REPUBLIC OF TURKEY
YILDIZ TECHNICAL UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
DEPARTMENT OF ECONOMICS
PROGRAM OF ECONOMICS

MASTER THESIS

THE EFFECTS OF COUNTRIES' INCOME LEVELS ON OBESITY: A PANEL DATA APPROACH

BÜŞRA KESİCİ
17729005

SUPERVISOR:
Assoc. Prof. Dr. YASEMİN ASU ÇIRPICI

İSTANBUL
2020

REPUBLIC OF TURKEY
YILDIZ TECHNICAL UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
DEPARTMENT OF ECONOMICS
PROGRAM OF ECONOMICS

MASTER THESIS

THE EFFECTS OF COUNTRIES' INCOME LEVELS ON OBESITY: A PANEL DATA APPROACH

BÜŞRA KESİCİ
17729005
ORCID NO: 0000-0002-0731-0920

SUPERVISOR:
Assoc. Prof. Dr. YASEMİN ASU ÇIRPICI

İSTANBUL
2020

REPUBLIC OF TURKEY
YILDIZ TECHNICAL UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
DEPARTMENT OF ECONOMICS
PROGRAM OF ECONOMICS

MASTER THESIS

THE EFFECTS OF COUNTRIES' INCOME LEVELS ON OBESITY: A PANEL DATA APPROACH

BÜŞRA KESİCİ
17729005

Thesis Issue Date:

Thesis Defense Date: 27/07/2020

The thesis is approved unanimously vote by the Jury.

		Title Name Surname
Thesis Supervisor	:	**Assoc. Prof. Dr. Yasemin Asu Çırpıcı**
Jury Members	:	**Assoc. Prof. Dr. Seçkin Sunal**
	:	**Assoc. Prof. Dr. Dilek Çetin**

İSTANBUL
JULY 2020

ÖZ

ÜLKELERİN GELİR DÜZEYİNİN OBEZİTE ÜZERİNE ETKİSİ: BİR PANEL VERİ ANALİZİ
Büşra KESİCİ
Temmuz, 2020

Obezite ve onunla ilişkili hastalıklar dünya genelindeki ölümlerin yaklaşık %60'ının nedenidir ve ülkelerin morbidite ve mortalite oranlarında büyük artışlara neden olmaktadır. Obezite probleminin tüm dünyada yıldan yıla artış gösterdiği gözlenmektedir. Bu sebeple obezite ve nedenleri üzerine yapılan çalışmalar önem kazanmıştır. Bu çalışmanın amacı, gelirin yetişkinlerde obezite hastalığı üzerindeki etkisini tahmin etmektir. Çalışmamızda obezitenin tanımı yapılmış, oluşum nedenlerinden, insan sağlığına ve ülke ekonomilerine etkilerinden bahsedilmiştir. 1975-2016 dönemine ait WHO ve World Bank verileri kullanılarak panel veri analiz yöntemi uygulanmıştır. Analiz 4 grup için ayrı ayrı yapılmıştır. Birinci grup 189 ülkeyi içeren tüm dünya ülkeleridir. Ülkelerin gelir durumlarının, yetişkinlerde obezite ve gelir ilişkisini ne şekilde etkilediğini belirlemek amacıyla bu ülkeler World Bank gelir gruplarına göre gruplandırılmıştır ve düşük gelirli, orta gelirli ve yüksek gelirli ülke grupları için analiz tekrarlanmıştır. Bağımlı değişken olarak WHO üzerinden alınan yetişkinlerde obezite prevelansı verisi kullanılmıştır. Çalışmamızın ilgi değişkeni kişi başına düşen gayri safi yurt içi hasıladır. Yetişkin obezitesi üzerine etkisi olduğu düşünülen şehirleşme, eğitim, endüstriyel istihdam ve sağlık harcamaları değişkenleri modele kontrol değişkenleri olarak eklenmiştir. Bu değişkenlerin verileri World Bank üzerinden alınmıştır. Yapılan ekonometrik testler sonucu, tüm gruplar için, Driscoll-Kraay dirençli standart hatalar ile sabit etkiler modelinin uygulanmasına karar verilmiştir. Çalışmamızın sonuçlarına göre gelir artışının, hem tüm dünya ülkelerinde hem de düşük, orta ve yüksek gelirli ülke gruplarında, yetişkin obezitesini arttırıcı etki gösterdiği tespit edilmiştir.

Anahtar Kelimeler: Driscoll-Kraay Standart Hatalar, Gayri Safi Yurtiçi Harcama, İktisat, Obezite, Panel Veri Analizi, Sabit Etkiler Modeli

ABSTRACT

THE EFFECTS OF COUNTRIES' INCOME ON OBESITY: A PANEL DATA APPROACH
Büşra Kesici
July, 2020

Obesity and the diseases related to it are the reasons of approximately 60% of deaths worldwide and cause great increases at rates of morbidity and mortality of countries. It is observed that the obesity problem showed increase year by year in the whole world. Therefore, the studies made on obesity and its reasons gained importance. This study aims to estimate the effect of income on the obesity disease at adults. In our study, obesity is defined, reasons of its emergence, and its effects on the human health and economies of countries are mentioned. The panel data analysis method was applied by using data of WHO and the World Bank belonging to the term 1975-2016. The analysis was made for four groups separately. The first group is the whole countries, including 189 countries. The others are low, middle, and high income countries. As the dependent variable, the prevalence of obesity in adults taken from WHO was used. The variable of interest of our study is GDP per capita. The urbanization, education, employment in industry, health expenditure data of the World Bank are used as control variables. The appropriate model for this analysis is found to be the fixed effects model with the Driscoll-Kraay robust standard errors for all groups. The results indicate that the income increase showed an effect increasing adult obesity in both the low, middle, and high income countries groups and also the whole countries according to our study.

Key Words: Driscoll-Kraay Robust Standard Errors, Economics, Fixed Effects Model, Gross Domestic Product, Obesity, Panel Data Analysis

ACKNOWLEDGEMENTS

My profound thanks to my dear advisor Associate Professor Yasemin Asu Çırpıcı does not stint every kind of her supports from me in spite of all difficulties experienced due to pandemic process in our country and all over the World, I could contact her every time, interested in all of my problems one by one, shared her experience with me until the down to the last detail, the greatest supporter of me during the thesis process, always reassured me and told that I would prepare this thesis in the best way and has the greatest share in my success as a result. I will be grateful to her lifelong. I would like to thank Associate Professor Dilek Çetin for every kind of her supports and helps in the econometric application used in my study, as she shared her knowledge with me, huge contribution in taking the final form of this thesis. I would like to thank Associate Professor Seçkin Sunal as he ensured through his constructive and realizing interpretations that my thesis took its final form.

I would like to especially remember my dear family members, the greatest supporters of all decisions made by me in life, with me every time, ensuring every kind of possibilities to me, so to speak, do whatever I want. I would like to thank my dear father Cengiz Kesici, shared his experience with me, presented his original opinions to me in order to find the subject of my thesis, tried to motivate me, my dear mother Aysel Kesici dedicated herself to her family, always became with me while preparing this thesis, I always felt her material and nonmaterial supports, helped me in all remained works of me, made many self-sacrifices for me and showed patience to me in the process, my clever and hardworking, honey brother Ahmet Salih Kesici, the most valuable wealth I have in my life, the person loved by me mostly in life, impressed me to his words with his nice child hearth and his over wise, source of the greatest morale and motivation of me. I owe thanking to dear Nesrin Karakaya, who I always feel is there for me, with the moral support and reassurance she gave me. I would like to thank all my friends for every kind of their supports great or small during process, particularly to my dear friend Raşit Şahin as he shared his thesis experiences with me.

Istanbul; July, 2020 Büşra Kesici

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

BMI	: Body Mass Index
ECHP	: European Community Household Panel Survey
FLP	: Female Labor Participation
GDP	: Gross Domestic Product
GLS	: Generalized Least Squares
GNI	: Gross National Income
HFCE	: Household Final Consumption Expenditure
KOF	: Konjunkturforschungsstelle
LBI	: Locally Best Invariants
LM	: Lagrange Multiplier
LR	: Likelihood Ratio
NHANES	: National Health and Nutrition Examination Survey
NUTS	: Nomenclature of Territorial Units for Statistics
OECD	: The Organization for Economic Cooperation and Development
OLS	: Ordinary Least Squares
POLS	: Pooled Ordinary Least Squares
PPP	: Purchasing Power Parity
p.p.	: percentage point
U.K.	: United Kingdom
U.S.	: United States
WHR	: Waist-Hip Ratio
WHO	: World Health Organization
VIF	: Variance Inflation Factor

1. INTRODUCTION

Obesity became one of the serious health issues in many countries. Being an important cause of many diseases, in many cases, obesity itself is accepted as a disease. It is shown that obesity is increasing in all countries year by year. According to the World Health Organization (WHO), in 2016, more than 1.9 billion adults above eighteen were overweight, and 650 million of them were obese. These figures show that 13.1% of the world's population has the obesity problem in the year 2016. In Turkey, this rate was found as 32.1%. It is becoming important to find the causes and consequences of obesity and control this increasing disease. Obesity is related to chronic medical terms, decreases the quality of life, raises the health expenditures, decreases the life expectancy. It is linked to other diseases. It damages people's metabolism and causes a rise in blood pressure and cholesterol. Hearth diseases, diabetes, and cancer risks rise with being obese. It is shown that obesity causes deaths more than the underweight problem.

While obesity was seen as a problem of the developed countries at the beginning, it is observed that it is increasing continuously in developing countries, even in underdeveloped countries. Since the obesity concerns the masses due to be seen in every community and level of income, it has become an economic issue beyond being just a health problem. Increase in the number of obese individuals increases the health care cost. Obesity lowers the efficiency at work and labor productivity of individuals. Decrease is seen in the employment rate because obese individuals are not preferred in recruitments in general. Obesity increases the disability of individuals and absent days at work. Also, obesity causes higher morbidity and mortality rates. The average life period and life expectations of them are low. All these negative cases also cause early retirement because of death or because of the inefficiency at work.

In the developing and underdeveloped countries, it is observed that increase in the income level, adoption of the western lifestyle, decrease in energy spending while energy intake increases, and immigration from rural to urban regions caused increase in rates of obesity. The life conditions got easy with the developments in technology, particularly in the transportation, production, and agricultural fields. Easier life conditions lower physical activities. Also, feeding habits changed in modern living conditions. In modern life, the diet, including the healthy, organic, low calorie, and home-made food was left, the diet including mostly fast food, extremely oily, energy-dense food, poor in the vegetable fibers, rich in the refined carbon hydrates, unhealthy food was started. The usage of advanced technology tools such as mobile phones, television, computer, home theater, fill the leisure times of individuals caused them to spend time on such activities rather than exercising in their spare time. All these are the primary reasons of the increase seen in obesity. In addition to these, the socioeconomic factors such as the income levels, the education levels, the living environment, sexualities, ages, the working conditions of persons also affect the rates of obesity.

Because of its rapid growth worldwide and its negative impact on human health and country economies, obesity studies become important. In this study, the effect of income on obesity among adults is analyzed between the years 1975-2016. The answers to the following questions are investigated: Is there such an effect, what is the sign of the relationship if any? Does the effect of income on obesity show any change as long as the income levels of countries change?.

The variable of interest is taken to be the GDP per capita; also, urbanization, education, employment in industry, and the public health expenditures are added as the control variables to the model. The dummy variable was added to the model in order to be able to observe the effect of countries that might be outlier by considering the average obesity values of countries. The model was analyzed by using the panel data method. Panel data analysis was made for four groups separately. Firstly it was applied for all 189 countries, and its results were evaluated. These countries were separated as the low income, middle income, high income according to their income groups subsequently, and the econometric analysis was repeated for all these groups.

The rest of the study is structured as follows: Section 2 provides information about the conceptual framework of obesity, its causes, methods of measurement and diagnosis, frequency of occurrence in Turkey and the World. Also, it addresses the perspective of economics on weight gain and obesity. Section 3 includes a literature review prepared by examining the studies on the relationship between obesity and GDP per capita. Section 4 explains the panel data analysis, the selected analysis method, the reasons for selecting the variables used in the model, the details of the variables and the data set used, and also presents the results of the panel data analysis, and Section 5 gives the conclusions.

2. CURRENT STATUS, DETERMINATION, CAUSES AND ECONOMICS OF OBESITY

2.1. The Conceptual Framework of Obesity

The obesity is a chronic disorder that stems from the excessive energy gaining via the nutrients to the body, which is more than the amount spent and becomes characterized by an increase of body fat mass in proportion to the lean body mass (Altunkaynak, Özbek, 2006, 138). World Health Organization (WHO) defines overweight and obesity as excess fat accumulation that causes people to become unhealthy. It may also be interpreted as "…eating addiction because the overeating is accepted as addiction stems from both psychological and physiological factors" (Keser, 2018).

At the times when the life span of humans was low, obesity was an indicator of power, welfare, and health. However, nowadays, it is accepted as a public health concern that should be treated. According to WHO, obesity is accepted as one of the most critical ten health problems in the global sense (Saruç, 2015, 47). It is a significant reason for morbidity and mortality (Ersoy, 2018). Obesity-related diseases are responsible for 60% of adult deaths worldwide. These diseases can be listed as the obesity and its accompanier of chronic endocrine (Type 2 diabetes), cardiovascular (hypertension, atherosclerosis), gastrointestinal (hepatosteatosis), and pulmonary diseases (sleep apnea and asthma). These diseases ruin life quality and shorten the lifetime. Obesity-related death frequency is increasing. According to the WHO data, 2.8 million people died because of obesity in 2016, and it was the first time that the frequency of obesity-related deaths surpasses the one that stems from undernourishment (Kara, 2018).

Obesity can cause significant complications in every age group. Not only adult men and women but also children and the young ones are being affected by this situation (Ministry of Health, 2010, 15). It influences 25-30% of children and adolescents. Childhood obesity has an increasing prevalence throughout the world, particularly in developed countries. It emerges as an essential health problem in terms of the increase in morbidity and mortality during the adulthood period regarding the obese ones in their childhood period, the fact that 50% of the obese ones in the adolescent period are also obese in adulthood and not to be mostly seen by families and physicians as a disorder that must be treated (Gürel, İnan, 2001, 39).

Because it is spreading increasingly and brings many critical health problems, obesity itself is now seen as a disease. The World Obesity Federation indicates that obesity is a chronic, repeated, progressive disease (WHO, 2000). They also stress that there is a need to prevent and control this global disease immediately.

2.2. The Various Factors Causing Obesity

Overeating that is accompanied by malnutrition and lack of physical activities are accepted as the most important reasons for obesity. Developments in today's technology have made life easier; on the other hand, it also limited daily movements to a considerable extent. Providing that the daily amount of energy intake is much than the one spent, the rest of the energy is stored in fat form into the body and causes obesity formation. Moreover, according to the data of National Health and Nutrition Examination Survey (NHANES), the average energy intake has shown an increase of 2350-2785 kcal in men and 1534-1946 kcal in women in comparison to the almost 40 years before (Nişancı Kılınç, 2018).

There are other reasons for obesity; it has psychological triggers and consequences. Also, genetic factors are effective. But, excessive increase of obesity throughout the world, especially during the childhood period, can’t be explained with solely the genetic alterations; it refers that the role of environmental factors in the formation of the obesity is in the forefront. Moreover, several other mechanisms and factors such as epigenetic, social, economic, behavioral, and biological affect obesity (Keser, 2018).

The Ministry of Health lists the main risks and factors affecting obesity as (Ministry of Health, 2010, 15):

- Food habits related to overeating and malnutrition
- Insufficient physical activity
- Age
- Gender

- Level of education
- Socio-cultural factors
- Income status
- Hormonal and metabolic factors
- Psychological problems
- Very low-energy diets implemented infrequent intervals
- Cigarette and alcohol consumption
- Certain pills taken (antidepressants etc.)
- Parity and inter-birth interval
- Genetic and epigenetic factors

Moreover, with the economic prosperity of countries increases, obesity rates have increased considerably (Saruç, 2015, 19). Another factor which is worthy of notice and has a role in obesity development is the nutrition style in the first years of one's life. In researches conducted, it was observed that the incidence of obesity was lower in children who were fed with breast milk than in children who were not fed (Ministry of Health, 2010, 15).

2.3. Determination of Obesity

The identification and classification of body weight is an important part of the evaluation of individuals. The methods of the assessment used for this purpose; Body Mass Index (BMI), waist circumference, waist-hip ratio (WHR), and body shape. The most accepted and most prevalent methods are BMI and waist circumference (Lewis et al., 2014). Although there are several other methods of evaluation, they will not be mentioned because of being out of the scope. Only BMI will be evaluated in this study.

2.3.1. Body Mass Index (BMI)

Among the methods which measure obesity, the most common measure is the BMI because it is an inexpensive and easy assessable tool. BMI is calculated by dividing the person's weight in kilograms by their height in meters squared (Dicker, 2018).

$$\mathrm{BMI}=\frac{\mathrm{weight(kg)}}{\mathrm{height(m^2)}} \tag{1}$$

We can classify the BMI evaluation as in adults, in children under 2-year old, in children over 2-year old and adolescents.

The international BMI classification in adults, according to WHO, is presented in Table 1.

Table 1: BMI Classification in Adults

Underweight	**<18.5**
Normal range	≥18.5 and <25
Overweight (Pre-obese)	≥25 and <30
Obesity	≥30
Obesity class I	≥30 and <35
Obesity class II	≥35 and <40
Obesity class III	≥40

World Health Organization. [06.06.2020]. Global Strategy on Diet, Physical Activity and Health.
https://www.who.int/dietphysicalactivity/childhood_what/en/.

BMI can be used to classify the person within groups ranging from underweight to obese. According to the table, the measurement of BMI that is less than 18.5 means weakness. It is within the normal range of 18.5 to 24.99.

Overweight is defined as a BMI of between ≥25 $\mathrm{kg/m^2}$ and <30 $\mathrm{kg/m^2}$. It is also defined as pre-obesity. Obesity is classified as a BMI of 30 $\mathrm{kg/m^2}$ or more, and is split into three classes of increasing severity:

Obesity class I with a BMI of ≥30 and <35 $\mathrm{kg/m^2}$

Obesity class II with a BMI of between ≥35 and <40 $\mathrm{kg/m^2}$

Obesity class III with a BMI of over 40 kg/m^2

The obesity class III persons, whose BMI evaluation is 40 or over, are also defined as morbid obese.

