight, since the pressure of being attractive decreases at this point. This stigma about overweight or obese people is present in developed countries (Klos & Sobal, 2013), but not all over the world, in some cultures being overweight or obese is a sign of economic prosperity and wealth (Ameye & Swinnen, 2019).

Also, of influence is a change in activities as a result of being married, people have less personal time and are involved with childbearing and childrearing, which decreases the time available for them to work out (Klos & Sobal, 2013).

The claim that married men and women are more likely to be heavier is confirmed by Janghorbani et al. (2008), who found the prevalence of overweight was more than two times higher for married individuals, than not married individuals.

3.6 Obesity in Europe

Obesity in Europe has tripled since 1980, and this number is still increasing (WHO, n.d.). Within Europe there is variation between and within countries, these inequalities can be found in terms of region, gender and socio-economic status (Eurostat, 2014). Obesity has been found to be more common in Eastern Europa than in Western Europe (Visscher & Seidell, 2001). This difference has been explained by a delay of the Western lifestyle in the Eastern countries, accompanied by the social, economic and nutritional transition. Women seem to be more susceptible to obesity than men are, which is especially true for women from Eastern Europe. Several explanations have been given for this gender difference, consisting of biological differences like genetics and hormones, but also the women's role in the family. When women are at home more, they have easy access to food (Rabin et al., 2007).

3.6.1 Obesity in France and Hungary

Obesity prevalence has increased over the last few decades in both France and Hungary (figure 2). In France, this increase was roughly the same for men and women, but since 2003 the increase was most for women. The increase was seen in all age groups, and among all different income groups (Charles et al., 2008).

In France, high obesity number are associated with lower SES and low-quality diets. Obesity numbers for people shopping at high-cost supermarket are 9% lower than for people shopping at low-cost supermarkets. The type of supermarket people shop at, is determined by their SES; those with a high SES shop at high-cost supermarkets (Drewnowski et al., 2014).

Just as in France, obesity numbers have increase in Hungary, where it has become the biggest health problem in the country with over 1.5 million people being obese (Horváth et al., 2007). Looking at socio-economic indicators in Hungary shows lower obesity prevalence among high educated individuals, with slightly higher numbers for men than for women. Obesity is more prevalent in villages than in cities and the capital Budapest (Rurik et al., 2014).

Within Hungary, there are large differences in health status in the Eastern and Western part of the country. In general, the country has the lowest life expectancy numbers in Europe, but these vary greatly between different regions within the country. Health status in de Eastern part is worse than in the Western part (Nédó & Paulik, 2012). Nédó & Paulik (2012) report a higher risk of obesity for low and medium educated individuals in Hungary.

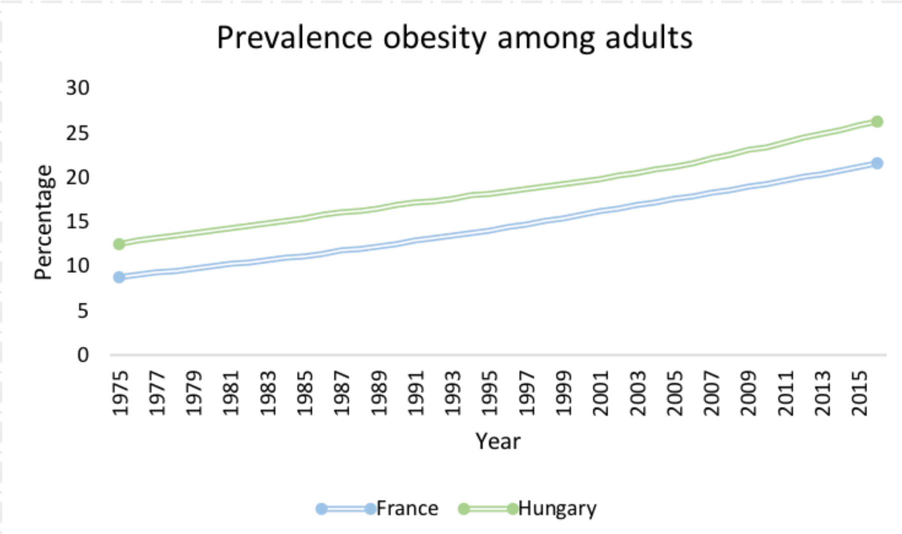

Figure 2. Prevalence of obesity among adults in France and Hungary (data: WHO, n.d.)

Figure 3 shows obesity by age and gender for France and Hungary in 2014. This shows obesity increases with age in both countries, with the percentage being higher in Hungary than in France for most ages. Obesity decreases around age 60 in both countries for both sexes.

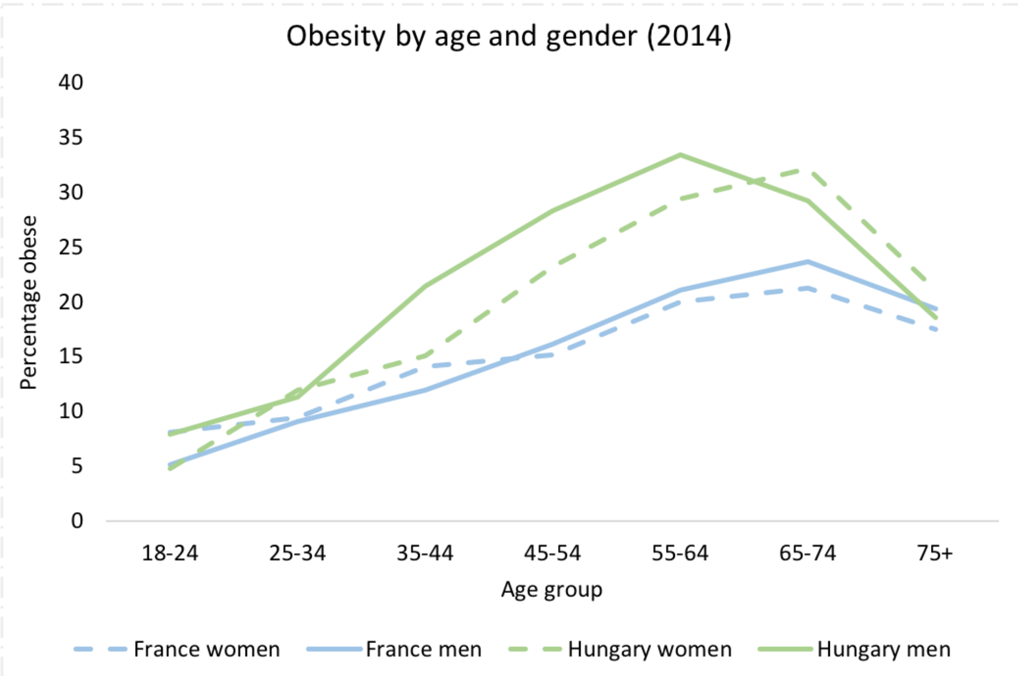

Figure 3. Obesity by age and gender in 2014 (data: Eurostat, 2020)

In both France and Hungary women are supported to work and both countries have a day-care system to support this (Riebling et al., 2016). Women are more often part-time employed than men are, in both countries, which gives women the possibility to be at home more. The difference in part-time employment between men and women is biggest in France, in Hungary this is divided more equal (Worldbank, n.d.). As Rabin et al. (2007) state, being more at home is associated with easier access to food.