For example, a 35-year-old woman with 1.60 m tall stature and weighing 60 kg is fat? According to the BMI formula:

$$\text{BMI} = \frac{\text{weight(kg)}}{\text{height}(\text{m}^2)} = \frac{60}{(1.60)\times(1.60)} = 23.43 \qquad (2)$$

She is not an overweight or obese person. She is in the normal range according to BMI measurements.

For children under two years of age, weight is evaluated in correspondence to length for obesity. It is normal to be within the ratio of 90-110% for weight in correspondence to the length. In the case of a ratio of 110-120%, it means overweight; if it is more than 120%, then there is a case of obesity (Kara, 2018).

There is not any classification in children and adolescents like the one in adults, and different approaches are used for determining the status of overweight and obesity. One of the most applied methods is using the percentage at the levels of individual and communal (percentile) or z score values. In order to evaluate the overweight and obesity in children correctly, it is necessary to consider the gender and age of the child. For this purpose, percentile curves are used. The percentile value of a child indicates child's ranking among a hundred children of the same age. For example, if the weight of a 12 years old boy is in the 49th percentile, his weight is more than 49% of boys at the same age and less than 51% of them.

The classification in over 2-year old children from weakness to obesity is presented in Table 2.

Table 2: The Percentile Classification in Children and Adolescents (> 2 age) at the Individual and Communal Levels

CLASSIFICATION	**PERCENTILE**
WEAK	<5% percentile
NORMAL	5%–84% percentile

Table 2 – continued

OVERWEIGHT	85%–94% percentile
OBESE	≥95% percentile

Kara, Cengiz. 2018. Pediatrik Obezitenin Önemi: Obezitesi Olan Çocuk daha Obez Erişkin mi Olacak?. **9. Ulusal Obezite Kongresi Bildiriler, 22- 25 November 2018.** Ankara: Türk Diabet ve Obezite Vakfı: 41-44.

According to the table, the value of evaluation, which is less than 5% percentile, is an indication of weakness in the children and adolescents over 2-year old. The value of assessment, which is between 5% and 85% percentile, is an indication of being within the normal range. The individual with a percentile between 85% and 95% is diagnosed as overweight while 95% percentile and more are diagnosed as obese (Kara, 2018, 41).

Childhood obesity is significant because the higher the BMI in childhood, and the earlier the obesity starts, the likelihood of obesity in adulthood is higher. 62-98% of obese patients in childhood and adolescent continue to have obesity in adulthood, and diabetes and heart disease are developed on these people at a younger age. The continuation of severe obesity from childhood to adulthood creates social and psychological costs on the individual, increases medical costs, limits productivity, and reduces life expectancy. If the obese adult is a woman, she commits the transduction of this obesity to the next generation through the same way, and a vicious circle comes to exist. This inter-generation transduction has a crucial role in obesity's becoming a prevalent disorder recently (Kara, 2018, 41-42). Hence, weight control starting from childhood is very important. Once obesity comes to exist, it is too hard to deal with it. For this reason, the real effort must be made to prevent obesity.

It might not be right to establish a diagnosis criterion via BMI in older people. In older people, the length becomes shorter due to osteoporosis; the fat rate becomes higher while the muscle mass lessens, and much more fat deposit comes to exist around the waist circumference as the body fat distribution is altered. Thereby, the BMI cut-off points, which are used in order to determine obesity in adults, may not be valid for older people. Actually, the "Obesity Paradox" term that is used in older people refers to this contradiction. Obesity-related morbidity and mortality in individuals over seventy years of age, unlike the other adults, start with BMI > 33 kg/m^2 (Şahin, 2018).

2.4. Prevalence of Obesity in Turkey and the World, Statistical Studies

World Health Organization (WHO, [13.06.2020]), states that the obesity almost threefold from 1975 to 2016, and more than 1.9 billion adults aged 18 and older are reported overweight (BMI ≥25) and more than 650 million of these are obese (BMI ≥30) in 2016. According to this data, 39% of the world population is overweight, and 13% of them are obese.

In this section, utilizing the prevalence of obesity among adults data from the WHO, the rate of obesity in adults aged 18 and above, both in Turkey and the World, were examined and evaluated with the help of graphs created from the data set.

2.4.1. Obesity in the World

Obesity rates are increasing day by day all over the world. In this subsection, with the help of graphs created from the WHO data, it is explained how obesity has changed in adults aged 18 and over between the years 1975 and 2016 in the world. Also, graphs are created and evaluated separately for both genders. Finally, by looking at the data of 2016, the rate of obesity in adults in the world has been compared, considering the income groups of countries. The change of adult obesity rate in the total population in the world between the years 1975 and 2016 is given in Figure 1.

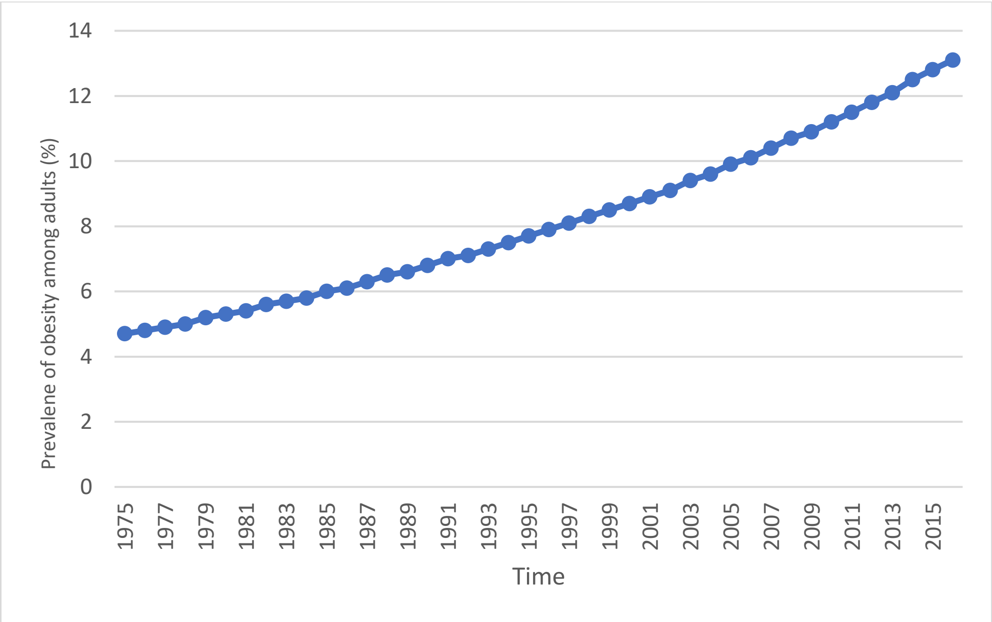

Figure 1: Prevalence of Obesity among Adults in the World (%)

Created by the author by using WHO prevalence of obesity among adults data

When Figure 1 is examined, it is observed that the rate of obesity in adults has increased from year to year between 1975 and 2016 in the world. While this rate was 4.7% in 1975, it increased to 13.1% in 2016.

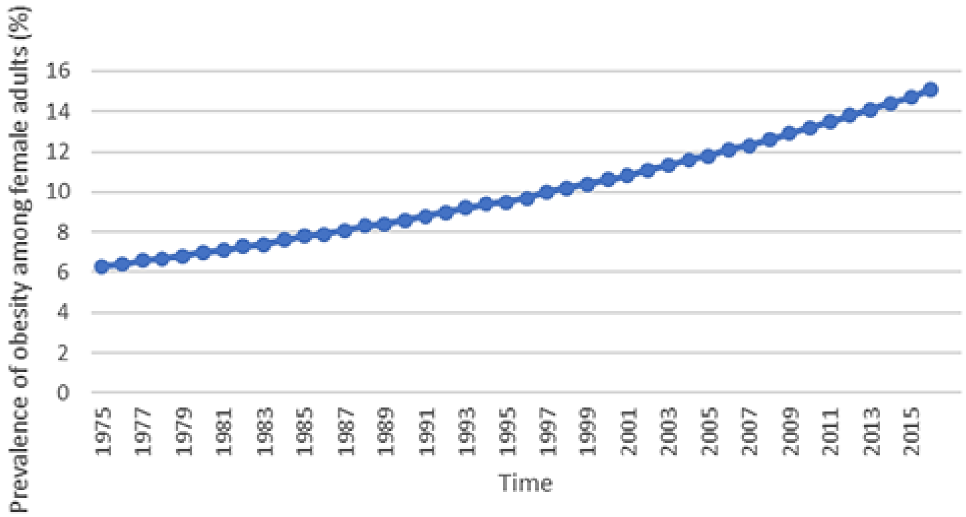

Figure 2: Prevalence of Obesity among Female Adults in the World (%)

Created by the author by using WHO prevalence of obesity among female adults data

When the Figure 2 and Figure 3 are examined together, between 1975 and 2016, the rate of obesity in adults increased for both sexes worldwide. In 1975, the obesity rate was 6.3% for women and 2.9% for men. This rate increased to 15.1% in women and 11.1% in men. Both in 1975 and 2016, women are observed to have a higher obesity rate than men. However, in the same time frame, it is observed that the obesity increase rate in men is higher than the increase rate in women.

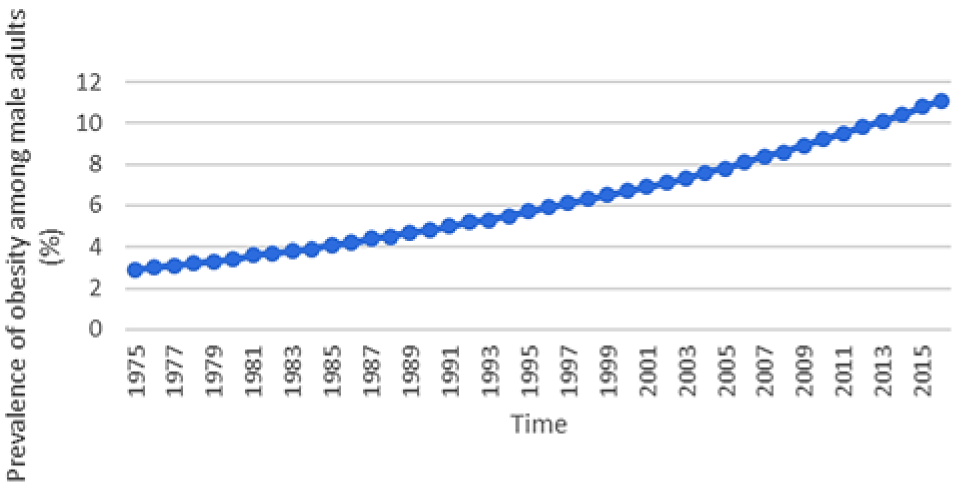

Figure 3: Prevalence of Obesity among Male Adults in the World (%)

Created by the author by using WHO prevalence of obesity among male adults data

In the WHO website, world countries are divided into four income groups, and obesity rates in adults were examined according to income groups. These groups are low income, lower middle income, upper middle income, and high income countries. In 2016, obesity rates in adults were founded 6.8% in low income, 7.6% in lower middle income, 13.8% in upper middle income, 24.6% in high income countries. According to the conclusion from these rates, the rate of obesity in adults is the highest in high income countries. This rate decreases as the income level of the countries decreases.

As a result, between 1975 and 2016 in the world, obesity has been observed to increase every year for both sexes and all income groups. This situation indicates that the problem of obesity, which is getting worse gradually, is a common problem for the whole world.

2.4.2. Obesity in Turkey

The obesity rate in adults aged 18 and older is increasing year by year in our country as in other world countries. Given the data in 2016, our country is the 17th country with the highest obesity rates in adults. This result shows that our country is also included in countries with obesity problems, and this problem is getting worse day by day. Therefore, obesity studies are of great value for our country. In this subsection, firstly, between 1975 and 2016, the change in adult obesity rates in Turkey was examined with the help of graphs created from WHO data. Also, graphs are created and evaluated separately for both genders. Afterward, obesity distribution in Turkey was evaluated by region by benefiting from the findings of Turkey Nutrition and Health Research, which is one of the original studies conducted by the Ministry of Health in 2010. The change of adult obesity rate in the total population in the world between the years 1975 and 2016 is given in Figure 4.

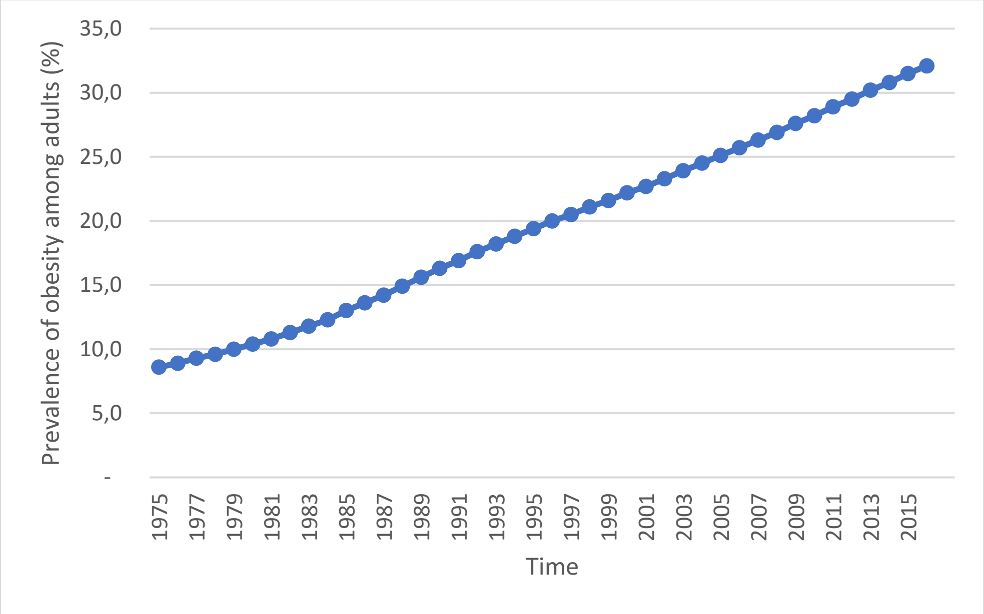

Figure 4: Prevalence of Obesity among Adults in Turkey (%)

Created by the author by using WHO prevalence of obesity among adults data

When Figure 4 is analyzed, it has been observed that the rate of obesity in adults increased every year between 1975 and 2016 in our country. In Turkey adult obesity rate, from 8.6% in 1975 to 32.1% in 2016, showed a considerable increase.

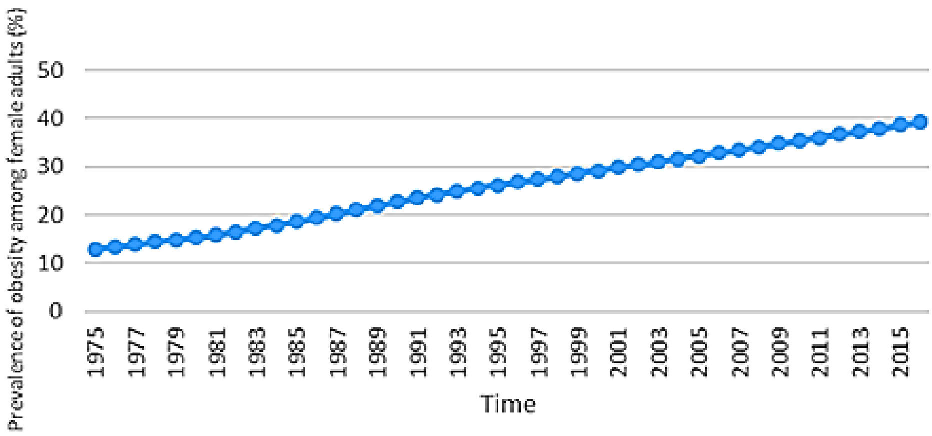

Figure 5: Prevalence of Obesity among Female Adults in Turkey (%)

Created by the author by using WHO prevalence of obesity among female adults data

When Figure 5 and Figure 6 are examined, it is observed that between 1975 and 2016, the obesity rate in adults increased for both women and men. In 1975, the rate of obesity in women was 12.9% and 3.9% in men. It seems that the rate of obesity in women is significantly higher. In 2016, the obesity rate rose to 39.2% in women and to 24.4% in men. In 2016, women still had a higher rate of obesity than men. However, in 42 years, the rate of increase in men was found to be higher than the increase in women.

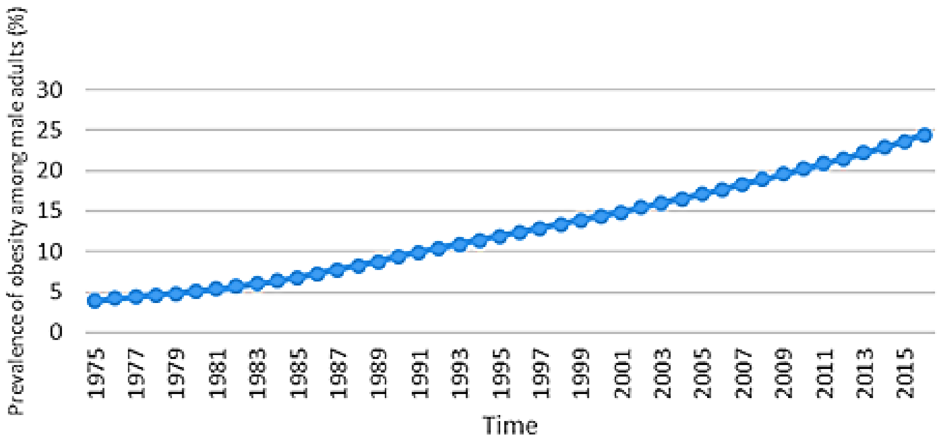

Figure 6: Prevalence of Obesity among Male Adults in Turkey (%)

Created by the author by using WHO prevalence of obesity among male adults data

According to the findings of the Turkish Nutrition and Health Research conducted by the Ministry of Health in 2010, obesity rates in adults in Turkey vary from region to region. The distribution of the obesity rate in adults by region in Turkey is shown in Table 3.

Table 3: Regional Distribution of Obesity

Nomenclature of Territorial Units for Statistics (NUTS) 1 Region	%
İstanbul	33,0
West Marmara	30,7
East Marmara	30,6
Aegean	28,0
Mediterranean	30,1
Western Anatolia	33,0
Central Anatolia	32,9
Western Black Sea	31,3
Eastern Black Sea	33,1
Northeastern Anatolia	23,5
Central East Anatolia	20,5
Southeastern Anatolia	22,9

Ministry of Health. [03.12.2019]. Türkiye'de Obezitenin Görülme Sıklığı. https://hsgm.saglik.gov.tr/tr/obezite/turkiyede-obezitenin-gorulme-sikligi.html.

As it is seen in the regional distribution, obesity is most common in İstanbul, the Eastern Black Sea, Western Anatolia, and Central Anatolia. West Marmara, East Marmara, Western Black Sea, and Mediterranean regions also have a high percentage of obesity. Regions in which obesity is the least common are Central East Anatolia, Southeastern Anatolia, Northeastern Anatolia. In the Aegean region, the rate is lower than the regions where the obesity rate is considered high but close to them. Regarding this issue, Surgeon Türker Karabuğa, who is a doctor in Kordon Obesity Center, stated that the obesity rate in Turkey increases westward. According to Dr. Karabuğa obesity rate is low in the Eastern and South-Eastern regions of Turkey because of their active lifestyle and natural diet. Even if they eat fatty foods, they do not get fat quickly.

Preferring healthy and natural foods, exercising regularly, being more active during the daytime, and drinking plenty of water is required for reducing obesity (Habertürk, [08.06.2020]).

2.5. Economic Overview of Obesity

Obesity is not only a medical problem but also an economic problem. If we try to explain obesity via economy science, we can say that individuals determine their nutrition styles, physical activity levels, and therefore their weight in a way that maximizes their utility. Of course, this utility maximization will be possible under time, budget, and biological constraints. The utility of individuals can be considered as a function of various factors such as the person's weight, health status, and the amount of food he/she eats.

According to Cawley (2010, 29), one of these constraints is time constraint. Since everybody has 24 hours in a day, if a person would allocate more time to exercise, he/she should cut down on his/her working or leisure time. The budget constraint expresses the limited income an individual has. For instance, having a membership in a sports club requires a certain budget. The budget constraint must be taken into consideration while deciding between nutritious, natural, organic, but expensive foods, and cheap but unhealthy foods. The biological constraint is the phenomenon of gaining weight as long as the calorie intake is more than the calorie expended.

Both current and future marginal benefits and costs are taken into consideration in the economic models. For example, while an individual eats junk food, as he/she takes into consideration both the price he/she paid for this food (current cost) and the taste and satisfaction he/she got (current benefit); he/she should also consider his/her future weight and health problems that may arise from the excess weight (future cost). The individuals generally prefer their short term interests to long term ones. However, an increase in preferring short-term interests may divert the individual from being a rational person. (Komlos, Smith, Bogin, 2004).

The marginal benefits of every lira spent by consumers must be equal in order to distribute their income optimal. Considering this situation for food consumption, the individual must gain equal net utility for each last unit lira that he/she has spent on different foods (Cawley, 2010, 29). If the marginal utility in spending the last lira of an individual for purchasing orange is less than the one in purchasing chips, it is expected the individual to increase the utility by buying the chips. When evaluated in terms of demand theory, if the prices of junk foods, fast foods, processed foods are lower than natural, healthy, organic foods, the individuals may prefer the unhealthy nutrition to appease their hunger. Moreover, considering the preparation and cooking times of healthy food groups, people may tend to consume fast foods due to time constraint.

If there is an increase in the benefit of the time we spent inactive after technological advances, for example, doing our job on computer, having fun by watching television, we expect an increase in the time we spend inactive. For this reason, the increase in inactive time will decrease the time we devote to sportive activities and exercise (Cawley, 2010, 30).

Considering from an economic point of view, some of the factors that cause obesity are given below (Crowle, Turner, 2010, 22):

- Situations where the individual's income increases and food costs decrease:

The income elasticity of food is usually low. When the individual's income rises, individuals reach the saturation point in terms of food consumption. Thus, they shift their income to other goods and services. Income growth leads individuals to out-of-home food consumption. Besides, rising income increases the opportunity cost of time for preparing food and exercising. With economic development, the effect of income on obesity can change. Also, technological development leads to a decline in food prices. This condition is one of the factors leading to an increase in the prevalence of obesity.

- Situations where the cost and opportunity cost of energy spending increases:

In addition to the fall in food prices, and the increase in income, the costs of physical activity are also increasing. Increasing production with technological development causes employees to have less physical activity and a decrease in energy spending. In this case, individuals are willing to pay money to be able to do physical activity in gyms in their spare time. High income level encourages physical activity.

- Situations in which the preferences of individuals change:

The fact that individuals prefer more and different food consumption and do less physical activity.

Individuals determine their own weight by determining their diet, what they eat, how much to exercise. In economics, individuals are expected to be rational and rational people want to maximize their benefits. The health status and weight of individuals are part of their utility function. An ideal level of weight positively affects the health of a person and increases his/her utility level. Various constraints are encountered while maximizing benefits. These are time, budget, and biological constraints. Individuals have difficulty making rational decisions consistently. They prefer current benefits such as unhealthy but delicious diet and not exercising to future costs such as future weight gains. It is more difficult to consider and evaluate the future benefits and costs compared to current benefits and costs. Individuals may not act in accordance with their own benefits, even if they have sufficient knowledge. These situations cause the problems of overweight and obesity to increase day by day.

3. REVIEW OF RELEVANT LITERATURE

The causes of obesity are the concern of different studies using panel data analysis. Masood and Reidpath (2017) investigate both individual-level and country-level causes of obesity using the data of World Health Survey in 2002-2004 for 70 low, middle, and high income countries for all regions. Gross National Income adjusted for purchasing power parity (GNI-PPP) and the Gini index are used as the main economic factors. Considering the work done at the country level, on average, low and middle income countries have lower BMI levels than high income countries. A 10.000 US$ increase in GNI-PPP was related to a 0.4 unit increase in BMI. Income inequality (Gini index) was not founded significant.

Loureiro and Nayga (2005) investigate the reasoning of obesity in OECD countries from 1990 to 2002. They use the panel regression model with generalized least squares (GLS) random effects and estimate two models. One of them has overweight, while the other one has obesity as the dependent variable of the model. BMI is taken as the measurement of overweight and obesity. As explanatory variables, average calorie expenditure per capita, the percentage of people who live in rural areas, the percentage of individuals who were older than 65, the percentage of women who work in the labor force, the per capita GDP constant at 1995 U.S. dollars, the percentage of GDP spent on education, the volume of traffic roads driven in each country by private vehicles, the emissions per capita, the rate of people who smoke, the agricultural output produced by per worker measured in monetary terms, the income transfers from consumers to agricultural sector are used. Results show that overweight has a positive and significant relationship with calorie expenditure per capita, female labor participation, and GDP per capita. The percentage of the population of people older than 65, rural population rate, smoker's percentage, CSE, and agricultural productivity per worker has a negative and significant relationship with overweight. Cars and emissions are founded insignificant.

The model for obesity indicates that calorie expenditures and cars are positively and significantly related to obesity. Besides, the rate of population older than 65, CSE and education expenditures has a significantly negative relationship with obesity. Other variables are not statistically significant.

Egger, Swinburn, and Islam (2012) try to relate the body weight with GDP, happiness, and carbon emission. Spline regression analysis is used for 175 countries in the year 2007. According to the scatter plot of GDP and mean BMI for both sexes, there is a close relationship between BMI and low levels of GDP. Spline analysis shows that two linear relationships (scatter plots of GDP and scatter plots of mean BMI) intersected best at a GDP of ~$3000. Below $3000 level, there have been 72 countries, and GDP is significantly and positively related to BMI and happiness in these countries. Above this level, 102 countries do not have a significant relationship between BMI and GDP.

Brunello, Michaud, and Sanz-de-Galdeano (2008) compare the prevalence of obesity in the United States (U.S.) and Europe. They observe that obesity prevalence in the U.S. is higher and increases more sharply. Comparing with Europe and Japan, one of the main reason of this higher obesity rate in the U.S. is the faster shift of its economy to the service sector. Their work states that obesity increases when people are getting older. They indicate that different countries have different obesity prevalence. It is known that obesity arises by taking more calories than consumed. However, there are more reasons causing obesity. Throughout the last two decades, the U.S. share of manufacturing employment has slightly risen compared to the United Kingdom (U.K.) and decreased a considerable extent with respect to other European countries and Japan. To find whether this shift related to the cross-country differences, they regress relative obesity rates – the U.S. and Europe, the U.S. and U.K., the U.S. and Japan – on the share of employees working in manufacturing. As a result, relative obesity rates and the relative share of manufacturing workers have a negative relationship. If the relative share of manufacturing rises 1 percent, relative obesity rates reduce 1.74 percent. This result shows that obesity increases as workers move from the exercise intensive agricultural or industrial jobs to the less physically demanding service sector jobs. Also, they control the effects of relative gross domestic product (GDP) per capita and relative female labor force participation. While the coefficient of the manufacturing share remained mostly unchanged, the only GDP per capita has a negative and significant effect. They argue that this negative relationship is due to the non-monotonic relationship between income and obesity and that there is a negative relationship between income and obesity for rich.

Also, they use cross country panel data from the OECD Health database, and the European Community Household Panel Survey (ECHP), including 12 developed countries from 1979 to 2004. The aim is to find the effects of obesity on life expectancy at birth. Life expectancy is founded to be related to GDP per capita negatively. Also, it has a positive relationship with schooling. There is an inverse relationship between life expectancy and obesity. An increase in obesity by 10 percent causes a decrease in life expectancy by 0.29 percent.

Some studies try to analyze the relation of obesity with certain variables. For example, Kinge et al. (2015) analyze the relationship between obesity and education. Data sets used for obesity and education contains 412.921 individuals and 70 countries between the periods 2002 and 2013. They apply two models as two-stage mixed-effects model and generalized linear models. Education levels are divided into four groups as no education, primary education, secondary education, tertiary education. Research has shown the relationship between GDP and individual education at both the individual levels and the country levels.

Results show that GDP is positively associated with obesity rates. Also, GDP has a positive relationship with each level of education for men and women. On the other hand, the relationship between GDP per capita and obesity change with the education level. For people with no education, there is a sharp increase in obesity prevalence when GDP per capita increases. The results are the same but weaker for people with primary education. For people with secondary education, GDP per capita, and obesity relationship are founded to be positive only for men. For people with tertiary education, when GDP per capita increases, there is little or no increase in obesity. As a result, obesity is positively associated with GDP per capita, but this result weakens when the education level of people increases. It is seen that these results decrease or disappear by being educated at a higher level. Education can mitigate the positive association between obesity and GDP.

Another model used in this article is generalized linear models in order to observe the educational inequalities in obesity, and the question is whether this is affected by economic development. According to the results of the generalized linear model, the prevalence of obesity increases when education level increases in the countries with lower levels of GDP (low income countries). In middle income or high income countries, obesity is more common in people with lower levels of education.

Pickett et al. (2005) aim to find whether obesity, deaths from diabetes, and daily calorie intake are related to income inequalities. Among the top 50 countries with the highest Gross National Income (GNI) per capita by PPP in 2002, the ones that have population greater than three million and have the necessary data available are taken. Twenty-one countries meet these requirements. They measured Pearson correlation coefficients, which are adjusted for absolute income per capita (GNI per capita), and used multiple linear regression models, which are adjusted for GNI per capita. After adjusting for GNI per capita, income equality has a positive correlation with both male and female obesity ratio in developed countries. GNI per capita does not have a significant relationship with either male or female obesity.

Lawson, Murphy, and Williamson (2016) examine the effects of socioeconomic freedom on obesity. They use an unbalanced pooled cross-section data of 135 countries with some control variables as development, gender, and health care spending. The analysis is implemented for the years 1995 and between 2000 and 2009. They also estimate the association of life expectancy with obesity, income, and economic freedom. Pooled OLS and fixed-effect models are used for both developing and developed countries. The dependent variable of the analysis is BMI. Independent variables are the log of real GDP per capita, the economic freedom rate, health spending share of the public sector, health care spending share in GDP, and per capita health spending.

The results show that an increase in economic freedom causes slightly more BMI levels for men in developing countries. In developed countries, an increase in income level causes higher BMI levels for men. No evidence is founded that economic freedom and income have an impact on female obesity. Also, they find that higher public health spending causes higher BMI levels in developed countries for both men and women. Also, in developing countries, economic freedom raises life expectancy in both men and women.

We are going to mention two studies specifically concentrated on obesity among women. One is by Minos (2016) who analyzed 126 low and middle income countries.

The article focuses especially on mother obesity. In order to correct heteroscedasticity, he uses fixed effects panel regression with robust standard errors. The main independent variables are income, which is the natural logarithm of the Gross Domestic Product per capita, purchasing power parity (PPP), in constant 2005 US$ and urbanization, which is the share of people who are living in urban areas. Control variables are education and healthcare. Secondary school enrollment is used for education variable, and for healthcare, the number of hospital beds per thousand people is used, and for robustness checks, the model includes the number of physicians per thousand people. In order to explain the structural changes in economics, the value-added services as a share of GDP and the food imports as a share of GDP are used.

The results show that per capita income and overweight rates have a significant and positive correlation. When the urbanization effect is examined, the urban population increases by 1%, the female obesity rate increases by 0.3946%. After adding the year dummies, the coefficient turns to negative and is not significant. Also, better health condition is negatively correlated with overweight, but it is not significant. Female education is positively related to female obesity and significant, but after year dummies are added, it turns to insignificant. The share of services in GDP and food imports are insignificant. Year dummies are significant to a large extent at the .1 significance level.

The second work is by Goryakin and Suhrcke (2014). They analyze obesity among women in low and middle income developing countries. They test hypotheses among 878.000 women aged 15-49. Data sets are obtained from 244 surveys for 56 countries from 1991 to 2009. In low and middle income countries, less educated women have about 11 percentage points less possibility of being overweight than more educated ones. The likelihood of being overweight is weaker for middle income countries. Also, in middle income countries, the probability of being overweight and education relationships turn negative after country-level fixed effects are added. More educated women have more probability of being overweight up until about $5000- 6000 GDP per capita (PPP). In very low income countries, the probability of being overweight increases with education. This situation disappears when countries become richer.

For all income levels, urbanization and being overweight are positively related. Women living in urban areas are more likely to be overweight with 7-12 p.p. more probability. In high income countries, this probability is lower. They show that there is a positive relationship between working in the service sector and the probability of being overweight in both low and middle income countries. The probability of being overweight increases by eight percentage points when women work in the service sectors.

Income-obesity relation is analyzed in different studies along with other possible variables affecting the obesity prevalence. Eleuteri (2004) uses panel data to test and find the direction of relations between obesity and income in the 11 OECD countries (Canada, Czech Republic, Denmark, Finland, France, Italy, Japan, Netherlands, Spain, Switzerland, and the United Kingdom). Also, the article is aimed to find the relationship of obesity with GDP per capita, caloric intake, total health spending as a percentage of GDP, the rate of the population over 65.

In this study, the fixed effects model is used between the years 1991 and 1995. It is found that GDP per capita has a positive effect on the obesity rate. Daily caloric intake has a significant and negative relationship with obesity. It is not logical, but the article explains it with a high rate of exercise. Population over 65 and health expenditure are not found statistically significant. The same regression is applied with using the percentage of female obesity as the dependent variable, and only the GDP per capita has a significantly positive relationship with obesity. As a result, Eleuteri (2004) states that when many developing countries are getting richer, the obesity rates of those countries increase.

Ameye and Swinnen (2019) analyze the relationship between gross domestic product (GDP) per capita and obesity. They state that obesity rates show different relations with income when the development of a country changes. In their within country analysis, they find that obesity increases with income. In middle income countries, no connection has founded, and in high income countries, obesity decreases when income increases. The rich are more obese in low income countries, and the poor are more obese in high income countries. In middle income countries, obesity is equally distributed. Considering gender differences, in low income countries, women are more obese than men, in middle income countries, women are much more obese than men. This gender gap disappears in high income countries.

Ameye and Swinnen (2019) suggest some reasons for the increases in obesity rates with GDP per capita in low income countries:

1- When poor people get wealthier, they are able to buy more food.

2- When income rises, the diet of people shifts from home cook meals to calorie-dense processed food like the way of westernized diet.

3- Job patterns change from labor-intensive manual jobs to sedentary ones. For this reason, the energy people spend at their work decreases.

4- Some developing countries, people with higher body mass seem to be more powerful, more beautiful, or healthier. It is seen that social preferences and culture also affect body shape.

In low and middle income countries, reaching healthcare, education, and healthy food is harder than in high income countries. When we look at middle and high income countries such as Russia, Turkey, and Brazil, this positive relation with GDP per capita disappears at a significant level of income. Moreover, after passing a certain level of income, the relationship turns to negative.

Regression results of across country analysis show that the coefficient of GDP per capita on obesity rate is positive in low income countries, not significant in the middle income ones, negative but significant only for women in high income ones. The turning point income level, which causes the relationship between GDP per capita and obesity rates to turn from positive to negative, is founded to be about $43.000.

Here, it is thought that obesity decreases when GDP per capita increases after income level reaches a certain level; as a result, obesity rates start to decrease with becoming a high income country. However, in fact, obesity rates seem to increase in all countries and at all times. The reason of this negative coefficient is that rate of obesity growth with income is fastest and highest in middle income countries, but much slower growth rate with income is seen in high income countries.

Investigating the relationship between obesity and urbanization, urban obesity rates are found 3% more than rural obesity rates considering all countries. When countries are divided into income groups, urban areas have more obesity rates than rural areas in low income countries. The same result is founded, but with much smaller differences in middle income countries, and both rural and urban areas have high obesity rates. In high income ones, rural areas have more obesity rates, but the difference between rural and urban obesity rates is not as vast as in low income ones.

Economic development, growth, and globalization are other important concerns of the panel data analyses on obesity. Studies investigate whether obesity rates are changing in accordance with these indicators. Windarti, Hlaing, and Kakinaka (2019) use panel data analysis to examine the relationship between economic development and obesity for 130 countries from 1975 to 2010 and conduct dynamic panel data analysis to decrease possible endogeneity problems. In this study, the obesity rate is the dependent variable, while income levels are the independent variable. Real GDP per capita is used as the measure of income level, country fixed effects are included to control time-invariant characteristics such as climate conditions and cultural factors. Trade openness, which is a measurement of the sum of exports and imports divided by GDP and the ratio of urban population for capturing the urbanization are used as control variables. The results show that the relationship between real GDP per capita and health status depending on weight is significantly positive, but health status depending on weight and real GDP per capita squared has significantly negative relation. According to Windarti, Hlaing, and Kakinaka (2019), this relation supports an inverted U-shaped Kuznets curve relationship between health status depending on weight and real income per capita. For low income countries, when income increases, overweight, obesity, and morbid obesity rates for both sexes increase. For high income countries, in contrast, when income increases, overweight, obesity, and morbid obesity rates decrease. After including control variables, which are Gini index and Female labor participation (FLP), respectively, the results are founded still consistent. Health status depending on weight has a positive relationship with both urbanization and Gini index, but less clear evidence is founded for trade and FLP.