The majority of the population in both France and Hungary is Roman Catholics. Religion can be an important influence in one's life in terms of lifestyle and moral actions. Previous studies (Koenig, 1999; Levin, 2001, cited by Cline & Ferraro, 2006) have reported better health outcomes for those who are religious and who attend church regularly. Obesity might be viewed as a form of gluttony and therefore be regarded as a sin. Nevertheless, church members were found to be more likely to become overweight. Several explanations are given for this. First, gluttony as a sin does not receive the same attention as other sins (smoking, alcohol consumption). Second, food is often seen as having a celebratory function. Third, religion can be viewed as a safe haven for those seeking protection from the stigma that obese people experience (Cline & Ferraro, 2006), this stigma is present in developed countries (Klos & Sobal, 2013).

3.7 Hypotheses

To answer the question how socio-economic status influences obesity in an urban or rural area in France and Hungary, several hypotheses have been formed. The hypotheses have been formed based on the literature review.

H1: Urban residents have a higher risk of obesity than rural residents in France and Hungary

H2: Income has a negative relationship with obesity in France and Hungary

H3: Education has a negative relationship with obesity in France and Hungary

H4: Men are more at risk of obesity than women are

H5: Being married is positively associated with obesity in France and Hungary

3.8 Conceptual model

The conceptual model shown in figure 4 is based on the literature review.

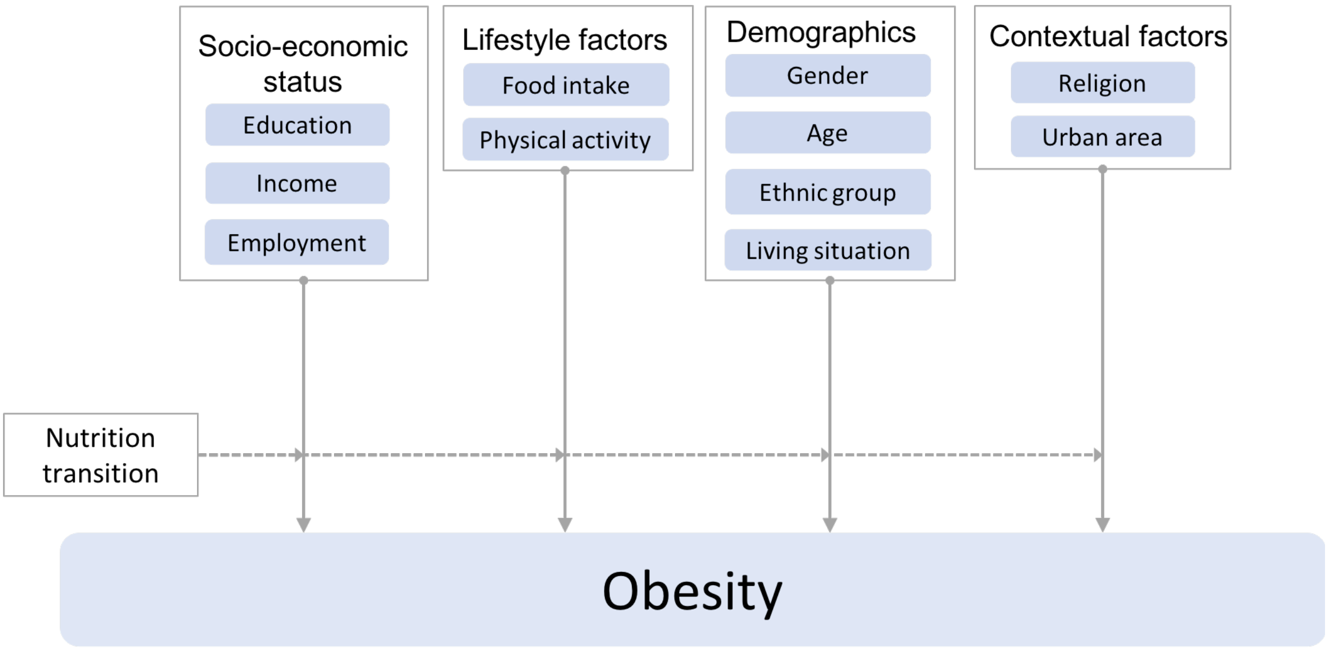

Figure 4. Conceptual model

4. Data and Methods

4.1 Dataset

This study has been conducted using secondary data from the European Social Survey (ESS). The ESS is performed in several European countries every two years since 2001, resulting in nine completed rounds. In total 38 different countries have been included in the survey over the years, some of which were included in each round and some have been part of only one round (European Social Survey, n.d.a). The dataset includes individuals aged 15 years and older, with no upper age limit. They are selected by random probability methods. The minimum number of respondents required for each country depends on the population size of the country. The cut-off point has been set at a population of 2 million people, countries with a smaller population size than 2 million people require 800 respondents, with a population size of more than 2 million people 1,500 respondents are required. These numbers of respondents are set to ensure an effective sample size. Data is collected via face-to-face interviews (European Social Survey, n.d.c). The survey consists of two different parts, one part is the core, this part is the same for each round, the other part is a thematic part with a different focus in each round. For this study, round 7 from 2014 has been used, which consists of a thematic part focusing on Social Inequalities in Health (European Social Survey, n.d.d).

4.2 Weights

The dataset must be weighted before used. Weights are used to generalize to the total population (Mehmetoglu & Jakobsen, 2017). By using weights, it is considered how likely it is for each respondent to be included in the dataset. The ESS provides different kind of weights which are applicable in different situations. For the purpose of this study, two weights provided by the ESS have been used, there two have been combined into one new weight to use during the analysis. First, design weights (dweight) are used, which account for the probability of the respondents to be in the sample. Second, population size weights (pweight) are used, these correct for different population sizes in different countries. These two weights are combined as follows (ESS, 2014):

*weightnw=dweight*pweight*

Weights are included in tables and analyses done with the dataset. When using commands such as tabulate and summarize, it is included as: [aweight=weightnw]. For regressions, weightnw is used by including the following in the command: [pweight=weightnw] (Mehmetoglu & Jakobsen, 2017).

4.3 Ethical considerations

For the purpose of this study, secondary data is used, this means the researcher has had no direct contact with the respondents. The ESS has agreed with and follows the Declaration on Professional Ethics, by the International Statistical Institute (European Social Survey, n.d.e). During data collection, all respondents are made aware of all aspects of participating in the survey and how the collected data is being handled. One of the aspects mentioned is the fact that it will not be possible to trace back the respondent based on the data. The ESS has thus made sure the collected data is being used responsibly and is aware of the confidentiality and anonymization of the data (European Social Survey, n.d.f).

For this study, the data is stored on a password protected computer at all times, this computer is only accessible for the researcher. The final product of this study, which is a thesis, will be shared with the supervisors of the thesis, and it will be accessible online for students of the Faculty of Spatial Sciences of the University of Groningen.

4.4 Variables

All variables used originate from or are calculated based on variables originating from European Social Survey Round 7 Data (2014). Table 1 states the number of observations in the sample and the weighted number of observations for France and Hungary.

Table 2. Number of observations by country (observations and weighted numbers)

	Observations		**Weighted numbers**	
	N	%	N	%
France	1753	53,40	2829,05	86,17
Hungary	1530	46,60	453,95	13,83
Total	3283	100,00	3283	100,00

4.4.1 The dependent variable

Two types of dependent variable are used, which are BMI and obesity. First, BMI is calculated by using the variables describing height and weight, creating a continuous version of BMI:

$$BMI = weight / height^2$$

Second, different nutrition statuses have been defined using BMI. Nutrition status is generated from BMI as follows: '3 = underweight (BMI < 18.5)', '0 = normal weight (BMI 18.5-25)', '1 = overweight (BMI 25-30)' and '2 = obesity (BMI 30 >)'. Table 2 shows nutrition status for both countries. Third, the dummy variable describing obesity is formed as follows: '1=obese (BMI 30 >) and '0=not obese (BMI < 30). Observations not including height and weight are excluded, body mass index could not be calculated for these respondents. Height was missing for 18 observations and weight was missing for 47 observations.

Table 3. Nutrition status by county (observations sample)

Variable	**France**		**Hungary**		**Total**	
	N	%	N	%	N	%
Nutrition status						
Underweight	64	3,65	29	1,90	93	2,83
Normal weight	894	51,00	546	35,69	1440	43,86
Overweight	562	32,06	675	44,12	1237	37,68
Obese	233	13,29	280	18,30	513	15,63
Total	1753	100,00	1530	100,00	3283	100,00
Being obese						
Yes	233	13,29	280	18,30	513	15,63

No	1520	86,71	1250	81,70	2770	84,37
Total	1753	100,00	1530	100,00	3283	100,00

4.4.2 Explanatory variables

Urban and rural

The main independent variable describes the area respondents live in. The answer options in the survey are '1 = a big city', '2 = suburbs or outskirts of big city', '3 = town or small city', '4 = country village', '5 = farm or home in countryside', 'refusal', 'don't know' and 'no answer'. This is recoded into 'urban = 1' from 'a big city', 'suburbs or outskirts of big city' and 'town or small city', and 'rural = 0' from 'country village' and 'farm or home in countryside'. The answers 'refusal', 'don't know' and 'no answer' are treated as missing values and left out of the analysis, which were two observations.

Income

The variable for income describes total net income for a household from all sources. It is measured in deciles, where the first decile represents the lowest income and the tenth decile represents the highest income. It is labelled as follows '1 = first decline', '2 = second decile', '3 = third decile', '4 = fourth decile', '5 = fifth decile', '6 = sixth decile', '7 = seventh decile', '8 = eight decile', '9 = ninth decile', '10 = tenth decile', 'refusal', 'don't know' and 'no answer'. The variable has a total of 81 respondents that did not know their total household income, and there were 405 respondents that refused to answer this question. Refusal of this question can be explained by the sensitivity of the question. To check differences between respondents who did and who did not answer this question, the means of the other variables for these two groups have been compared. Based on this comparison, it can be said that the data is missing at random and no further actions have been taken (Mehmetoglu & Jakobsen, 2017).

The variable is recoded into '1 = low income' from 'first decline', 'second decile', 'third decile', '2 = medium income' from 'fourth decile', 'fifth decile', 'sixth decile', 'seventh decile' and '3 = high income' from 'eight decile', 'ninth decile', 'tenth decile'.

Education

The variable for education describes the highest level of education achieved and uses the ISCED classification. This classification makes it possible to compare educational levels between countries (Eurostat, 2018). The variable is labelled '0 = not possible to harmonize into ES-ISCED', '1 = ES-ISCED I, less than lower secondary', '2 = ES-ISCED II, lower secondary', '3 = ES-ISCED IIIb, lower tier upper secondary', '4 = ES-ISCED IIIa, upper tier upper secondary', '5 = ES-ISCED IV, advanced vocational, sub-degree', '6 = ES-ISCED V1, lower tertiary education, BA level', '7 = ES-ISCED V2, higher tertiary education, >= MA', 'refusal', 'don't know' and 'no answer'. The answers 'refusal', 'don't know' and 'no answer' are treated as missing values and left out of the analysis, which accounts for eight observations.

The other observations have been recoded into '0 = low educated' from 'ES-ISCED I, less than lower secondary' and 'ES-ISCED II, lower secondary', '1 = medium educated' from 'ES-ISCED IIIb, lower tier upper secondary', 'ES-ISCED IIIa, upper tier upper secondary' and 'ES-ISCED IV, advanced vocational, sub-degree', '2 = high educated' from 'ES-ISCED V1, lower tertiary education, BA level' and 'ES-ISCED V2, higher tertiary education, >= MA'.

Living situation

The variable whether someone lives with a partner is labelled '1 = legally married', '2 = in a legally registered civil union', '3 = living with my partner – not legally recognized', '4 = living with my partner – legally recognized', '5 = legally separated', '6 = legally divorced/civil union dissolved', 'refusal', 'don't know' and 'no answer'. This variable has been transformed into the following: '1 = living with partner', made from: 'legally married', 'in a legally registered civil union', 'living with my partner – not legally recognized', 'living with my partner – legally recognized' and '2 = living with divorced partner' made from 'legally separated' and 'legally divorced/civil union dissolved'. This question was a follow up question, therefore those answers that were 'not applicable' have been transformed into '3 = not living with partner'. The answers 'refusal', 'don't know' and 'no answer' are treated as missing values and left out of the analysis, which accounts for fourteen observations.