Pisa and Pisa (2016) investigate the effects of South Africa's economic growth on adult obesity prevalence. Obesity rate data are obtained from national surveys, including 1998, 2003, and 2012. The method is applying unadjusted time trend plots for obesity prevalence. Economic indicators used in the research are GDP per capita, Household Final Consumption Expenditure (HFCE), and Gini coefficients. They state that GDP per capita and HFCE increases when obesity prevalence increases in both sexes. For all ethnicities and both gender, as Gini coefficient increases, obesity prevalence decreases. For both genders, urban dwellers had more obesity rates.

Fox, Feng, and Asal (2019) evaluate the relationship between obesity and globalization by implementing two way fixed effects OLS regression with panel data for 190 countries in 1980-2008. BMI is used as the dependent variable. Independent variables are economic globalization and economic development measures. They use the Konjunkturforschungsstelle (KOF) index as economic globalization measure. Economic development measures are GDP per capita, PPP, women's political empowerment index, democratization, urbanization, food supply, and carbon dioxide emissions. The regression is run with country and time fixed effects. Bivariate models are used to find the independent effects of each variable on BMI. Also, models are run after dividing into income groups. GDP per capita is founded to be more important in low and middle income countries. In all countries, when GDP per capita increases, BMI of women decreases, and BMI of men increases. Considering the income groups of countries, in low and middle income countries increase in GDP per capita results in higher BMI. Yet, in high income countries, the result is the opposite.

Fox, Feng, and Asal (2019) find a positive relationship between urbanization and BMI. In countries with low development levels, a rise in GDP per capita is related to higher weight, but at higher levels of GDP per capita, this connection flattens. This result suggests that there is an inverted J-shaped relation between income per capita and weight. Over time, an increase in GDP per capita is linearly associated with an increase in BMI in low and middle income countries. In contrast, it is negatively related to BMI in high income countries.

4. THE EFFECTS OF COUNTRIES’ INCOME LEVELS ON OBESITY: PANEL DATA ANALYSIS

In this part, an econometric model was formed for the countries of the various income groups by benefiting from the literature made with respect to the subject. The primary purpose of this model is to measure the effect of income on adult obesity prevalence. GDP per capita data was used as indicator of income and added to the model as variable of interest. Some variables, which are frequently used in the literature and thought to have an effect on the prevalence of obesity, have been added to the model as control variables. This model was estimated through the panel data analysis. Our model also was examined separately under four different categories as all countries, the high income countries, middle income countries, and low income countries.

For this aim, firstly, the panel data analysis that is the econometric estimation method to be used in our research is mentioned. Then the variables those will be used in our research, and the information belonging to the data set are presented. Finally, it is informed regarding the model formed and the results obtained by estimating the models.

4.1. Methodology of Research: Panel Data Analysis

The regression analysis and time series analysis are two statistical methods used for the data analysis. Dynamic analysis can be made by observing a cross-sectional data during the time with the time series analysis, while the cross-sectional data in a specific time can be analyzed with the regression analysis (Frees, 2004). The analysis of the panel data formed by the collection of data belonging to the units during a specific time period helps researchers to research the subjects that will not be able to be studied with the cross-section or the time series by them (Seddighi, 2012). The Panel data analysis is an estimating method of the economic relations by using of the cross-sectional data belonging to the time dimension (Greene, 2003). In our research, there are many reasons for selecting the panel data analysis method. The Panel data analysis comes to the forefront, according to the other econometric analysis methods, because it has important advantages. The most important characteristic of this analysis is that it enables forming of a two-dimensional data set having both time and cross-sectional dimensions by gathering the cross-sectional series and the time series. Consequently, the panel data set has at least two dimensions as the time series (t) and the cross-sectional series (i) (Hsiao, 2014). The total cross-sectional unit number is shown with N, and the total time unit number is shown with T (Gujarati, Porter, 2009).

4.1.1. Advantages of Panel Data Analysis

The advantages owned by the panel data can be listed as followings (Hsiao, 2014; Baltagi, 2005; Gujarati, 2004; Erlat, 2008):

- It quite increases the number of observations to use both of the cross-sectional and the time series data in the panel data models. It arises the degree of freedom, and the multicollinearity problem is experienced less. Thus, the efficiency and reliability of the economic estimations increase.
- It is possible to examine the differences occurred both between the cross-sectional units and also in itself, of each cross-sectional unit depending on time with the panel data analysis.
- It enables to set up and to test more complex behavior models than the cross-section or the time series.
- The omitted variables caused to the important bias in the estimation results by using the time series or cross-sectional data do not cause to an important problem in the panel data analysis.
- It also allows measuring the effects of the factors that cannot be expressed numerically, observed, and clearly measured.
- It can regard heterogeneity of individuals by allowing to some variables specific to the cross-section. The data set can be controlled against heterogeneity.

4.1.2. Panel Data Models

In general, the functional indication of the panel data model is as followings (Yerdelen Tatoğlu, 2018):

$$Y_{it} = \alpha + \beta_{1it} X_{1it} + \beta_{2it} X_{2it} + ... + \beta_{kit} X_{kit} + u_{it} \tag{3}$$

$$i = 1,2,\ldots,N \quad t = 1,2,\ldots,T \quad k = 1,\ldots,K$$

Here i expresses the cross-sectional units such as household, individual, firm, N expresses the total number of units, t expresses the time dimension such as day, month, year, T expresses total time dimension, k expresses the number of the explanatory variables.

Y_{it} : indicates the dependent value in t time of the ith cross-sectional unit,

α : the constant term,

β_{kit} : the coefficient estimated of kth explanatory variable for the ith unit and tth time period,

X_{kit} : the kth explanatory variable value in t time of ith cross-sectional unit,

u_{it} : the error term with the constant variance and zero mean.

In the panel data studies, a regression can be defined in various ways according to the assumptions made regarding the constant term, the slope coefficient, and the error term.

There are also two kinds of models as balanced and unbalanced besides all models to be explained. There are observations with the same number for each cross-sectional unit as any missing data case is not mentioned in the balanced panel. Therefore the total number of observations is as N times T. On the other hand, in the unbalanced panel, the missing data case is mentioned, and the number of observations is not equal for each cross-sectional unit (Johnston, Dinardo, 1997).

In our study, the models with constant slope coefficients were used. The constant coefficient may vary according to individual, time, or both individual and time effects except the classical model. In our study, since two-way models with both individual and time effects and models with time effects will not be used, these models are not included in this section.

4.1.2.1. Classical Model

The first of the panel data models is the classical (pooled) model. In this model, the cross-sectional and time dimensions of the pooled data are neglected. It is assumed that both the constant term and also the slope parameters are constant according to units and time, and all observations are homogeneous. In this model, all independent variables affect the cross-sectional units equally. In this case, the panel data model, in general, can be written as:

$$Y_{it} = \beta_0 + \sum_{k=1}^{K} \beta_k X_{kit} + u_{it} \qquad (4)$$

$$i = 1,\ldots,N;\ t = 1,\ldots,T$$

(Hsiao, 2014).

4.1.2.2. One Way Fixed Effects Model

It is called the fixed effects model to the models where the constant coefficients show alterations only between the time units or only between the cross-section units or both units, and the slope coefficients are the same for the time and cross-section units. The regression model to be formed is the one way fixed effects model with individual effects, if any differentiation depending on time is not mentioned while there is a difference among individuals in the panel variables. In this model, the differences among the cross-sectional units are explained with the differences in the constant term (Hsiao, 2014; Wooldridge, 2010).

In the panel data, as mentioned previously, the individual effects those cannot be observed in each unit can arise. The fixed effects are mentioned if these effects are considered as a parameter estimated for each cross-sectional observation. Also, in the fixed effects model, it is allowed that correlation between the explanatory variables and the individual effects is different from zero. The constant term changes according to units, and the slope parameter is constant in the one way fixed effects models with individual effects. This model is shown as the following equation:

$$Y_{it} = \beta_{0i} + \sum_{k=1}^{K} \beta_k X_{kit} + u_{it} \tag{5}$$

$$i = 1,\dots,N; \quad t = 1,\dots,T$$

In this model, the constant term gets different values for each cross-sectional unit, and as also mentioned previously, the differences among the units are expressed with the differences in the constant term. It is allowed that the individual effect and independent variables have correlations, while it is made an assumption that the independent variables do not have a correlation with the error term (Yerdelen Tatoğlu, 2018).

In this equation, the individual effects those cannot be observed (every unit's characteristics particular to itself, not changed in time, for example, the habits, preferences, culture… for countries) are indicated with μ_i and included in the constant term. The constant term may be indicated as followings in the way also to include the individual effects (Gujarati, Porter, 2009):

$$\beta_{0i} = \beta_0 + \mu_i \tag{6}$$

As it will also be understood through this equality, the reason of the differences in the constant term is the individual effects. In the one-way individual effects model, the constant term does not change against time while it may change according to units. The time effect is accepted invalid on the constant term (Gujarati, 2004).

If there is a correlation between the individual effects and the independent variables, it would be right to use the fixed effects model. As known in the fixed effects model, the individual effect is not indicated within the error term but within the constant term. It is aimed to eliminate the individual effect from the model because it is in correlation with the independent variables. Here it is needed to mention two disadvantages of the fixed effects model:

- A decrease in the degrees of freedom is observed as the dummy variables are used while the fixed effects model is estimated.
- The transformation made during this estimation eliminates all independent variables not changed with time in one unit. Here it is mentioned to be required to eliminate the individual effects because of correlation. The explanatory variables not

changed in time, such as sexuality, race, religion are dropped from the model (Kennedy, 2008).

4.1.2.3. One Way Random Effects Model

In the random effects model, it is assumed that the differences in the cross-sectional units are random as the error term (Hsiao, 2014). Changes that occur depending on cross-sectional units or cross-sectional units and time are included into the model as a component of the error term. The most important reason of it is the prevention of loss of the degrees of freedom seen in the fixed effects model (Baltagi, 2005).

In this model, the individual or time effects those cannot be observed in this model are handled as a random variable like error term. In the model, there can be individual effects or time effects or both the individual and time effects together. The model including both of them is named as two-way model. Here only the one way model including the individual effects will be mentioned. In this approach, the individual differences between units such as countries, households, and firms come up randomly. In the random effects model, it is assumed that the correlation between the individual effects and the explanatory variables is zero.

The fixed effects model is used in cases where the individual effects are constant and are expressed with the differences in the constant term. However, sometimes the units in sample are selected randomly, and the differences among units are also random. If there is not any correlation between the individual effects and the explanatory variables, the fixed effects model is not efficient as it eliminates the individual effects from the model. The error term in the pooled ordinary least square (POLS) also includes both the individual effects, if any, and also the residual error term, as the random effects. However, in the pooled ordinary least square model, there will be the efficiency loss as the estimation of these two error components cannot be separated from each other. Consequently, in such cases, the random effects model is used, which puts the individual effects (μ_i) within the error term, such as the POLS model, but tries to separate these two error components (Yerdelen Tatoğlu, 2018).

Shortly, as the individual effect is not constant in the random effects model; it is included not within the constant term but within the error term as it is random. The one-way random effects model is indicated as in followings:

$$Y_{it} = \beta_0 + \sum_{k=1}^{K} \beta_k X_{kit} + v_{it} \tag{7}$$

$$i = 1,\ldots,N; \quad t = 1,\ldots,T$$

Here the error term is expressed as in followings:

$$v_{it} = u_{it} + \mu_i \tag{8}$$

Here μ_i indicates the individual effects; in other words, the unit differences while u_{it} indicates the residual error term (Gujarati, 2004). Consequently, the random effects model has two component error term, and an aim such as eliminating the individual effects (μ_i) is not available in this model as in the fixed effects model.

4.1.3. Model Selection in Panel Data Analysis

It is important which assumptions will be made while making the panel data analysis and which model will be selected in the direction of these assumptions. For example, in cases where the individual and time effects are not available, the classical model is preferred, and there are some tests where we can test the validity of the classical model.

The validation of the classical model is examined with tests such as F test, Likelihood Ratio Test (LR Test), Breusch-Pagan Lagrange Multiplier Test (LM Test), Score Test. These tests are aimed at testing whether there is individual or time effect in the model. If the individual or time effect is detected, the fixed effects or random effects models are preferred.

4.1.3.1. F Test

The validity of the classical model is tested with this test. In general terms, it is tested whether data varies according to the units. If data does not vary according to the units, the classical model is appropriate. For this aim, two types of models are used: Restricted model and unrestricted model.

It is assumed that in the unrestricted model, the data belonging to variables get value according to units; in the restricted model the unit differences are not important.

Hypothesises of F test are as followings:

H_0 = the restricted model is right, the classical model is valid.

H_1 = the unrestricted model is right, the classical model is not valid for usage. (9)

If the null hypothesis cannot be rejected, the model can be expressed with the classical model and solved with the pooled ordinary least squares method (POLS). If the null hypothesis is rejected, the fixed effects model will be selected (Greene, 2003).

4.1.3.2. Breusch-Pagan Lagrange Multiplier Test

Breusch-Pagan developed the LM test based on the residuals of the pooled ordinary least squares (POLS) model, testing whether the POLS model is proper to use. Test statistics are shown as follows:

$$LM = \frac{NT}{2(T-1)}\left[\frac{\sum_{i=1}^{N}\left(\sum_{t=1}^{T} u_{it}\right)^2}{\sum_{i=1}^{N}\sum_{t=1}^{T} u_{it}^2} - 1\right]^2 \qquad (10)$$

In this model, the hypothesis that the variance of individual effects is equal to zero is tested. If the null hypothesis is rejected, there is a significant random effect in the panel data. If it can not be rejected, it is convenient to use the classical model. The null hypothesis is shown as follows:

$$H_0 : \sigma_\mu^2 = 0 \qquad (11)$$

(Yerdelen Tatoğlu, 2018; Park, 2011).

4.1.3.2. Hausman Test

In the econometric estimations those will be performed by using the panel data, various tests can be applied while deciding concerning whether the fixed effects model or the random effects model will be used. The most common method used is Hausman (1978) model determination method.

The Hausman test statistic is calculated as follows:

$$H = \left(\hat{\beta}_{FE} - \hat{\beta}_{RE}\right)' \left[Var\left(\hat{\beta}_{FE}\right) - Var\left(\hat{\beta}_{RE}\right)\right]^{-1} \left(\hat{\beta}_{FE} - \hat{\beta}_{RE}\right) \qquad (12)$$

The null hypothesis of the Hausman test expresses that there is not any relation between the error terms and the independent variables in the regression model. The hypotheses on test are indicated as in followings:

$$H_0 = E\left(u_{it}, X_{kit}\right) = 0$$
$$H_1 = E\left(u_{it}, X_{kit}\right) \neq 0 \quad (13)$$

Here the null hypothesis means that there is not any correlation between the time or individual effects and the explanatory variables. The alternative hypothesis determines that there is a correlation between them. If the null hypothesis cannot be rejected, both models are consistent, but the random effects model is efficient as it does not drop the individual effects from the model while the fixed effects model is not efficient. It makes the random effects model inconsistent that the null hypothesis is rejected, and the fixed effects model should be preferred (Johnston, Dinardo, 1997).

4.1.4. Diagnostic Tests in Panel Data

Like time series and cross-sectional models, the panel data models are also based on a set of assumptions. It is assumed that in the panel data models, the error term is within the unit and among units has an equal variance. Also, it is expected that the error terms are unrelated with each other. It is assumed that the error term is periodic and spatial uncorrelated; in other words, not autocorrelated and not cross-sectional dependent. There are many tests particular to every model to test these assumptions.

In the model, if there is at least one or a few of heteroscedasticity, autocorrelation or cross-sectional dependency, the standard errors found as a result of estimation will be biased, R^2 value, the test statistics and consequently the confidence intervals give the wrong results, and the efficiency of estimations disappeared (Hsiao, 2014).

In this part, some of the important heteroscedasticity, autocorrelation, and cross-sectional dependency tests that are used in our study will be explained. Then, the method of correcting these problems will be explained.

4.1.4.1. Heteroscedasticity in Classical Model

Some tests used for determination of heteroscedasticity in the classical model are: Breusch-Pagan / Cook-Weiesberg Test, White Test.

Breusch-Pagan / Cook-Weiesberg Test:

In the classical model at first, the square of residuals is obtained from the estimation of the pooled ordinary least squares model in order to be able to examine the heteroscedasticity with Breusch-Pagan (1979) / Cook-Weiesberg (1983) test (Wooldridge, 2018).

$$\hat{u}_{it}^2 = \delta_0 + h_{it}\delta + \varepsilon_{it} \tag{14}$$

In equation 14, h_{it} may include all or a subset of X_{it} or estimated value of the dependent variable.

The null hypothesis is as follows:

$$H_0 \text{ : homoscedastic variances } \left(H_0 : \delta = 0\right) \tag{15}$$

In the null hypothesis, it is told that $\hat{u}_{it}^2$ is uncorrelated with the functions of X_{it} and there is no heteroscedasticity (Yerdelen Tatoğlu, 2018).

4.1.4.2. Autocorrelation in Classical Model

Some tests used for determination of autocorrelation in the classical model are: t test, Durbin-Watson test, Breusch-Godfrey Test, Wooldridge test

Wooldridge Test:

Wooldridge (2010) suggested a test with a H_0 hypothesis that there is no first-order autocorrelation to examine the autocorrelation in the panel data models. It is indicated as followings:

$$H_0 \text{: no autocorrelation} \tag{16}$$

In test of Wooldridge the residuals obtained from the first differences model are used (Born, Breitung, 2014).

4.1.4.3. Heteroscedasticity in Fixed Effects Model

In the fixed effects model, the modified Wald test is used for the determination of heteroscedasticity.

Modified Wald Test:

The null hypothesis for the examination of heteroscedasticity with modified Wald test is set as followings:

$$H_0 : \sigma_i^2 = \sigma^2 \text{ (variances are homoscedastic)} \tag{17}$$

In the case where the null hypothesis is rejected, we mention the presence of heteroscedasticity in the fixed effects model (Greene, 2003).