Religion

The variable religion describes whether a respondent belongs to a religion or denomination, or whether they do not belong to any religion. This variable is labelled '1 = Roman Catholic', '2 = Protestant', '3 = Eastern Orthodox', '4 = Other Christian denomination', '5 = Jewish', '6 = Islamic', '7 = Eastern Religions', '8 = Other non-Christian religions', '66 = Not applicable', 'don't know', 'refusal', 'no answer'. This variable is the result of a follow-up question, therefore the respondent with 'not applicable' have been labelled 'Atheist'. This variable has been recoded into '1 = Christian religions' from 1 = Roman Catholic', '2 = Protestant', '3 = Eastern Orthodox', '4 = Other Christian denomination', '2 = Jewish', '3 = Islamic', '4 = Others' from '7 = Eastern Religions', '8 = Other non-Christian religions' and '5 = Atheist'. The answers 'refusal', 'don't know' and 'no answer' are treated as missing values and left out of the analysis, which accounts for eleven observations.

Having a job

This variable is labelled '1 = in paid work', '2 = not in paid work' and 'not available'. The answer 'not available is treated as missing value and left out of the analysis, which accounts for seventeen observations.

Minority

This variable describes whether someone belongs to a minority or not, it has the options '1 = yes', '2 = no', 'refusal', 'don't know' and 'no answer'. The answers 'refusal', 'don't know' and 'no answer' are treated as missing values and left out of the analysis, which accounts for twenty-one observations.

Age

Age is a continuous variable. Because BMI is only applicable for adults, respondents aged 15-19 have been dropped from the analysis. In addition, there is some debate about using BMI for elderly people, it would not reflect morbidity as it does for younger people (Bahat et al., 2012; Grzegorzewska et al., 2016). The continuous variable age is transformed into a categorical variable with different age groups: '1 = ages 20-29', '2= ages 30-39', '3 = ages 40-49', '4 = ages 50-59', '5 = ages 60-70', '6 = ages 70+'.

Gender
This variable has the options '1 = male', '2 = female' and 'no answer'.

Fruit intake
This variable describes how often someone eats fruits. It is labelled: '1 = three times or more a day', '2 = twice a day', '3 = once a day', '4 = less than once a day but at least 4 times a week', '5 = less than 4 times a week but at least once a week', '6 = less than once a week', '7 = never', 'refusal', 'don't know' and 'no answer'. This variable is recoded into '1 = at least once a day' from '1 = three times or more a day', '2 = twice a day', '3 = once a day', '2 = less than once a day' from '4 = less than once a day but at least 4 times a week', '5 = less than 4 times a week but at least once a week', '6 = less than once a week' and '3 = never' from '7 = never'. The answers 'refusal', 'don't know' and 'no answer' are treated as missing values and left out of the analysis, which accounts for one observation.

Vegetable intake
This variable describes how often someone eats vegetables or a salad. It is labelled: '1 = three times or more a day', '2 = twice a day', '3 = once a day', '4 = less than once a day but at least 4 times a week', '5 = less than 4 times a week but at least once a week', '6 = less than once a week', '7 = never', 'refusal', 'don't know' and 'no answer'. This variable is recoded into '1 = at least once a day' from 1 = three times or more a day', '2 = twice a day', '3 = once a day', '2 = less than once a day' from '4 = less than once a day but at least 4 times a week', '5 = less than 4 times a week but at least once a week', '6 = less than once a week' and '3 = never' from '7 = never'. The answers 'refusal', 'don't know' and 'no answer' are treated as missing values and left out of the analysis, which accounts for two observations.

Physical activity
This variable describes how many days a week someone does sports or other physical activity for at least 30 minutes. It is a continuous variable. Observations missing this variable have been left out of the analysis, this were twenty-five observations.

4.5 Analysis

To explore the influence of various socio-economic status indicators on obesity and BMI, several analyses will be done. The type of analysis depends on the type of dependent variable used.

First, BMI is used as the dependent variable. In this case, it is a continuous variable, therefore a multiple linear regression is the appropriate type of analysis. Three linear regression are performed, first one pooled regression including both countries, next, stratified regressions for each individual country are performed. This linear model follows the next equation, including the dependent variable BMI (Y), all parameters (β_0 ... β_k), all explanatory variables ($X_{1i} \ldots X_{ki}$), and the error term (ε_i):

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_k X_{ki} + \varepsilon_i$$

Second, nutrition status is used as the dependent variable, with two options: being obese or not being obese. Three logistic regression are performed, first one pooled regression including both countries, next, stratified regressions for each individual country are performed. The logistic regression follows the next equation, including the logit (L), all parameters (β_0 ... β_k) and all explanatory variables (X_{1i} ... X_{ki}):

$$L_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_k X_{ki}$$

5. Results

5.1 Descriptive statistics

Table 4 states the descriptive statistics of all variables, all numbers are weighted in this table. When looking at the different dependent variables used, it shows that mean BMI is higher in Hungary than in France, and that the share of overweight or obese respondents is highest in Hungary, compared to France. Furthermore, it shows that most people in France earn a medium income, where in Hungary most people earn a high income. In both countries most people have enjoyed medium education and most people are in paid work. France has the highest proportion of people being atheist, in Hungary most people belong to a Christian religion. For both countries, most people live together with a partner, and most people are women. People in France eat more fruit and vegetables and do more sports, than they do in Hungary.

Table 4. Descriptive statistics (weighted numbers)

Variable	**France**				**Hungary**			
	N	%	Mean	SD	N	%	Mean	SD
BMI			25,11	4,79			26,43	4,75
Obesity								
Obese	395,50	13,98			83,08	18,30		
Not obese	2433,55	86,02			370,88	81,70		
Nutrition status								
Underweight	109,79	3,88			8,60	1,90		
Normal weight	1407,51	49,75			162,00	35,69		
Overweight	916,24	32,39			200,27	44,12		
Obese	395,50	13,98			83,08	18,30		
Area								
Urban	1674,69	59,20			302,34	66,60		
Rural	1154,36	40,80			151,61	33,40		
Income								
Low income	618,54	24,85			54,09	17,55		
Medium income	1154,00	46,37			125,94	40,87		
High income	716,30	28,78			128,12	41,58		
Education								
Low educated	568,12	20,08			85,75	18,89		
Medium educated	1711,76	60,51			293,44	64,64		
High educated	594,17	19,41			74,77	16,47		
Work								
In paid work	1649,58	58,31			248,04	54,64		
Not in paid work	1179,57	41,69			205,91	45,36		
Religion								
Catholic denominations	1152,93	40,75			226,98	50,00		
Jewish	9,74	0,34			0,30	0,07		
Islamic	152,30	5,38			0,30	0,07		
Other	23,24	0,82			0,59	0,13		

Atheist	1490,84	52,70			225,79	49,74		
Living situation								
Living with partner	2137,28	75,55			270,00	59,48		
Living with ex-partner	4,47	0,16			0,30	0,07		
Not living with partner	687,30	24,29			183,66	40,46		
Gender								
Male	1361,35	48,12			191,37	42,16		
Female	1467,70	51,88			262,58	57,84		
Belonging to a minority								
Yes	129,85	4,59			21,96	4,84		
No	2699,20	95,41			432,00	95,16		
Eating fruit								
At least once a day	1927,73	68,14			191,67	42,22		
Less than once a day	836,94	29,58			260,80	57,45		
Never	64,38	2,28			1,48	0,33		
Eating vegetables								
At least once a day	2181,87	77,12			166,75	36,73		
Less than once a day	634,46	22,43			284,54	62,68		
Never	12,71	0,45			2,67	0,59		
Doing sports (days/week)			2,31	2,45			1,85	2,34
Age			48,33	16,14			51,50	17,29
Age groups								
20-29	312,48	11,05			56,97	12,55		
30-39	644,15	22,77			70,02	15,42		
40-49	673,14	23,79			83,37	18,37		
50-59	486,80	17,21			78,92	17,39		
60-69	382,27	13,51			84,86	18,69		
70+	330,21	11,67			79,81	17,58		

A two-sample t-test was conducted to compare BMI in both countries, a significant difference was found for BMI in France and Hungary (table 5). In both countries most people live in an urban area, this share is biggest in Hungary. A two-sample t-test was conducted to compare BMI in urban and rural areas, a significant difference was found for BMI in urban and rural areas (table 5). These tests have conducted for each country separately as well, to compare BMI in urban and rural areas for the individual countries. In the case of France, a significant difference was found for BMI in urban and rural. In the case of Hungary, no significant difference was found for BMI in. The results of these t-test are also presented in table 5.

Table 5. Results t-test

Input t-test	**Mean**	**St. Dev.**	**Result t-test**
BMI in France	25,11	4,79	t3281(-7,86), p=0,000
BMI in Hungary	26,43	4,75	

BMI urban area	25,60	4,90	t3281(2,16), p=0,0310
BMI rural area	25,99	4,62	
BMI urban France	24,88	4,73	t1751(3,19), p=0,0014
BMI rural France	25,67	4,91	
BMI urban Hungary	26,31	4,29	t1528(-0,64), p=0,5204
BMI rural Hungary	26,48	4,97	

5.2 Multiple linear regression

The results of the linear regressions are presented in table 6. The variables describing fruit and vegetable intake have been left out of the analysis due to multicollinearity issues. The analyses have been done with only one of them, but in both cases the issues remained.

5.2.1 France and Hungary combined

First, a linear regression analysis was performed for both countries in one. The results show that living in France reduces your BMI by .7858 kg/m^2, compared to living in Hungary, all other variables being constant (5% significance level). Living in an urban area increases your BMI by .8118 kg/m^2, compared to living in rural areas, all other variables being constant (5% significance level). These two variables have been combined in an interaction term, the coefficient of this interaction term is 1.0960 kg/m^2 (statistically significant at 5% significance level), all other variables being constant. This means BMI is 1.0960 kg/m^2 higher in France urban areas, compared to Hungary urban areas.

A linear regression including only the main explanatory variable, the area where someone lives, does not show any significant relationship between area and BMI. Adding additional variables to the regression describing socio-economic status increases the coefficient for area, and at the same time decreases the p-value more for each extra added variable, resulting in a change from being insignificant to being significant.

Next, several socio-economic status variables show a statistically significant influence on BMI. Earning medium or high income reduces BMI, medium income reduces it by 1.0065 kg/m^2 and high income by 1.1226 kg/m^2, compared to low income, statistically significant at 5% significance level and all other variables being constant. Being high educated decreases BMI by 1.5385 kg/m^2, compared to low educated, statistically significant at 1% significance level and all other variables being constant. Compared to atheists, BMI increases by .7321 kg/m^2 for Christian religions and by 2.5012 kg/m^2 for Islamic, at 5% and 1% significance level and all other variables being constant. Living with a partner increases BMI by .6159 kg/m^2, compared to living alone, at 5% significance level and all other variables being constant.

The demographic variables show that BMI decreases by 1.6786 kg/m^2 for women, compared to men, statistically significant at 1% and all other variables being constant. Compared to the age group 20-29, BMI increases for every other age group. BMI increases by 1.4931 kg/m^2 for the age group 30-39 (5% significance level), by 1.7283 kg/m^2 for the age group 40-49, by 1.9610 kg/m^2 for the age group 50-59, by 2.8105 kg/m^2 for the age group 60-69, and 1.9820 kg/m^2 for the age group 70+ (all at 1% significance level), all other variables being constant.

5.2.2 France and Hungary separately

The results of the stratified linear regressions are presented in table 6. The main predictor variable, area, is not significant in either of these two models. The socio-economic status variables also show something different than in the first regression. Earning medium or high income in France decreases BMI by 1.0957 kg/m^2 (medium income) or by 1.2886 kg/m^2 (high income), compared to low income, statistically significant at 5% significance level and with all other variables being constant. In Hungary, income level has no significant effect on BMI. In both countries, BMI decreases when being high educated, compared to low educated. In France, BMI decreases by 1.5920 and in Hungary by 1.0946 kg/m^2. Which is statistically significant at 5% significance level, all other variables being constant. In France, belonging to a Christian religion or Islamic increases BMI, for Christian religions by .7390 kg/m^2 and for Islamic by 2.4714 kg/m^2, compared to being atheist, at 5% significance level and all other variables being constant. In Hungary, belonging to a Christian religion increases BMI by .6126 kg/m^2 (5% significance level), by 3.1642 kg/m^2 for Jewish (1% significance level), BMI decrease by 1.1426 kg/m^2 for Islamic (5% significance level) and by 11.6461 kg/m^2 for other religions and denominations (1% significance level), all other variables being constant. Living with a partner increases BMI by .6773 kg/m^2 in France, compared to living alone, which is statistically significant at 10% significance level and all other variables being constant. Living together with an ex-partner lowers BMI by 3.0729 kg/m^2 in Hungary, compared to living alone, statistically significant at 1% significance level and all other variables being constant.