4.1.4.4. Autocorrelation in Fixed Effects Model

Some tests used for the determination of autocorrelation in the fixed effects model: Baltagi-Wu Locally Best Invariants (LBI) Test, Durbin-Watson test of Bhargava, Franzini, and Narendranathan.

The tests of Baltagi-Wu and Durbin-Watson examine the presence of the first-order autocorrelation. In these tests, the null hypothesis is in the way there is not the first-order autocorrelation (Baltagi, 2005).

It is interpreted that autocorrelation is important if the value found from the statistics of Durbin-Watson and Baltagi-Wu is less than 2. Also, in the case of rejection of the null hypothesis, the presence of autocorrelation is mentioned (Yerdelen Tatoğlu, 2018).

4.1.4.5. Heteroscedasticity in Random Effects Model

The tests applied for determining of heteroscedasticity in the random effects model are: Breusch-Pagan LM Test, tests of Levene, Brown and Forsythe

Tests of Levene, Brown and Forsythe:

The traditional F tests developed to examine the equality of variances bases on the Gauss distribution. Levene (1960) also suggested a resistant heteroscedasticity test in a case where the normal distribution assumption was not performed. Brown and Forsythe (1974) also suggested the alternative locally estimators based on the trimmed average ensuring a resistant structure against the traversable observations instead of the average in the test statistics of Levene (Yerdelen Tatoğlu, 2018).

4.1.4.6. Autocorrelation in Random Effects Model

In the random effects model, the Baltagi-Wu Locally Best Invariants (LBI) Test and Durbin-Watson test of Bhargava, Franzini, and Narendranathan are used for determining of autocorrelation as in fixed effects model. Also, the LM test can be used (Baltagi, 2005; Yerdelen Tatoğlu, 2018).

4.1.4.7. Cross-Sectional Dependency Tests

Correlation is a measure of change of two variables together. The cross-section is also named as the cross-sectional dependency in the panel data resources. It is searched whether the cross-sectional units are equally affected by a certain shock (Breusch, Pagan, 1980).

It is generally seen that the error terms have a simultaneous correlation throughout the cross-sectional units. Breusch-Pagan LM test, Pesaran Test, Friedman Test, Frees Test are used in order to examine the presence of cross-section correlation. In the classical model, the cross-section correlation is not considered. Other tests can be applied except LM test in the random effects model. In the fixed effects model, all tests can be applied (Yerdelen Tatoğlu, 2018).

Test of Pesaran:

Pesaran (2004) suggested Pesaran CD test to examine the presence of the cross-section correlation in the case where T is small, and N is big. The statistics of this test is indicated as followings:

$$CD = \sqrt{\frac{2T}{N(N-1)}} \left(\sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij} \right) \tag{18}$$

Here: $\hat{\rho}_{ij}$ is the i,j^{th} residual correlation coefficient.

For the unbalanced panel, Pesaran suggested the following test statistics:

$$CD = \sqrt{\frac{2T}{N(N-1)}} \left(\sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \sqrt{T_{ij}}\, \hat{\rho}_{ij} \right) \tag{19}$$

Here: T_{ij} is the number of observations of the time series between the units i and j (Pesaran, 2015).

4.1.4.8. Multicollinearity, Correlation Matrix and Variance Inflation Factor

The multicollinearity is seen in case there is a highly linear relationship among the independent variables. In the presence of this problem, the standard errors, variances, and common variances of the independent variables become very big, and therefore the confidence intervals become very large. Also, t values of one or more than one coefficient become statistically not significant because of this result. $\boldsymbol{R}^2$ value of model may be found high, but very few of the independent variables may be found significant according to the partial t test. (Gujarati, 2004). The correlation matrix and variance inflation factor (VIF) values of the independent variables used for the determination of whether the model has multicollinearity. The correlation matrix indicates the positive or negative relations of all variables in model with each other. The correlation matrix where the correlations belonging to all variables used in the model should be formed and examined before the model was set in order to avoid multicollinearity problems.

Another method used in determining multicollinearity is Variance Inflation Factor. If VIF value is bigger than 5 in general, we mention about the presence of multicollinearity (Kim, 2019).

4.1.4.9. Robust Estimators: Driscoll-Kraay Estimator

It is searched whether there is any bias in assumptions of the panel data models with heteroscedasticity, autocorrelation, and cross-section correlation tests. In the case at least one of these three assumptions is not provided, estimations of the model are not efficient and consistent. Driscoll and Kraay (1998) said that the estimation results of standard techniques are inconsistent in the presence of cross-sectional dependency in the model.

The efficiency is affected, while there is no inconsistency in cases where the big samples are analyzed. Heteroscedasticity, autocorrelation, and cross-section correlation affect the validity of t and F statistics, the standard errors, variances, confidence intervals, and R^2 obtained in the model estimation by affecting the values of them. If the mentioned deviations are examined, the robust standard errors should be obtained with the help of a correction in conformity with deviation.

One of the robust estimators used in cases of heteroscedasticity, autocorrelation, and cross-sectional dependency is the Driscoll-Kraay estimator. The standard error estimations are consistent with this approach based on the cross-sectional averages regardless of the N which is cross-sectional dimension of units. Driscoll-Kraay estimator provides consistency even in the case that N goes to infinity. Also, the standard errors obtained from the covariance matrix estimated are robust for very common forms of the spatial and periodic correlation (Yerdelen Tatoğlu, 2018).

Hoechle (2007) presented 'xtscc' Stata command. This command estimates POLS and fixed effect regressions with Driscoll-Kraay standard errors. In our research, we used this command in Stata to deal with heteroscedasticity, autocorrelation, and cross-sectional dependency problems. Hoechle (2007) compared Driscoll-Kraay estimators that are consistent in the presence of cross-sectional dependency, with other covariance matrix estimators that do not take into account this dependency by using Monte Carlo simulations. They concluded that in the presence of cross-sectional dependency, it is more appropriate to use Driscoll-Kraay estimators. Ignoring cross-sectional dependency causes severely biased estimations. Compared to other estimators, when N is larger than T, Driscoll-Kraay estimator is consistent. In the presence of cross-sectional dependency, while other covariance matrix estimation techniques like OLS, White, clustered standard errors are biased, Driscoll-Kraay estimator is robust. 'xtscc' command is used in pooled OLS and fixed effect models.

4.2. Data Set and Model

In this subsection, the data set used in the empiric study, the transformations made related to data, and the resource of the data set will be explained. Also, the econometric model set up to be used in the empiric study will be indicated, the variables used in the model will be presented, and the expected signs belonging to variables will be given. Gross Domestic Product per capita (GDP per capita) was chosen as the variable of interest in order to measure the effect of income on adult obesity prevalence. Control variables were selected from among the variables with effects on adult obesity prevalence found statistically significant by examining the empirical studies made previously in the literature. Also, the accessibility of data was considered as selecting the variables. Finally, it will be controlled whether there is a correlation among the independent variables.

4.2.1. Explanations concerning Data Set

This study aims to determine the effects of income on obesity prevalence among adults. Urbanization, education, industrial employment, and health expenditures, which seem to have an impact on the prevalence of adult obesity, was added to the model as control variables. The interval of 1975-2016 selected years was determined by considering the years where the obesity data that is our dependent variable can be obtained. The results of the analysis were obtained by using STATA 15 program in the analysis part of the study. In the selection of countries, the countries having obesity data were selected. The countries common both in the site of World Health Organization (WHO) where the obesity data is taken and in the site of World Bank where the economic data is taken were included into the model. The analysis was first applied to all countries for which the data is available. Then, based on the income groups determined by the World Bank, the countries were divided into three income groups as the low income, middle income, and high income.

Obesity is the dependent variable of our model. The Obesity data was obtained from WHO. Our data is mentioned in WHO as the prevalence of obesity among adults, BMI is greater than or equal to 30 (%). WHO considers the individual older than 18 as an adult. Obesity and its measure BMI are explained in the previous parts in detail.

Variable of interest and control variables data of the model was obtained from the World Development Indicators database of World Bank for the years 1975-2016.

Consequently, the panel data analysis contains 42 years through the years 1975-2016 (T=42). The data set used in the study is an unbalanced panel data set. A total of 189 countries (N=189) that have obesity data and are both included in the World Bank and WHO data sets were determined as the cross-sectional unit. At first, our model was applied to all of 189 countries. Thirty of these countries were classified as the low income, 104 as the middle income, 55 as the high income according to the classification of the World Bank, and analysis was repeated separately for every income group. The countries and income groups used in the study are given in Annex1.

4.2.2. Independent Variables and Explanations

4.2.2.1. Loggdp

The variable of interest in the model is loggdp. In the literature, in general, the income indicator was used by taking the logarithm of the gross domestic product (GDP) per capita data. The GDP per capita data used in our model was taken from the World Bank Data is mentioned as GDP per capita (constant 2010 US$) in the World Bank. GDP per capita is found by dividing GDP to the population in the middle of the year.

GDP is used as a measure of income and expenditures in the economy. GDP is defined as the market value of the final goods and services in a country, given in a specific time. GDP is a measure of the total incomes of all persons in an economy. Also, it is a measure of total expenditures spent on the goods and service outputs by an economy. These two measures are equal to each other. This case is indicated with the following equality.

$$Y = C + I + G + NX \tag{20}$$

On the left side of equation 20, Y indicates the total income; in other words, GDP. On the right side of equality, C indicates the consumption spending by households, I the investments, G government expenditures, NX the net export. The right side of equality represents the total expenditures in an economy (Mankiw, 2018).

A higher income level may enable individuals to consume higher quality goods, have better accommodation and living conditions. However, studies indicate that, it is seen that individuals join in less physical activities along with income growth, prefer worse consumption patterns, have a busier and stressed lifestyle, individuals started to live a more sedentary life along with the developing technology.

According to Egger, Swinburn, and Islam (2012), there is a positive relation between income and BMI. One of these positive relations is the increase of the household assets like car, dishwasher along with income. These assets cause to an inactive life. As income increases, it increases BMI that the food expenditures increase and the energy expenditures decrease. The transition from the low income to high income causes less healthy nutrition transitions where fatty and high-calorie foods are consumed. Also, it is seen that in general, the physical activity of these persons decreased at work and spare times of them decreased because of their high work hours. Also, it is seen that usage of the traditional healthy cooking methods decreased, less healthy food and snacks are consumed more frequently along with the high income.

According to Goryakin and Suhrcke (2014), there is a positive relation between being overweight and the national income. This case is explained with the nutrition transitions. Especially since 1970, in developed countries, cases such as increasing accessibility of processed food, being ready for consumption more easily, being more economical caused more oily, high-calorie, and sugary nutrition. Also, technological development decreases the calorie intake cost while it increases the calorie expenditure cost. On the other hand, according to Grossman health is a normal good, and its demand increases with income growth. Therefore, an increase in the income affects the weight positively or negatively depending on whether the food demand or the health demand increases more.

4.2.2.2. Lurban_pop

Lurban_pop is the first control variable of our model. Urbanization is indicated as one of the crucial reasons of obesity in literature. The urban population data was used for the measurement of urbanization. Data of the urban population was taken from the World Bank. As the obesity data that is the independent variable is a percentage data, data of the urban population was used by taking its logarithm.

According to Goryakin and Suhrcke (2014), urbanization causes the consumption of cheaper and energy-intensive foods and increases their supply and decreases energy expenditure. People living in the city spend less energy than people living in rural areas. There are various reasons of it. People living in the city may have fewer opportunities to exercise. They usually work at jobs that require less physical activity. The people living in urban areas transit from the low-calorie fruit, vegetable, and grain to the calorie-rich, high-fat and processed carbohydrate ‘Western’ diets more quickly and easily. Also, the processing technologies, marketing, and distribution systems were developed more in cities. It encourages the consumption of fast and processed food.

According to Ameye and Swinnen (2019), economic development and increase in income are associated with urbanization. Many studies indicate that urbanization is a key reason of the increase in obesity. In the first studies, it was told that urbanization had a positive effect on food safety as it decreased the undernourishment. The studies started to point out the relation between urbanization and high consumption after the 2000s. The studies indicated that people living in the city side of the low income countries changed their nutrition ways and inclined to consume high oil and sugar, the processed fast food and preferred the street food more. In some countries, it is seen that three-quarter of the total food consumptions of the middle income persons and poor people living in cities are street food. These foods are high-calorie, oily, and sugary food, generally devoid of the essential vitamin, minerals, and fibers. This case causes an increase in obesity when it combines with a more sedentary lifestyle increasing with urbanization.

According to Minos (2016), obesity is mostly seen in urban areas in developed countries because it is easy to access to the high oily food at a low price and at large quantity in the big cities, the high urbanization, and the increasing incomes. This case compromises with the area deficiency in the big cities and the development process. It is not possible for people to grow fruit and vegetable by themselves and consume what they produce in city life. Moreover, living in city life increases the working possibility in the service sector requiring less physical activity. Also, it is indicated as some of the factors increasing obesity that transportation in cities is developed, more vehicles are used, television and radio are used commonly, people stay indoors more than the people in the rural side due to the high rates of crimes.

4.2.2.3. Education

Education is the second control variable of our model. It is known that education affects the life conditions, incomes, jobs of people. Therefore, it was also required to test whether there is any effect on obesity. The education data used in the model was taken from the World Bank Data is available as the gross enrollment ratio of primary school enrollment in the World Bank. It is the percentage of the number of students enrolled in primary school among the children in primary school age.

According to Minos (2016), the net effect of education on obesity is still not clear. Education has positive externalities according to the literature and makes people more conscious about the risks of obesity. On the other hand, an increase in education level causes the incomes of people to increase and more people to be employed in the service sector, and as a result, decreases physical activity. According to Cawley (2015), an increase in the level of education can allow a person to stay a healthy weight in his later life. High education levels may result in gaining more information about health issues, more healthy nutrition, increase of physical activity, high income, having better health insurance, living in safer neighborhoods where they can exercise outdoor. On the other hand, jobs requiring higher education may be more sedentary.

Relation of education with obesity differs from country to country substantially. This relation may also vary according to region, race, and ethnic origin. Mirowsky and Ross (1998) state that education leads people to healthy behaviors, gives them the ability to control their health, and enables them to pass on these healthy behaviors to their children. According to the analysis made by Wardle, Waller, and Jarvis (2002), higher years of education decreases the risks of obesity in England. Kim (2016) finds that education and obesity are inversely related in his research with siblings. Böckerman et al. (2017) state that education level is negatively related with obesity in advanced countries.

Since most studies in the literature found the relationship between education level and obesity negative, our coefficient sign expectation for our model is negative.

4.2.2.4. Emp_Industry

Emp_industry is the third control variable of our model, and data is available as the employment in industry, the percentage of total employment in the World Bank. Before the service sectors often referred to as causing a sedentary life in the literature developed so much, people were working more often in jobs that require physical force and movement. Therefore, the percentage of the number of people working in the industry sector requiring more physical activity in the total labor force data was included. Data was taken from the World Bank. Employment was defined as the persons at the working age, join in any activity to provide service or to produce goods for profit or charge. The industrial sector consists of occupational groups such as mining and quarrying, manufacture, construction, and public services (electricity, gas, water).

It is seen that increase in the number of people working at such occupations decreases obesity as the agricultural occupations and the industrial occupations are the occupations based on physical activity and body power mostly according to literature. It is an advantage because people have difficulty finding time to exercise in the times remained from their works. Besides this, the number of people employed in the service sectors not requiring much physical power and activity increases along with the developing world's conditions and increase of urbanization and education levels. This case also causes an increase in obesity.

According to Brunello, Michaud, and Sanz-de-Galdeano (2008), in the service sector, works require less physical power and activity because of moving away from the exercise-intensive blue-collar works in factories and agricultural works. According to Goryakin and Suhrcke (2014), the switch of employment in the agricultural and industrial sectors to the service sector as a result of urbanization and technological changes is associated with the possibility of being overweight in the low and middle income countries substantially. For example, the rate of the employees employed in the manufacturing industries decreased from 27% in 1980 to 19% in 2000. The rate of obese men almost doubled in this term.

4.2.2.5. Health_Exp

Health_exp is the fourth control variable of our model. This data is the domestic general government health expenditure. We were tried to measure the effect of the health expenditures on obesity with this variable. Data was taken from the World Bank. It is given as the share of the public health expenditures in the total public expenditures.

Eleuteri (2004) indicates that, even though the health expenditures may be useful in the decrease in obesity rates, it is also possible that obesity causes an increase in health expenditures. These two-way causalities may be hiding the real relation between obesity and health expenses. According to Lawson, Murphy, and Williamson (2016), the increase in health spending is thought to have positive effects on health, such as reducing obesity. On the other hand, an increase in health expenditures can cause moral hazard problems and perverse incentives. An increase in health expenditures can subsidize wrong choices, such as consume more calories. If people think that public health is free and bad health choices do not cost them, these negative results can be more apparent with public sector health expenditures. They find that in developed countries, there is a positive relationship between public health expenditures and BMI levels of both men and women. In her time series analysis work for Finland, covering the years between 1978 and 2007, Halicioglu (2013) find that the increase in real public health expenditures per capita decreases obesity rates.

The increase in health expenditures primarily means the increase in health services and facilities that society will benefit. Also, health expenditures provide the supply of many goods and services to society that raise the level of health. On the other hand, health expenditures may contribute negatively on the health level. For example, how these expenditures are financed matters. If the health expenditures spent by public in particular, are financed from the user's contributions or taxes and are ineffective, they may affect the health level negatively because individuals may have to economize the basic expenses those are directly effective on the health level such as accommodation, food, clothing, hygiene to be able to pay these taxes and contributions (Fayissa, Gutema, 2005; Thornton, 2002).

4.2.2.6. Dummy Variable

The graphs indicating the bilateral relation between obesity and loggdp data against probability that there may be the countries those may be outliner were formed separately for all groups while testing relation of income on obesity. The graph formed for data set including all of 189 countries is as following.