Being a woman lowers BMI by 1.7784 kg/m^2 in France (1% significance level), and by .9112 kg/m^2 in Hungary (5% significance level), compared to being a man, keeping all other variables constant. In both countries, BMI is higher for every age group, compared to the age group 20-29. In France, being in the age group 30-39 increases BMI by 1.4749 kg/m^2 (5% significance interval), being in the age group 40-49 increases BMI by 1.6121 kg/m^2 (5% significance interval), being in the age group 50-59 increases BMI by 1.9078 kg/m^2 (1% significance interval), being in the age group 60-69 increases BMI by 2.7006 kg/m^2 (1% significance interval) and being 70 or older increases BMI by 1.7782 kg/m^2 (5% significance interval), all other variables being constant. In the case of Hungary, being in the age group 30-39 increases BMI by 1.4845 kg/m^2 (5% significance interval), being in the age group 40-49 increases BMI by 2.9424 kg/m^2 (1% significance interval), being in the age group 50-59 increases BMI by 2.5442 kg/m^2 (1% significance interval), being in the age group 60-69 increases BMI by 3.9062 kg/m^2 (1% significance interval) and being 70 or older increases BMI by 3.5719 kg/m^2 (1% significance interval), all other variables being constant.

Table 6. Results linear regressions

Dependent variable BMI	France and Hungary	France	Hungary
Country (ref: Hungary)			
France	-0,79** (0,32)		
Country * area	-1,10** (0,41)		
Main predictor variable			
Area (ref: rural)			
Urban	0,81** (0,29)	-0,27 (0,30)	0,37 (0,28)
Socio-economic status variables			
Income (ref: low income)			
Medium income	-1,01** (0,42)	-1,10** (0,47)	-0,05 (0,51)
High income	-1,12** (0,48)	-1,29** (0,53)	0,47 (0,59)
Educated (ref: low educated)			
Medium educated	-0,57 (0,37)	-0,64 (0,41)	-0,11 (0,39)
High educated	-1,54*** (0,42)	-1,59** (0,46)	-1,09** (0,47)
Work (ref: in paid work)			
Not in paid work	-0,21 (0,36)	0,23 (0,39)	-0,12 (0,36)
Religion (ref: atheist)			
Christian religions	0,73** (0,24)	0,74** (0,27)	0,61** (0,27)
Jewish	-0,36 (1,25)	-0,23 (1,30)	-3,16*** (0,54)
Islamic	2,50*** (0,71)	2,47** (0,72)	-1,14** (0,49)
Other	1,44 (2,78)	1,30 (2,83)	11,65*** (0,67)
Partner (ref: not living with partner)			
Living with partner	0,62** (0,30)	0,68* (0,35)	0,10 (0,32)
Living with ex-partner	-2,59 (2,49)	-2,48 (2,66)	-3,07*** (0,47)
Minority (ref: belonging to a minority)			
Not belonging to a minority	0,79 (0,57)	0,87 (0,65)	-0,06 (0,60)
Nutrition and physical activity			
Doing sports (days/week)	-0,07 (0,05)	-0,07 (0,06)	-0,04 (0,06)
Demographic variables			
Gender (ref: men)			
Women	-1,68*** (0,26)	-1,78*** (0,30)	-0,91** (0,28)
Age group (ref: 20-29)			
30-39	1,49** (0,47)	1,47** (0,52)	1,48** (0,43)
40-49	1,73*** (0,46)	1,61** (0,52)	2,94*** (0,52)
50-59	1,96*** (0,47)	1,91*** (0,52)	2,54*** (0,43)

60-69	2,81*** (0,47)	2,70*** (0,54)	3,91*** (0,47)
70+	1,98*** (0,50)	1,78** (0,56)	3,57*** (0,52)
Constant	25,20*** (0,85)	24,56*** (1,02)	23,96*** (0,81)
R2	0,1062	0,1034	0,1052
Number of observations	2797	1669	1128

*90% significant level (p-value<0.10), **95% significance level (p-value<0.05), ***99% significance level (p-value<0.01)

Notation in table: $\beta^{significance}$ (Std. Err.)

5.3 Logistic regression

Three logistic regression have been done, to estimate the influence of several explanatory variables on the dummy variable being obese or not being obese. The results of these analyses are presented in table 7.

5.3.1 France and Hungary combined

First, a logistic regression analysis for both countries combined is performed, the results are stated in table 7. These results show there is no significant relationship between being obese and country. The main explanatory variable, area, shows that the log odds of being obese increase by .2077 for urban areas, compared to rural areas, at 10% significance interval keeping all other variables constant.

The socio-economic status variables show various significant relationships with being obese. Those with medium and high income are less likely to be obese, compared to low income, at 5% and 1% confidence interval. The log odds of being obese increase by -.6259 (medium income) and -.9593 (high income), all other variables constant. Next, the log odds of being obese increase by -.5545 (high educated) compared to low educated, at 10% confidence interval with all other variables constant. The log odds of being obese increase by .7508 for Islamic at 10% confidence interval, compared to atheists, all other variables constant.
Doing sports increases the log odds of being obese by -.0793, at 5% confidence interval keeping all other variables constant.

The demographic variables show the log odds of being obese increase by -.2920 for women compared to men, at 10% confidence interval and all other variables constant. Lastly, the log odds of being obese increase by .7640 for the age group 30-39), compared to the age group 20-29, all at 5% confidence interval, all other variables constant.

5.3.2 France and Hungary separately

The results of the logistic regressions performed for each country are presented in table 7. First, there is no statistically significant relationship between being obese and the area people live in. This means hypothesis 1 can be rejected; urban residents do not have a higher risk of being obese than rural residents.

Next, in France, those with medium and high income are less likely to be obese, compared to low income. The log odds of being obese increase by -.7239 (medium income) (5% significance interval) and -1.0809 (high income) (1% significance interval), compared to low income, all other variables constant. With these numbers, hypothesis 2 is accepted for

France, but can be rejected for Hungary; income has a negative relationship with obesity for France, not for Hungary. In the case of Hungary, the log odds of being obese increase by -.4940 for the high educated, compared to the low educated, at 10% confidence interval with all other variables constant. With these numbers, hypothesis 3 is confirmed for high educated people in both France and Hungary. For France, the log odds of being obese increase by .6891 for Islamic, compared to atheists, at 10% confidence interval with all other variables constant. In Hungary, the log odds of being obese increase by .3030 compared to atheists, at 10% confidence interval, all other variables constant. All other religions have been omitted from the analysis.

In France, the log odds of being obese increase by -.3355 for women, compared to men, at 10% confidence interval, with all other variables constant. This means hypothesis 4 is accepted, men are more at risk of obesity than women.

Hypothesis 5 is rejected, since there is no evidence that obesity is statistically significant associated with partner status.

While executing the logistic regression, some observations have been dropped. All observations of respondents living with an ex-partner have been dropped, because these all predict failure perfectly. In this case this means that all respondents living with an ex-partner are not obese. For the regression done for only Hungary, observations are dropped because they either predict failure or success of the dependent variable perfectly. This means that in the case of Hungary, Jewish respondents are all not obese, Islamic respondents are all not obese, ad those belonging to other religions or denominations are all obese.

Table 7. Results logistic regressions

Dependent variable obesity	**France and Hungary**	**France**	**Hungary**
Country (ref: Hungary)			
France	-0,27 (0,38)		
Country * area	-0,38 (0,26)		
Main predictor variable			
Area (ref: rural)			
Urban	0,31* (0,18)	-0,07 (0,20)	0,13 (0,18)
Socio-economic status variables			
Income (ref: low income)			
Medium income	-0,64** (0,19)	-0,72** (0,22)	-0,04 (0,22)
High income	-0,96*** (0,24)	-1,08*** (0,29)	-0,02 (0,27)
Educated (ref: low educated)			
Medium educated	-0,18 (0,19)	-0,17 (0,22)	-0,28 (0,20)
High educated	-0,56* (0,29)	-0,57* (0,33)	-0,51* (0,29)
Work (ref: in paid work)			
Not in paid work	0,23 (0,20)	0,21 (0,22)	0,26 (0,24)
Religion (ref: atheist)			

Christian religions	0,21 (0,16)	0,19 (0,18)	0,31* (0,17)
Jewish	-0,14 (1,00)	-0,03 (1,00)	-
Islamic	0,75* (0,38)	0,69* (0,39)	-
Other	0,34 (1,13)	0,21 (1,21)	-
Partner (ref: not living with partner)			
Living with partner	0,22 (0,17)	0,30 (0,20)	-0,09 (0,18)
Living with ex-partner	-	-	-
Minority (ref: belonging to a minority)			
Not belonging to a minority	0,56 (0,43)	0,59 (0,50)	0,41 (0,40)
Nutrition and physical activity			
Doing sports (days/week)	-0,08** (0,04)	-0,08* (0,04)	-0,04 (0,04)
Demographic variables			
Gender (ref: men)			
Women	-0,29* (0,15)	-0,34* (0,18)	-0,14 (0,16)
Age group (ref: 20-29)			
30-39	0,80* (0,36)	0,76** (0,38)	0,91** (0,50)
40-49	0,55 (0,36)	0,45 (0,40)	1,34** (0,48)
50-59	0,91** (0,35)	0,87** (0,38)	1,31** (0,48)
60-69	1,17** (0,34)	1,13** (0,38)	1,79*** (0,47)
70+	0,25 (0,37)	-0,17 (0,44)	1,87*** (0,48)
Constant	-2,09** (0,60)	-2,26** (0,74)	-3,16*** (0,61)
(Pseudo) R2	0,0641	0,0751	0,0749
Number of observations	2793	1666	1122

*90% significant level (p-value<0.10), **95% significance level (p-value<0.05), ***99% significance level (p-value<0.01)

Notation in table: $\beta^{\text{significance}}$ (Std. Err.)

6. Conclusion and discussion

6.1 Conclusion

This study analysed the influence of socio-economic status on obesity in France and Hungary, with a special focus on the type of area people live in. The analyses show several significant relationships between different socio-economic status components and either BMI or obesity, the relationships differ for each country.

The results show there is no significant relationship between BMI or obesity and the area people live in. This result is not what was expected and is not in line with studies by Popkin (2001) and Kushi (2006) who focus on the difference in diets and environment between rural and urban areas. The results that there is no difference in urban and rural areas has also been found by Peytremann-Bridevaux et al. (2007), who studied 10 European countries.

The relationship between socio-economic status and BMI or obesity differ for each country, these relationships are concluded in the following paragraph. First, the expectation that higher income is associated with lower BMI and obesity numbers, is confirmed only for France. This result is in line with studies of Nikolaou and Nikolaou (2008) and Atella and Kopinska (2014). Studies by Wilkinson (1997), Su et al. (2012) and Devaux et al. (2011) show that in addition to absolute educational level and income, relative educational level and income are important contributors to obesity. This has not been considered in this study. Second, as was expected, people with a high educational level have a lower BMI and are less likely to be obese than people with a low educational level. This is in line with what Atella and Kopinska (2014) report. This result was found in both countries, but the coefficients for France are higher than for Hungary. Third, a statistically significant relationship was found between gender and either BMI and obesity. Being a woman decreases BMI and women are less likely to be obese, this result was found in both France and Hungary and is what was expected. This result is in line with Kanter and Caballero (2012) who state that in the developed world men are more often obese than women are, which is confirmed by Ameye and Swinnen (2019) who raise several explanations for this difference, one explanation they raise is that women are more concerned with healthy behaviour and diets. Fourth, a statistically significant relationship is found between BMI and living situation. For France people living with their partner BMI increases, while in Hungary BMI decreases for people living with their ex-partner. The relationship found in France was expected and is in line with what Klos and Sobal (2013) found, who explain this by stating that being married results in less personal time that can be spend working out. No significant relationship was found for obesity and living situation.

Taking all information into consideration and to answer the research question, it can be concluded that in France, a high socio-economic status is associated with a lower likelihood of being obese. In Hungary, there are some signs of this association, but it cannot be concluded based on this study.

6.2 Discussion

This study has demonstrated obesity is a complex disease, associated with many other factors, there are also some limitations to this study. First, the use of BMI and its application to determine obesity have both been criticized by many. BMI is a measure that is easy to use, since only height and weight are needed to calculate it. But, this calculation leaves no room for information about muscle mass and fat distribution. As a result, one can be attributed a high

BMI and be regarded as being obese, while in fact being very muscular. In addition, BMI is often measured using self-reported height and weight. Bodor et al. (2010) draw attention to the fact that men often overreport their height, and that women underreport their weight. As a result, the number of obese people might be higher in reality than has been calculated based on BMI.

Second, weights are used during the regression analyses, the weighed number of cases for Hungary is much lower than the number of respondents in the sample. To check if these low numbers can explain the absence of significant relations between various variables and obesity in Hungary, the regression has also been done without applying the weights. This regression shows the same results as the regression with weights does. Therefore, it can be concluded that the number of cases is no explanation for the absence of significant relationships. This second regression does show the robustness of the first model, performed with weights.

Third, for all regression performed, (pseudo) R-squared is low. Which suggests there are factors influencing BMI or obesity that have not been included in the models in this study.

6.3 Recommendations

It has become clear that obesity is a global problem that can cause damage to many people. The results of this study have also shown that some groups of people show higher BMI values and are more likely to be obese. Taking this into consideration, policies that promote a healthy lifestyle should focus on those in the lower socio-economic classes. Educating people about the effect lifestyle changes might make them more aware of the consequences of their choices and the health benefits they can achieve by changing these choices. Not only can individuals benefit from better health, the society can benefit from this by a decrease in medical costs caused by obesity and obesity related diseases. The money that is being saved, can be directed towards more and better education for all.