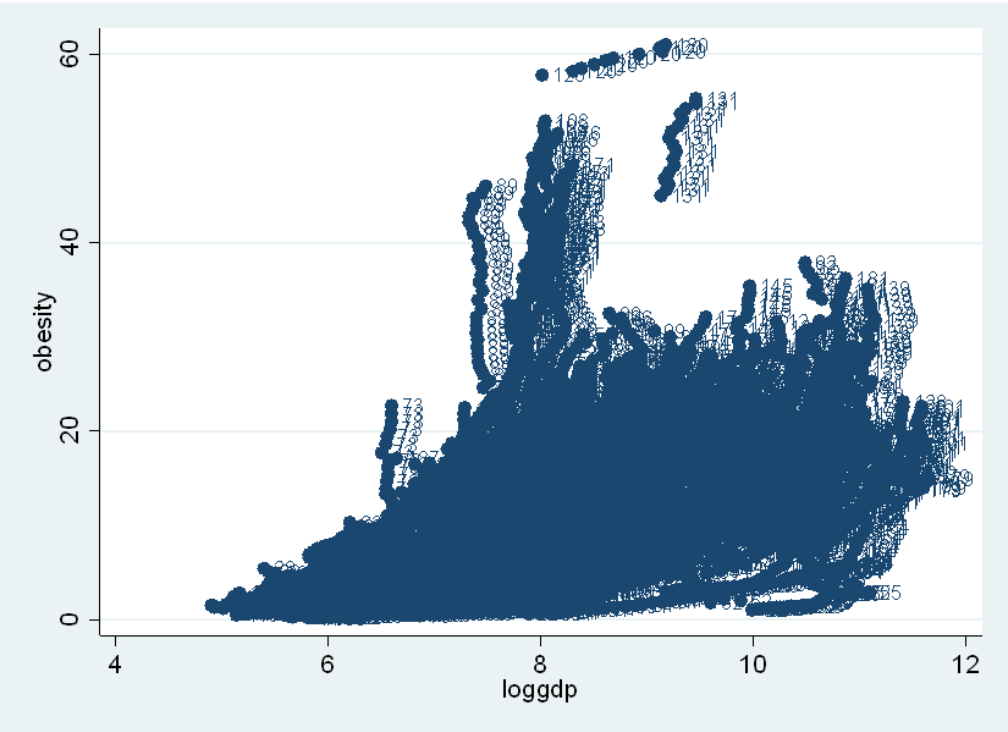

Figure 7: Relationship between Obesity and Loggdp Variables for All Countries

Created by the author

When the prevalence of obesity among adults data was averaged between the years 1975 and 2016 for all countries separately, it was decided by examining Figure 7 that the countries with average 23 and over may be outliers. Therefore, the dummy variable was formed and added as the independent variable to the model. Averages of the prevalence of obesity among adults data for all countries separately between 1975 and 2016 are given in Annex 2. If the average of obesity of a country is 23 and lower than it, the dummy variable formed gets value 0. If the average value of obesity is 23 or over, it gets value 1. It was tested in our analysis whether the dummy variable is significant. The countries with average obesity value over 23 in all countries of the world are Jordan, Kiribati, Kuwait, Marshall Island, Micronesia, Nauru, Palau, Qatar, Samoa, Saudi Arabia, Tonga, Tuvalu. Also, the graph was formed and examined separately again for the income groups of countries.

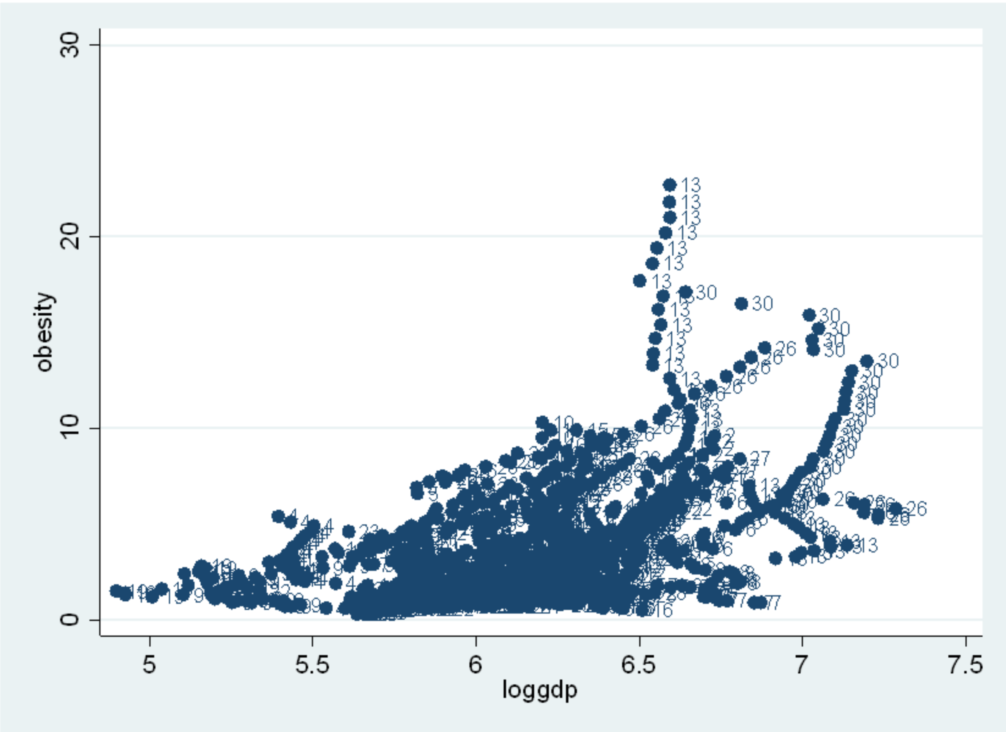

Figure 8: Relation between Obesity and Loggdp Variables for Low Income Countries

Created by the author

It was decided by examining Figure 8 belonging to the low income countries that the countries with the average obesity value over 8 between the years 1975 and 2016 may be outlier. Therefore, the dummy variable was formed for the analysis to be made with the data group of the low income countries and added to model as the independent variable. Averages of prevalence of obesity among adults data for all low income countries separately between 1975 and 2016 are given in Annex 2. It gets value 1 for the countries with the average obesity value over 8 while the dummy variable gets value 0 for the countries with the obesity value 8 and lower than 8. Significance of the dummy variable was tested in our analysis. The countries with obesity value over 8 for the low income countries are Haiti, Syrian, Yemen.

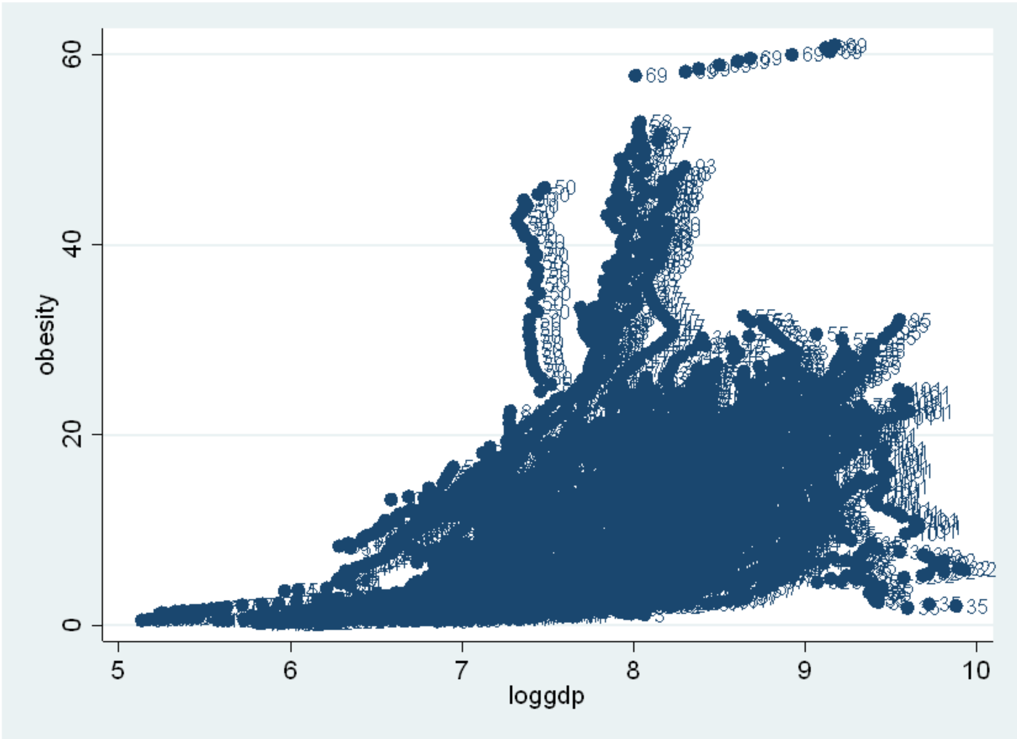

Figure 9: Relation between Obesity and Loggdp Variables for Middle Income Countries

Created by the author

It was decided by examining the Figure 9 belonging to the middle income countries that the countries with the average obesity value over 23 may be outlier when average of the prevalence of obesity among adults data between the years 1975-2016 for every country is taken. Averages of the prevalence of obesity among adults data for all middle income countries separately between 1975 and 2016 are given in Annex 2. Therefore, the dummy variable was formed for the analysis to be made with the data group of the middle income countries and added to model as the independent variable. It gets value 1 for the countries with the average obesity value over 23 while the dummy variable gets value 0 for the countries with the obesity value 23 and lower. The significance of the dummy variable was tested in our analysis. Countries with obesity value over 23 for the middle income countries are Jordan, Kiribati, Marshall Islands, Micronesia, Nauru, Samoa, Tonga, and Tuvalu.

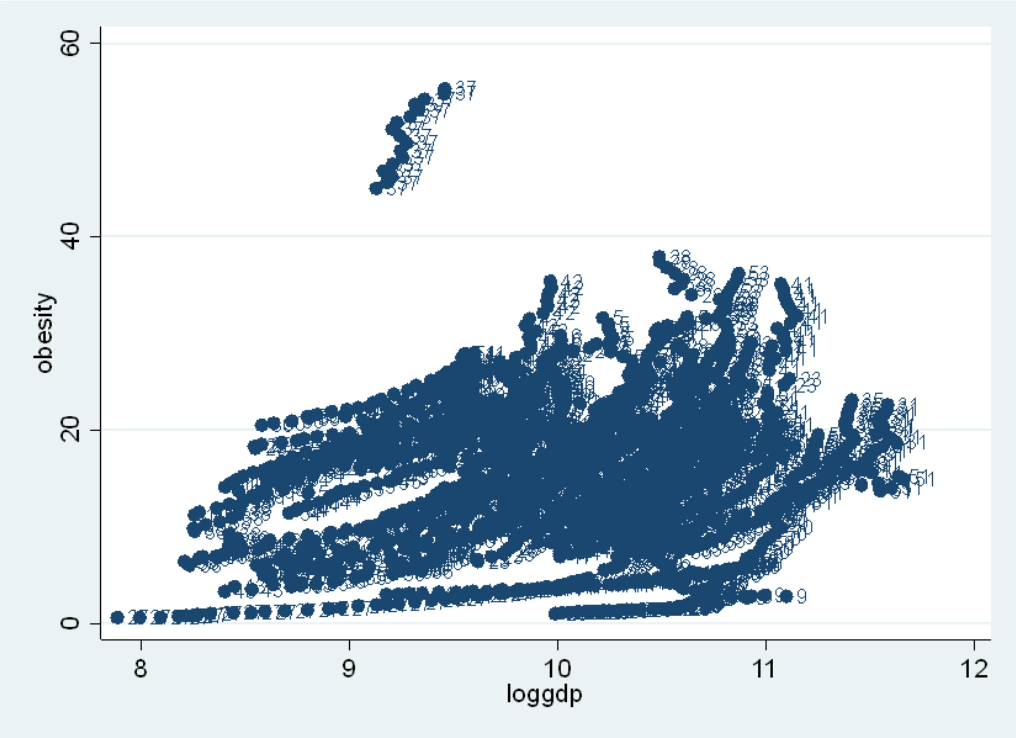

Figure 10: Relation between Obesity and Loggdp Variables for High Income Countries

Created by the author

It was decided by examining the Figure 10 belonging to the high income countries that the countries with the average value of obesity 23 and over between the years 1975 and 2016 may be outlier. Averages of prevalence of obesity among adults data for all high income countries separately between 1975 and 2016 are given in Annex 2. Therefore, the dummy variable was formed for the analysis to be made with the data group of the high income countries and added as the independent variable to model. The dummy variable gets value 1 for the countries over 23 while it gets value 0 for the countries with the obesity value 23 and lower. The significance of the dummy variable was tested in our analysis. The countries with the obesity value over 23 for the high income countries are Kuwait, Palau, Qatar, and Saudi Arabia.

4.2.3. Expected Signs of Econometric Model and Variables

The econometric model to be estimated, determined in order to be used in the analysis is as followings:

$$\begin{aligned} obesity_{it} &= \beta_{0i} + \delta dum + \beta_1 \log gdp_{1it} + \beta_2 lurban\_pop_{2it} \\ &+ \beta_3 education_{3it} + \beta_4 emp\_industry_{4it} + \beta_5 health\_\exp_{5it} + u_{it} \end{aligned} \tag{21}$$

i indicates countries, t time, u error term in the model.

Model was used in the same way for both all countries and also the groups separated to the income groups. The sign expectations belonging to the coefficients indicating the effect of the independent variables on the dependent variable are indicated in Table 4.

Table 4: Expected Coefficient Signs of Independent Variables

INDEPENDENT VARIABLE	EXPECTED COEFFICIENT SIGN
loggdp	+
lurban_pop	+
education	-
emp_industry	-
health_exp	+/-

It is expected that effect of income on obesity will be positive, effect of urbanization will be positive and effect of the industrial employment will be negative for all groups. The coefficient of this variable may also have both signs in the study as the education and health expenditures may affect obesity positively or negatively according to literature.

4.2.4. Correlation Relation of Independent Variables: Correlation Matrix and VIF Table

In this subsection, it will be analyzed whether there is multicollinearity among the independent variables. In this context, the correlation matrix and VIF table were formed separately for the models separated into the income groups as low, middle, high, and all countries.

Table 5: Correlation Matrix Belonging to All Countries

	loggdp	lurban_~p	education	emp_ind~y	health_~p
loggdp	1				
lurban_pop	0.0893***	1			
education	0.0639**	-0.0460*	1		
emp_industry	0.605***	0.153***	0.0661**	1	
health_exp	0.530***	0.0830***	0.0768***	0.285***	1

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Table 6: All Countries VIF Table

VARIABLE	VIF	1/VIF
loggdp	2.02	0.494786
lurban_pop	1.03	0.970891
education	1.01	0.988462
emp_industry	1.61	0.621066
health_exp	1.40	0.713451
MEAN VIF	**1.41**	

It is seen in Table 5 and Table 6 that there is not any multicollinearity to cause to the econometric problems among the explanatory variables when the correlation matrix of our model belonging to all countries including 189 countries are looked at. VIF values also support this result.

Table 7: Correlation Matrix Belonging to Low Income Countries

	loggdp	lurban_~p	education	emp_ind~y	health_~p
loggdp	1				
lurban_pop	0.0724	1			
education	0.0505	0.0597	1		
emp_industry	0.352***	-0.00713	0.0160	1	
health_exp	-0.212***	-0.0704	0.0275	-0.228***	1

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Table 8: Low Income Countries VIF Table

VARIABLE	VIF	1/VIF
loggdp	1.17	0.851525
lurban_pop	1.01	0.986140
education	1.01	0.992454
emp_industry	1.18	0.849655
health_exp	1.08	0.922514
MEAN VIF	**1.09**	

It is seen in Table 7 and Table 8 that there is not any multicollinearity to cause the econometric problems among the explanatory variables when the correlation matrix of our model including groups of the low income countries are looked at. VIF values also support this result.

Table 9: Correlation Matrix Belonging to Middle Income Countries

	loggdp	lurban_~p	education	emp_ind~y	health_~p
loggdp	1				
lurban_pop	0.0829**	1			
education	0.193***	-0.137***	1		
emp_industry	0.505***	0.225***	0.0749**	1	
health_exp	0.320***	-0.0496	0.156***	0.267***	1

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Table 10: Middle Income Countries VIF Table

VARIABLE	**VIF**	**1/VIF**
loggdp	1.45	0.691414
lurban_pop	1.09	0.916958
education	1.07	0.931356
emp_industry	1.44	0.695342
health_exp	1.16	0.864435
MEAN VIF	**1.24**	

It is seen in Table 9 and Table 10 that there is not any multicollinearity to cause to the econometric problems among the explanatory variables when the correlation matrix of our model including the groups of the middle income countries are looked at. VIF values also support this result.

Table 11: Correlation Matrix Belonging to High Income Countries

	loggdp	lurban_~p	education	emp_ind~y	health_~p
loggdp	1				
lurban_pop	0.153**	1			
education	-0.0251	0.161***	1		
emp_industry	-0.228***	0.0122	0.0376	1	
health_exp	0.318***	0.318***	-0.00486	-0.308***	1

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Table 12: High Income Countries VIF Table

VARIABLE	**VIF**	**1/VIF**
loggdp	1.14	0.876202
lurban_pop	1.24	0.807857
education	1.03	0.967889
emp_industry	1.16	0.865244
health_exp	1.40	0.716456
MEAN VIF	**1.19**	

It is seen in Table 11 and Table 12 that there is not any multicollinearity to cause the econometric problems among the explanatory variables when the correlation matrix of our model including the groups of the high income countries are looked at. VIF values also support this result.

4.3. Findings of Panel Data Analysis

We started our analysis by examining the effects of income and the other variables on obesity for all countries of concern. Then, the same analysis was repeated for different income groups of countries. The model was estimated with the Pooled Ordinary Least Square (POLS) method, the one way fixed effects estimation method, and the one way random effects estimation method.

The first column of the tables expressing the results shows the estimation results of the analysis of the interest variable on the dependent variable. Later, control variables and dummy variable were added to the model one by one, and their results were evaluated. The last column shows the effects of all explanatory variables on the dependent variable.

4.3.1. Findings for All Countries

4.3.1.1. Estimation Results of Pooled OLS

The Pooled OLS method ignores the effects of the cross section and time section. In this model, it is supposed that the constant term is constant for every country, and every year and all coefficients do not change according to the cross sectional units and time unit. POLS results were included into the study in order to compare them to other models considering the country and time effects; however, it is not a very realist assumption. The estimation results of POLS model for all countries are shown in Table 13 below.