Recommendations for future studies include other or additional measures to determine obesity. While BMI is an easy and approachable method to determine nutrition status, it has some shortcomings. These can be solved by including other measures, for instance waist-hip ratio. Also, self-reported height and weight might be slightly different from reality, to achieve real numbers it would be better for researchers to measure height and weight, although this is time consuming and expensive.

In addition, to gain better insight in the trends observed in obesity, it is recommended to study the association between obesity and socio-economic status over a longer period of time. By doing this, possible trends in the association with obesity can be uncovered, which in turn might improve educating people and better target policies.

In the case of Hungary, there are large internal differences in health status, therefore to deepen knowledge about obesity in Hungary it is recommended to differentiate between different areas in the country.

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Appendices

Appendix 1. Results unweighted linear regressions

Table 8. Results unweighted linear regressions

Dependent variable BMI	**France and Hungary**	**France**	**Hungary**
Country (ref: Hungary)			
France	-0,5844* (0,216)		
Country * area	-1,2017** (0,382)		
Main predictor variable			
Area (ref: rural)			
Urban	0,6709** (0,294)	-0,5006** (0,254)	0,3773 (0,295)
Socio-economic status			
Income (ref: low income)			
Medium income	-0,6288** (0,230)	-0,8970** (0,288)	-0,0471 (0,397)
High income	-0,5115* (0,281)	-1,0644** (0,374)	0,4655 (0,453)
Educated (ref: low educated)			
Medium educated	-0,5227** (0,240)	-0,8436** (0,313)	-0,1070 (0,383)
High educated	-1,5205*** (0,309)	-1,7761*** (0,398)	-1,0946** (0,511)
Work (ref: in paid work)			
Not in paid work	-0,1021 (0,240)	-0,1154 (0,307)	-0,1245 (0,387)
Religion (ref: atheist)			
Christian religions	0,6615*** (0,184)	0,6593** (0,243)	0,6126** (0,282)
Jewish	-0,3239 (1,331)	0,1102 (1,424)	-3,1643 (4,448)
Islamic	1,8838*** (0,529)	1,7161** (0,558)	-1,1426 (4,445)
Other	1,0329 (1,270)	0,0260 (1,350)	11,6461** (4,443)
Partner (ref: not living with partner)			
Living with partner	0,4132** (0,199)	0,5999** (0,264)	0,1005 (0,307)

Living with ex-partner	-1,9872 (2,275)	-1,4425 (2,668)	-3,0729 (4,437)
Minority (ref: belonging to a minority)			
Not belonging to a minority	0,3977 (0,421)	0,4793 (0,582)	0,0586 (0,615)
Nutrition and physical activity			
Doing sports (days/week)	-0,1013** (0,0354)	-0,1271** (0,045)	-0,0426 (0,060)
Demographic variables			
Gender (ref: men)			
Women	-1,2528*** (0,177)	-1,4930*** (0,231)	-0,9112** (0,276)
Age group (ref: 20-29)			
30-39	1,4846*** (0,336)	1,5445*** (0,432)	1,4835** (0,535)
40-49	2,0736*** (0,334)	1,5801*** (0,435)	2,9424*** (0,531)
50-59	2,2808*** (0,335)	2,2597*** (0,434)	2,5442*** (0,543)
60-69	3,1398*** (0,347)	2,8088*** (0,455)	3,9062*** (0,552)
70+	2,6450*** (0,374)	2,2023*** (0,490)	3,5719*** (0,590)
Constant	25,0340*** (0,576)	25,1480*** (0,782)	23,9618*** (0,816)
R2	0,1063	0,1042	0,1052
Number of observations	2,797	1669	1128

*90% significant level (p-value<0.10), **95% significance level (p-value<0.05), ***99% significance level (p-value<0.01)

Notation in table: $\beta^{significance}$ (Std. Err.)

Appendix 2. Results unweighted logistic regressions

Table 9. Results unweighted logistic regressions

Dependent variable BMI	**France and Hungary**	**France**	**Hungary**
Country (ref: Hungary)			
France	-0,2566 (0,1894)		
Country * area	-0,3678 (0,232)		
Main predictor variable			
Area (ref: rural)			
Urban	0,2383 (0,169)	-0,1103 (0,164)	0,1290 (0,175)
Socio-economic status			
Income (ref: low income)			
Medium income	-0,3604** (0,138)	-0,6176** (0,185)	-0,0353 (0,223)
High income	-0,5427** (0,177)	-0,8800** (0,257)	-0,0207 (0,270)
Educated (ref: low educated)			
Medium educated	-0,2742** (0,136)	0,3153* (0,184)	-0,2801 (0,209)
High educated	-0,5868** (0,203)	-0,7117** (0,280)	-0,5101* (0,306)
Work (ref: in paid work)			
Not in paid work	0,1894 (0,153)	0,1057 (0,199)	0,2605 (0,242)
Religion (ref: atheist)			
Christian religions	0,2629** (0,116)	0,2071 (0,162)	0,3084* (0,170)
Jewish	-0,2347 (1,064)	0,0416 (1,094)	-
Islamic	0,7322** (0,314)	0,5001 (0,331)	-
Other	0,3387 (0,798)	-0,6011 (1,075)	-
Partner (ref: not living with partner)			
Living with partner	0,0819 (0,125)	0,2620 (0,176)	-0,0921 (0,185)
Living with ex-partner	-	-	-
Minority (ref: belonging to a minority)			

Not belonging to a minority	0,4685 (0,288)	0,5131 (0,434)	0,4100) (0,388)
Nutrition and physical activity			
Doing sports (days/week)	-0,0890*** (0,023)	-0,1113*** (0,032)	-0,0386 (0,037)
Demographic variables			
Gender (ref: men)			
Women	-0,1616 (0,111)	-0,2205 (0,153)	-0,1366 (0,167)
Age group (ref: 20-29)			
30-39	0,8155** (0,282)	0,7769** (0,344)	0,9108* (0,497)
40-49	0,7957** (0,281)	0,4359 (0,359)	1,350** (0,477)
50-59	1,0261*** (0,275)	0,9318** (0,342)	1,3122** (0,480)
60-69	1,3560*** (0,273)	1,1974** (0,347)	1,7909*** (0,469)
70+	0,9487** (0,287)	0,1485 (0,385)	1,9703*** (0,480)
Constant	-2,4040*** (0,410)	-2,1926*** (0,582)	-3,1598*** (0,614)
(Pseudo) R2	0,0644	0,0689	0,0748
Number of observations	2793	1666	1124

*90% significant level (p-value<0.10), **95% significance level (p-value<0.05), ***99% significance level (p-value<0.01)

Notation in table: $\beta^{significance}$ (Std. Err.)