Table 13: Pols Model Estimation Results for All Countries

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	obesity	obesity	obesity	obesity	obesity	obesity
loggdp	3.064***	3.163***	3.049***	2.830***	2.384***	2.257***
	(0.0652)	(0.0637)	(0.0668)	(0.0870)	(0.117)	(0.103)
lurban_pop		-0.832***	-0.483***	-0.449***	-0.585***	-0.229***
		(0.0436)	(0.0456)	(0.0562)	(0.0683)	(0.0613)
education			0.0589***	0.0325***	0.0192**	0.0217***
			(0.00511)	(0.00651)	(0.00912)	(0.00799)
emp_industry				0.191***	0.257***	0.170***
				(0.0153)	(0.0190)	(0.0169)
health_exp					0.318***	0.394***
					(0.0305)	(0.0269)

Table 13 - continued

dum						16.89***
						(0.619)
Constant	-12.97***	-1.577**	-11.81***	-9.968***	-6.077***	-10.34***
	(0.548)	(0.801)	(0.885)	(1.156)	(1.574)	(1.389)
Observations	6,867	6,867	5,747	3,687	2,471	2,471
R-squared	0.243	0.282	0.335	0.447	0.490	0.609
F-value	F(1, 6865) = 2208.72	F(2, 6864) = 1345.29	F(3, 5743) = 964.10	F(4, 3682) =744.79	F(5, 2465) = 473.93	F(6, 2464) = 638.44
Prob>F	0.000	0.000	0.000	0.000	0.000	0.000

Standard errors in parentheses

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

R^2 value increases with the addition of control variables. It is observed that the addition of the dummy variable leads to a significant increase in the model's explanation of obesity. The model was found to explain obesity at the highest rate of 61%. The sign of the GDP per capita, which is the variable of interest, is positive as expected and statistically significant. The addition of control variables did not change the sign and significance of GDP per capita. In contrast to the expected signs, the sign of the urban population is negative, the sign of education is positive, the sign of employment in the industry is positive, and they all are statistically significant. The sign of health expenditures is positive and significant.

4.3.1.2. Estimation Results of Random Effects Model

The estimation results of random effects model for all countries are shown in Table 14 below.

Table 14: Random Effects Model Estimation Results for All Countries

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	obesity	obesity	obesity	obesity	obesity	obesity
loggdp	6.382***	4.017***	4.783***	5.262***	5.545***	5.474***
	(0.130)	(0.123)	(0.133)	(0.133)	(0.167)	(0.164)
lurban_pop		5.126***	5.093***	4.782***	4.607***	4.308***
		(0.104)	(0.123)	(0.155)	(0.185)	(0.178)
education			-0.0220***	-0.00604*	-0.00139	0.000807
			(0.00358)	(0.00346)	(0.00415)	(0.00418)
emp_industry				-0.269***	-0.206***	-0.206***
				(0.0122)	(0.0136)	(0.0137)
health_exp					0.118***	0.118***
					(0.0145)	(0.0146)

Table 14 - continued

dum						23.96***
						(2.621)
Constant	-39.68***	-94.88***	-98.44***	-96.04***	-98.20***	-94.17***
	(1.232)	(1.561)	(1.686)	(2.107)	(2.591)	(2.517)
Observations	6,867	6,867	5,747	3,687	2,471	2,471
Number of country	186	186	181	169	168	168
R-sq within	0.2665	0.5074	0.5425	0.6154	0.6257	0.6212
Wald Chi2 Value	2392.61	5704.66	5471.73	4566.91	2921.20	2882.95
Prob>Chi2						
	0.000	0.000	0.000	0.000	0.000	0.000

Standard errors in parentheses

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

As control variables are added, the increase in R^2 is a positive situation. The sign of the GDP per capita is positive as expected, and statistically significant. With the addition of control variables and dummy variable, its sign and significance have not changed. Compared with the POLS model, urban population and employment in industry variables have expected signs and are positive and negative, respectively. The education variable is found negative as expected, but in the last two cases it is not statistically significant. The sign of health expenditures is positive and significant. In this model, the impact of dummy is not as effective as the POLS model, still it is found statistically significant.

4.3.1.3. Estimation Results of Fixed Effects Model

The estimation results of fixed effects model for all countries are shown in Table 15 below.

Table 15: Fixed Effects Model Estimation Results for All Countries

	(1)	(2)	(3)	(4)	(5)
VARIABLES	obesity	obesity	obesity	obesity	obesity
loggdp	6.737***	3.575***	4.290***	4.515***	4.679***
	(0.137)	(0.124)	(0.134)	(0.137)	(0.171)
lurban_pop		6.217***	6.524***	7.411***	7.956***
		(0.107)	(0.130)	(0.178)	(0.216)
education			-0.0420***	-0.0293***	-0.0182***
			(0.00348)	(0.00330)	(0.00374)
emp_industry				-0.286***	-0.244***
				(0.0114)	(0.0122)
health_exp					0.120***
					(0.0128)

Table 15 – continued

Constant	-43.36***	-108.4***	-115.6***	-127.1***	-139.6***
	(1.132)	(1.456)	(1.602)	(2.223)	(2.753)
Observations	6,867	6,867	5,747	3,687	2,471
R-squared	0.266	0.511	0.549	0.633	0.653
Number of country	186	186	181	169	168
F value	F(1,6680) = 2426.50	F(2,6679) =3493.78	F(3,5563) =2255.04	F(4,3514) =1516.05	F(5,2298) =863.79
Prob>F	0.000	0.000	0.000	0.000	0.000

Standard errors in parentheses

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

As control variables are added, the increase in R^2 is a positive situation. The sign of the GDP per capita, which is the variable of interest, is positive as expected and statistically significant. With the addition of control variables, its sign and significance have not changed. Urban population and employment in industry variables have expected signs and are positive and negative, respectively. The education variable is negative as expected and statistically significant in all conditions, unlike the random effects model. The health expenditure variable is positive and significant. The dummy variable has fallen from the model as expected.

4.3.1.4. Selection of Model and Diagnostic Tests

Breusch Pagan LM test, F test, and Hausman test are applied in order to choose the right model to use from the POLS model, fixed effects model, and random effects model. Also, according to the selected model type, it will be checked on whether there is at least one or a few of the heteroscedasticity, autocorrelation, or cross sectional dependency problems. As also determined in the method part previously, the presence of these econometric problems will cause R^2, test statistics and, consequently, confidence intervals to give the wrong results and biased standard errors, so the efficiency of estimations will be eliminated.

Table 16: Model Selection Test Results

Test Type		
Breusch – Pagan LM Test	chibar2(01) = 13362.04	Prob > chibar2 = 0.0000
F test	F(167, 2298) = 383.02	Prob > F = 0.0000
Hausman Test	chi2(5)= 594.52	Prob > chi2 = 0.0000

According to Breusch - Pagan LM test results, the null hypothesis is rejected. It suggests that the use of the classical POLS model is inappropriate. Based on the Breusch - Pagan LM test results, it may be appropriate to use the random effects model. According to the results of the F test, the rejection of the null hypothesis again suggests that the use of the classical model is not appropriate, and it may be appropriate to use the fixed effects model.

Hausman test was performed to choose between random effects and fixed effects models. Hypothesis H_0 in Hausman test means that there is no correlation between explanatory variables and individual effects. Alternative hypothesis states that there is a correlation between them. In this case, if hypothesis H_0 cannot be rejected, the fixed effects model and the random effects model will both be consistent, but only the random effects model will be effective. If H_0 is rejected, the random effects model will be inconsistent, and the fixed effects model will be used. According to Hausman test results, H_0 hypothesis is rejected, which suggests that the use of fixed effects model will be appropriate.

After the fixed effects model was selected, diagnostic tests were performed in accordance with the fixed effects model. In fixed effects model, for heteroscedasticity Modified Wald Test, for autocorrelation modified Bhargava et al. Durbin-Watson Test and Baltagi-Wu LBI Test, for cross sectional dependency Pesaran CD test was applied. The test results are given in Table 17.

Table 17: Diagnostic Tests for Fixed Effects Model

Test Type		
Modified Wald Test	chi2(168)= 3.7e+33	Prob > chi2 = 0.0000

Table 17 – continued

modified Bhargava et al. Durbin-Watson Test	0.17327652	
Baltagi-Wu LBI Test	0.57612913	
Pesaran (2015) test for weak cross sectional dependence	CD = 23.090	p-value = 0.000

Based on Modified Wald Test results, H_0 hypothesis is rejected. This result shows that the model has heteroscedasticity.

It is seen in the Stata output that only test statistics are included for both Durbin – Watson test and Baltagi – Wu LBI test, probability values are not given. Although critical values are not given in the literature, it is interpreted that autocorrelation is important if the value is less than 2 (Yerdelen Tatoğlu, 2018). It is seen that both results are less than 2. This result shows that the model has autocorrelation. According to Pesaran CD test results, the H_0 hypothesis is rejected. This result shows that there is also cross sectional dependency in the model. Since our model has both heteroscedasticity, autocorrelation, and cross sectional dependency, it would be appropriate to rely on the results of the Driscoll-Kraay robust estimator and to select the results of this estimator as the final model.

5.3.1.5. Estimation Results of the Fixed Effects Model with Driscoll – Kraay Robust Standard Errors

The estimation results of fixed effects model with Driscoll – Kraay standard errors for all countries are shown in Table 18 below.

Table 18: Fixed Effects Model with Driscoll-Kraay Robust Standard Errors Estimation Results for All Countries

VARIABLES	(1) obesity	(2) obesity	(3) obesity	(4) obesity	(5) obesity
loggdp	6.737***	3.575***	4.290***	4.515***	4.679***
	(0.636)	(0.319)	(0.249)	(0.308)	(0.259)
lurban_pop		6.217***	6.524***	7.411***	7.956***
		(0.184)	(0.369)	(0.289)	(0.383)
education			-0.0420***	-0.0293***	-0.0182***
			(0.0105)	(0.00444)	(0.00295)
emp_industry				-0.286***	-0.244***
				(0.0212)	(0.0230)
health_exp					0.120***
					(0.0199)
Constant	-43.36***	-108.4***	-115.6***	-127.1***	-139.6***
	(4.887)	(4.620)	(6.252)	(5.965)	(6.097)
Observations	6,867	6,867	5,747	3,687	2,471
Number of groups	186	186	181	169	168
R-sq	0.2665	0.5113	0.5488	0.6331	0.6527
F-value	F(1, 185) = 112.34	F(2, 185) = 719.06	F(3, 180) = 396.27	F(4, 168) = 423.46	F(5, 167) = 5670.93
Prob>F	0.000	0.000	0.000	0.000	0.000

Standard errors in parentheses

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

With the addition of control variables, the increase in R^2 is positive. Our variable of interest, GDP per capita, is positive as expected, and statistically significant. With the addition of control variables, its significance and sign were not affected. The drop in GDP per capita coefficient is remarkable when the urban population variable is added. In the literature, the effect of urbanization on obesity comes to the fore, so this decline is quite significant. Urban population, employment in industry, and education variables have expected signs and are positive, negative, and negative, respectively. The health expenditure variable is positive and significant. The dummy variable has fallen from the model as expected. Constant term was founded negative and statistically significant. Even when the variables take the value 0, it is observed that the model has a negative effect on the adult obesity rates. As the control variables were added, the constant term was observed to decrease.

4.3.2. Findings for Low Income Countries

4.3.2.1. Estimation Results of Pooled OLS

The estimation results of POLS model for low income countries are shown in Table 19 below.

Table 19: Pols Model Estimation Results for Low Income Countries

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	obesity	obesity	obesity	obesity	obesity	obesity
loggdp	3.628***	3.400***	2.519***	2.704***	2.912***	2.104***
	(0.218)	(0.205)	(0.184)	(0.241)	(0.307)	(0.302)
lurban_pop		0.947***	0.630***	0.356***	0.0314	-0.0923
		(0.0790)	(0.0713)	(0.0944)	(0.123)	(0.115)
education			0.0183***	0.00961***	-0.00116	0.00197
			(0.00240)	(0.00289)	(0.00406)	(0.00378)
emp_industry				0.132***	0.120***	0.114***
				(0.0168)	(0.0207)	(0.0192)
health_exp					-0.0478	-0.0479
					(0.0317)	(0.0294)

Table 19 - continued

dum						5.074***
						(0.638)
Constant	-18.56***	-30.83***	-22.61***	-19.59***	-14.15***	-7.645***
	(1.353)	(1.627)	(1.468)	(1.961)	(2.583)	(2.528)
Observations	993	993	847	562	380	380
R-squared	0.218	0.317	0.368	0.398	0.354	0.448
F-value	F(1, 991) = 275.80	F(2, 990) = 229.57	F(3, 843) = 163.95	F(4, 557) = 92.05	F(5, 374) = 41.04	F(6, 373) = 50.41
Prob>F	0.000	0.000	0.000	0.000	0.000	0.000

Standard errors in parentheses

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

R^2 value is seen to increase as control variables are added, and it can be seen that the value can reach up to 45%. In this case, urban population, education, health expenditure variables are pointless. When this 45% is achieved, it appears that the variables of urban population, education, and health expenditures are not significant. Our interest variable GDP per capita is found positive and significant.

4.3.2.2. Estimation Results of Random Effects Model

The estimation results of random effects model for low income countries are shown in Table 20 below.

Table 20: Random Effects Model Estimation Results for Low Income Countries

VARIABLES	(1) obesity	(2) obesity	(3) obesity	(4) obesity	(5) obesity	(6) obesity
loggdp	1.636***	-0.460**	0.431***	1.137***	1.316***	1.411***
	(0.290)	(0.185)	(0.151)	(0.208)	(0.254)	(0.262)
lurban_pop		3.310***	2.634***	3.755***	4.542***	4.329***
		(0.0808)	(0.0931)	(0.170)	(0.206)	(0.209)
education			0.00722***	0.00280	0.00111	0.00243
			(0.00227)	(0.00264)	(0.00289)	(0.00298)
emp_industry				-0.0754***	-0.0552***	-0.0518***
				(0.0158)	(0.0165)	(0.0170)
health_exp					-0.0180	-0.0197
					(0.0133)	(0.0138)

Table 20 - continued

dum						3.087
						(2.270)
Constant	-6.109***	-41.13***	-37.54***	-57.31***	-70.19***	-67.88***
	(1.829)	(1.465)	(1.568)	(2.336)	(2.730)	(2.772)
Observations	993	993	847	562	380	380
Number of country	27	27	27	27	26	26
R-sq within	0.0208	0.6711	0.7739	0.7949	0.8339	0.8303
Wald Chi2 Value	31.90	1744.93	2653.60	1719.18	1281.03	1178.81
Prob>Chi2	0.000	0.000	0.000	0.000	0.000	0.000

Standard errors in parentheses

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

In column (1) where GDP per capita is analyzed alone, we see that the value of R^2 is quite low. Adding only urban population raises the value of R^2 quickly but disrupts the sign of our interest variable. With the addition of the other control variables, the sign of the interest variable is returned to positive as expected. While R^2 value is up to 83%, it is seen that the variables of education and health expenditure lose their significance. It was found that adding dummy is not significant in this model.

4.3.2.3. Estimation Results of Fixed Effects Model

The estimation results of fixed effects model for low income countries are shown in Table 21 below.

Table 21: Fixed Effects Model Estimation Results for Low Income Countries

	(1)	(2)	(3)	(4)	(5)
VARIABLES	obesity	obesity	obesity	obesity	obesity
loggdp	1.361***	-0.699***	0.365**	0.864***	0.816***
	(0.301)	(0.180)	(0.149)	(0.196)	(0.226)
lurban_pop		3.457***	2.743***	4.383***	5.425***
		(0.0791)	(0.0935)	(0.170)	(0.195)
education			0.00550**	-0.00331	-0.00370
			(0.00226)	(0.00254)	(0.00256)
emp_industry				-0.0922***	-0.0699***
				(0.0148)	(0.0145)
health_exp					-0.0113
					(0.0116)
Constant	-4.550**	-41.79***	-38.83***	-64.58***	-79.98***
	(1.859)	(1.373)	(1.510)	(2.255)	(2.479)

Table 21 – continued

Observations	993	993	847	562	380
R-squared	0.021	0.672	0.774	0.799	0.841
Number of country	27	27	27	27	26
F value	F(1, 965) = 20.50	F(2, 964) = 985.86	F(3, 817) = 933.66	F(4, 531) = 528.29	F(5, 349) = 368.23
Prob>F	0.000	0.000	0.000	0.000	0.000

Standard errors in parentheses

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

With the addition of control variables, it appears that the value of R^2 rises rapidly. In the last case where R^2 is 84%, the urban population, and employment in industry variables are in the expected signs and are significant, respectively positive and negative. Education and health expenditure variables appear to be statistically insignificant. Our interest variable GDP per capita is found positive and significant.

4.3.2.4. Selection of Model and Diagnostic Tests

Table 22: Model Selection Test Results

Test Type		
Breusch – Pagan LM Test	chibar2(01) = 1278.07	Prob > chibar2 = 0.0000
F test	F(25, 349) = 232.07	Prob > F = 0.0000
Hausman Test	chi2(5)= 116.99	Prob > chi2 = 0.0000

According to Breusch — Pagan LM test results, the null hypothesis is rejected. This suggests that the use of the classical POLS model is not appropriate, it may be appropriate to use the random effects model. According to F test results, the rejection of the null hypothesis again suggests that the use of the classical model is not appropriate, and it may be appropriate to use the fixed effects model. The Hausman test was performed to choose between random effects and fixed effects models. According to Hausman test results, hypothesis H_0 is rejected. This indicates that it is appropriate to apply the fixed effects model. After the fixed effects model was selected, diagnostic tests were performed in accordance with the fixed effects model.

Table 23: Diagnostic Tests for Fixed Effects Model

Test Type		
Modified Wald Test	chi2(26)= 56761.75	Prob > chi2 = 0.0000
modified Bhargava et al. Durbin-Watson Test	0.20463827	
Baltagi-Wu LBI Test	0.64189942	
Pesaran (2015) test for weak cross sectional dependence	CD = 6.548	p-value = 0.000

Based on the results of the tests, it is seen that our model has both heteroscedasticity, autocorrelation, and cross sectional dependency. It would be appropriate to rely on the results of the Driscoll-Kraay robust estimator and choose the results of this estimator as the final model.

4.3.2.5. Estimation Results of Fixed Effects Model with Driscoll – Kraay Robust Standard Errors

The estimation results of fixed effects model with Driscoll – Kraay standard errors for low income countries are shown in Table 24 below.

Table 24: Fixed Effects Model with Driscoll-Kraay Robust Standard Errors Estimation Results for Low Income Countries

	(1)	(2)	(3)	(4)	(5)
VARIABLES	obesity	obesity	obesity	obesity	obesity
loggdp	1.361*	-0.699*	0.365	0.864***	0.816***
	(0.789)	(0.352)	(0.237)	(0.255)	(0.204)
lurban_pop		3.457***	2.743***	4.383***	5.425***
		(0.363)	(0.243)	(0.356)	(0.278)

Table 24 – continued

education			0.00550**	-0.00331	-0.00370***
			(0.00262)	(0.00284)	(0.00125)
emp_industry				-0.0922***	-0.0699***
				(0.00888)	(0.00621)
health_exp					-0.0113
					(0.00848)
Constant	-4.550	-41.79***	-38.83***	-64.58***	-79.98***
	(4.457)	(5.048)	(4.199)	(6.090)	(3.094)
Observations	993	993	847	562	380
Number of groups	27	27	27	27	26
R-sq	0.0208	0.6716	0.7742	0.7992	0.8406
F-value	F(1, 26) = 2.98	F(2, 26) = 45.57	F(3, 26) = 63.01	F(4, 26) = 260.85	F(5, 25) = 1535.75
Prob>F	0.0963	0.000	0.000	0.000	0.000

Standard errors in parentheses

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

When all control variables are added, the value of R^2 is seen to be 84%. Variable of interest, GDP per capita, is positive and significant. Urban population, education, employment in industry variables are found at expected signs, and are positive, negative, and negative, respectively. Only health expenditure variable was found insignificant. The number of observations in the low income group is less than in other groups. After adding the health expenditure variable, this number is seen to decrease even more. This could be one of the factors that make the variable insignificant. Constant term has been observed to be negative and significant. As the control variables were added, the constant term decreased.

4.3.3. Findings for Middle Income Countries

4.3.3.1. Estimation Results of Pooled OLS

The estimation results of POLS model for middle income countries are shown in Table 25 below.

Table 25: Pols Model Estimation Results for Middle Income Countries

VARIABLES	(1) obesity	(2) obesity	(3) obesity	(4) obesity	(5) obesity	(6) obesity
loggdp	5.534***	5.506***	5.433***	4.784***	4.211***	4.536***
	(0.171)	(0.163)	(0.179)	(0.225)	(0.288)	(0.241)
lurban_pop		-1.135***	-0.814***	-0.716***	-0.781***	-0.150*
		(0.0561)	(0.0601)	(0.0721)	(0.0899)	(0.0797)
education			0.0104	0.00145	0.00107	0.0297**
			(0.00887)	(0.0117)	(0.0160)	(0.0134)
emp_industry				0.221***	0.225***	0.0961***
				(0.0240)	(0.0316)	(0.0270)
health_exp					0.416***	0.367***
					(0.0442)	(0.0370)

Table 25 - continued

dum						21.94***
						(0.923)
Constant	-30.83***	-13.97***	-19.50***	-17.88***	-15.18***	-28.11***
	(1.352)	(1.532)	(1.672)	(2.097)	(2.802)	(2.407)
Observations	3,800	3,800	3,124	1,995	1,325	1,325
R-squared	0.216	0.292	0.288	0.349	0.386	0.570
F-value	F(1, 3798) = 1044.09	F(2, 3797) = 782.48	F(3, 3120) = 421.68	F(4, 1990) = 267.28	F(5, 1319) = 165.64	F(6, 1318) = 291.26
Prob>F	0.000	0.000	0.000	0.000	0.000	0.000

Standard errors in parentheses

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

The model explains obesity by 57%. As seen in the last column (6), all variables are significant. The sign of GDP per capita is positive as expected and does not change. Urban population, education, and employment in industry signs are the opposite of the expected ones and were found negative, positive, and positive, respectively. Education is significant only when all control variables are added. Health expenditure variable was found positive and significant. The addition of dummy considerably improves R^2 and the dummy variable is statistically significant.

4.3.3.2. Estimation Results of Random Effects Model

The estimation results of random effects model for middle income countries are shown in Table 26 below.

Table 26: Random Effects Model Estimation Results for Middle Income Countries

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	obesity	obesity	obesity	obesity	obesity	obesity
loggdp	6.114***	2.715***	3.123***	5.557***	6.786***	6.844***
	(0.177)	(0.174)	(0.188)	(0.188)	(0.232)	(0.226)
lurban_pop		5.974***	5.827***	4.122***	3.139***	2.972***
		(0.155)	(0.169)	(0.222)	(0.265)	(0.245)
education			0.00890	0.0173***	0.00485	0.00574
			(0.00552)	(0.00563)	(0.00665)	(0.00661)
emp_industry				-0.290***	-0.209***	-0.213***
				(0.0225)	(0.0252)	(0.0250)
health_exp					0.0903***	0.0902***
					(0.0205)	(0.0204)

Table 26 - continued

dum						33.82***
						(3.813)
Constant	-34.78***	-94.76***	-96.81***	-88.74***	-84.34***	-83.36***
	(1.631)	(2.123)	(2.250)	(2.962)	(3.641)	(3.445)
Observations	3,800	3,800	3,124	1,995	1,325	1,325
Number of country	104	104	100	93	93	93
R-sq within	0.2410	0.5299	0.5615	0.5965	0.6186	0.6154
Wald Chi2 Value	1199.57	3164.33	2974.21	2349.66	1729.09	1796.07
Prob>Chi2	0.000	0.000	0.000	0.000	0.000	0.000

Standard errors in parentheses

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

The addition of the urban population variable has considerably increased R^2. When all variables are added, R^2 is at the level of 62%. The signs of the variables are as expected; however, the education variable is found insignificant.

4.3.3.3. Estimation Results of Fixed Effects Model

The estimation results of fixed effects model for middle income countries are shown in Table 27 below.

Table 27: Fixed Effects Model Estimation Results for Middle Income Countries

	(1)	(2)	(3)	(4)	(5)
VARIABLES	obesity	obesity	obesity	obesity	obesity
loggdp	6.119***	1.580***	1.930***	4.071***	5.026***
	(0.179)	(0.167)	(0.181)	(0.190)	(0.240)
lurban_pop		7.806***	7.780***	7.677***	7.590***
		(0.159)	(0.175)	(0.273)	(0.359)
education			-0.00923*	-0.00142	-0.00403
			(0.00514)	(0.00524)	(0.00605)
emp_industry				-0.297***	-0.217***
				(0.0210)	(0.0233)
health_exp					0.0766***
					(0.0186)
Constant	-35.41***	-114.2***	-117.1***	-128.7***	-136.9***
	(1.404)	(1.943)	(2.054)	(3.342)	(4.493)
Observations	3,800	3,800	3,124	1,995	1,325
R-squared	0.241	0.540	0.574	0.627	0.659
Number of country	104	104	100	93	93

Table 27 – continued

F value	F(1, 3695) = 1173.05	F(2, 3694) = 2170.21	F(3, 3021) = 1355.47	F(4, 1898) = 797.70	F(5, 1227) = 475.26
Prob>F	0.000	0.000	0.000	0.000	0.000

Standard errors in parentheses

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

The value of R^2 is 66%. The signs of coefficients are as expected. As in the random effects model, the education variable is insignificant.

4.3.3.4. Selection of Model and Diagnostic Tests

Table 28: Model Selection Test Results

Test Type		
Breusch – Pagan LM Test	chibar2(01) = 7131.43	Prob > chibar2 = 0.0000
F test	F(92, 1227) = 395.06	Prob > F = 0.0000
Hausman Test	chi2(5)=241.46	Prob > chi2 = 0.0000

According to Breusch - Pagan LM test results, the H_0 hypothesis is rejected. This suggests that the use of the classical Pols model is not suitable, it may be appropriate to use the random effects model. The rejection of the H_0 hypothesis according to the F test results again, suggests that the use of the classical model is inappropriate, it may be appropriate to use the fixed effects model. According to Hausman test results, the hypothesis H_0 is rejected. This suggests that the proper model is fixed effects model. After the fixed effects model was selected, diagnostic tests were performed in accordance with the fixed effects model.

Table 29: Diagnostic Tests for Fixed Effects Model

Test Type		
Modified Wald Test	chi2(93)= 5.9e+32	Prob > chi2 = 0.0000

Table 29 – continued

modified Bhargava et al. Durbin-Watson Test	0.17075885	
Baltagi-Wu LBI Test	0.58639229	
Pesaran (2015) test for weak cross sectional dependence	CD = 16.200	p-value = 0.000

Based on the test results, our model has both heteroscedasticity, autocorrelation, and cross sectional dependency. It would be appropriate to rely on the results of the Driscoll-Kraay robust estimator and consider the results of this estimator as the final model.

4.3.3.5. Estimation Results of Fixed Effects Model with Driscoll – Kraay Robust Standard Errors

The estimation results of fixed effects model with Driscoll – Kraay standard errors for middle income countries are shown in Table 30 below.

Table 30: Fixed Effects Model with Driscoll-Kraay Robust Standard Errors Estimation Results for Middle Income Countries

	(1)	(2)	(3)	(4)	(5)
VARIABLES	obesity	obesity	obesity	obesity	obesity
loggdp	6.119***	1.580***	1.930***	4.071***	5.026***
	(0.699)	(0.439)	(0.504)	(0.546)	(0.484)
lurban_pop		7.806***	7.780***	7.677***	7.590***
		(0.238)	(0.288)	(0.149)	(0.385)
education			-0.00923	-0.00142	-0.00403
			(0.0110)	(0.00500)	(0.00570)

Table 30 – continued

emp_industry				-0.297***	-0.217***
				(0.0379)	(0.0351)
health_exp					0.0766***
					(0.0130)
Constant	-35.41***	-114.2***	-117.1***	-128.7***	-136.9***
	(5.106)	(5.632)	(5.944)	(4.323)	(6.345)
Observations	3,800	3,800	3,124	1,995	1,325
Number of groups	104	104	100	93	93
R-sq	0.2410	0.5402	0.5738	0.6270	0.6595
F-value	F(1, 103)	F(2, 103)	F(3, 99)	F(4, 92)	F(5, 92)
	= 76.59	= 625.90	= 466.24	= 2148.07	= 1323.68
Prob>F	0.000	0.000	0.000	0.000	0.000

Standard errors in parentheses

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

GDP per capita is significant and positive. The model explains obesity by 66% when all variables are added. The signs of urban population and employment in industry variables are as expected. The health expenditure variable is positive and significant. As with most other middle income group models, the education variable is insignificant. Constant term is negative and significant. The absolute value of it is greater than the constant term of low income countries. As control variables were added, the constant term decreased.

4.3.4. Findings for High Income Countries

4.3.4.1. Estimation Results of Pooled OLS

The estimation results of POLS model for high income countries are shown in Table 31 below.

Table 31: Pols Model Estimation Results for High Income Countries

VARIABLES	(1) obesity	(2) obesity	(3) obesity	(4) obesity	(5) obesity	(6) obesity
loggdp	1.576***	1.785***	1.986***	0.764***	0.278	-1.773***
	(0.236)	(0.244)	(0.235)	(0.272)	(0.348)	(0.296)
lurban_pop		-0.250***	0.153*	0.172	0.141	-0.0170
		(0.0774)	(0.0826)	(0.108)	(0.137)	(0.110)
education			0.0803***	-0.0267	-0.0828*	-0.175***
			(0.0203)	(0.0325)	(0.0434)	(0.0351)
emp_industry				-0.0470*	0.0471	-0.0699***
				(0.0266)	(0.0325)	(0.0266)
health_exp					0.106*	0.528***
					(0.0566)	(0.0497)

Table 31 - continued

dum						17.09***
						(0.827)
Constant	0.165	1.759	-14.12***	12.73***	21.84***	51.10***
	(2.379)	(2.424)	(3.206)	(4.324)	(5.787)	(4.845)
Observations	2,074	2,074	1,776	1,130	766	766
R-squared	0.021	0.026	0.054	0.016	0.017	0.371
F-value	F(1, 2072) = 44.57	F(2, 2071) = 27.60	F(3, 1772) = 33.81	F(4, 1125) = 4.53	F(5, 760) = 2.62	F(6, 759) = 74.48
Prob>F	0.000	0.000	0.000	0.0012	0.0233	0.000

Standard errors in parentheses

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

It is seen that R^2 value is very low in the model. All variables can be observed insignificant at some stages. It seems that the model could not explain the system correctly.

4.3.4.2. Estimation Results of Random Effects Model

The estimation results of random effects model high income countries are shown in Table 32 below.

Table 32: Random Effects Model Estimation Results for High Income Countries

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	obesity	obesity	obesity	obesity	obesity	obesity
loggdp	9.875***	7.705***	8.726***	7.888***	6.250***	6.026***
	(0.257)	(0.214)	(0.227)	(0.292)	(0.441)	(0.460)
lurban_pop		7.955***	7.583***	8.822***	8.443***	7.372***
		(0.230)	(0.256)	(0.289)	(0.358)	(0.355)
education			0.000829	0.0233*	0.0415***	0.0378**
			(0.0107)	(0.0136)	(0.0158)	(0.0167)
emp_industry				-0.194***	-0.259***	-0.245***
				(0.0160)	(0.0185)	(0.0194)
health_exp					0.184***	0.200***
					(0.0301)	(0.0318)

Table 32 - continued

dum						13.07***
						(3.944)
Constant	-81.98***	-177.5***	-181.5***	-192.8***	-172.5***	-154.8***
	(2.765)	(3.577)	(3.749)	(5.115)	(6.942)	(7.014)
Observations	2,074	2,074	1,776	1,130	766	766
Number of country	55	55	54	49	49	49
R-sq within	0.4356	0.7078	0.7422	0.7839	0.7484	0.7335
Wald Chi2 Value	1476.88	3614.07	3700.13	2606.95	1218.55	1025.27
Prob>Chi2	0.000	0.000	0.000	0.000	0.000	0.000

Standard errors in parentheses

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

All variables in the model are significant, and their signs are as expected. The R^2 value is 74%.

4.3.4.3. Estimation Results of Fixed Effects Model

The estimation results of fixed effects model for high income countries are shown in Table 33 below.

Table 33: Fixed Effects Model Estimation Results for High Income Countries

	(1)	(2)	(3)	(4)	(5)
VARIABLES	obesity	obesity	obesity	obesity	obesity
loggdp	10.17***	7.291***	8.206***	7.893***	6.505***
	(0.258)	(0.194)	(0.205)	(0.251)	(0.364)
lurban_pop		10.22***	10.27***	11.48***	12.01***
		(0.229)	(0.260)	(0.277)	(0.340)
education			-0.0248***	0.0203*	0.0510***
			(0.00950)	(0.0115)	(0.0127)
emp_industry				-0.191***	-0.312***
				(0.0136)	(0.0151)
health_exp					0.152***
					(0.0243)
Constant	-86.23***	-208.6***	-216.5***	-233.5***	-228.9***
	(2.592)	(3.301)	(3.521)	(4.638)	(6.157)
Observations	2,074	2,074	1,776	1,130	766
R-squared	0.436	0.716	0.753	0.794	0.765
Number of country	55	55	54	49	49

Table 33 – continued

F value	F(1, 2018) = 1557.38	F(2, 2017) = 2543.60	F(3, 1719) = 1747.93	F(4, 1077) = 1037.42	F(5, 712) = 463.53
Prob>F	0.000	0.000	0.000	0.000	0.000

Standard errors in parentheses

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

The value of R^2 is 77%. All variables are significant. The signs of the GDP per capita, urban population, and employment in industry are as expected. At first, the sign of education is negative, but after the addition of other control variables, it is found to be positive and significant, contrary to expected.

4.3.4.4. Selection of Model and Diagnostic Tests

Table 34: Model Selection Test Results

Test Type		
Breusch – Pagan LM Test	chibar2(01) = 3172.74	Prob > chibar2 = 0.0000
F test	F(48, 712) = 461.49	Prob > F = 0.0000
Hausman Test	chi2(5)= 324.38	Prob > chi2 = 0.0000

According to Breusch - Pagan LM test results, the H_0 hypothesis is rejected. This suggests that the use of the classical Pols model is not suitable, it may be appropriate to use the random effects model. The rejection of the H_0 hypothesis according to the F test results again, suggests that the use of the classical model is inappropriate, it may be appropriate to use the fixed effects model. According to Hausman test results, the hypothesis H_0 is rejected. This suggests that the proper model is fixed effects model. After the fixed effects model was selected, diagnostic tests were performed in accordance with the fixed effects model.

Table 35: Diagnostic Tests for Fixed Effects Model

Test Type		
Modified Wald Test	chi2(49)= 15677.71	Prob > chi2 = 0.0000
modified Bhargava et al. Durbin-Watson Test	0.18077162	
Baltagi-Wu LBI Test	0.48831845	
Pesaran (2015) test for weak cross sectional dependence	CD = 11.394	p-value = 0.000

Based on the results of the tests, it is seen that our model has both heteroscedasticity, autocorrelation, and cross sectional dependency. It would be appropriate to rely on the results of the Driscoll-Kraay robust estimator and choose the results of this estimator as the final model.

4.3.4.5. Estimation Results of Fixed Effects Model with Driscoll – Kraay Robust Standard Errors

The estimation results of fixed effects model with Driscoll - Kraay standard errors for high income countries are shown in Table 36 below.

Table 36: Fixed Effects Model with Driscoll-Kraay Robust Standard Errors Estimation Results for High Income Countries

	(1)	(2)	(3)	(4)	(5)
VARIABLES	obesity	obesity	obesity	obesity	obesity
loggdp	10.17***	7.291***	8.206***	7.893***	6.505***
	(0.668)	(0.527)	(0.466)	(0.394)	(0.391)
lurban_pop		10.22***	10.27***	11.48***	12.01***
		(0.425)	(0.599)	(0.412)	(0.478)

Table 36 – continued

education			-0.0248***	0.0203*	0.0510***
			(0.00779)	(0.0103)	(0.0174)
emp_industry				-0.191***	-0.312***
				(0.0316)	(0.0230)
health_exp					0.152***
					(0.0213)
Constant	-86.23***	-208.6***	-216.5***	-233.5***	-228.9***
	(6.282)	(10.57)	(12.02)	(9.017)	(4.608)
Observations	2,074	2,074	1,776	1,130	766
Number of groups	55	55	54	49	49
R-sq	0.4356	0.7161	0.7531	0.7939	0.7650
F-value	F(1, 54)	F(2, 54)	F(3, 53)	F(4, 48)	F(5, 48)
	= 231.72	= 300.75	= 128.46	= 276.69	= 2594.67
Prob>F	0.000	0.000	0.000	0.000	0.000

Standard errors in parentheses

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

The value of R^2 is 77%. All variables are significant. The signs of GDP per capita, urban population, and employment in industry are as expected. The sign of education remained to be positive, contrary to expected, as in the fixed effects model. Constant term is negative and significant. As absolute term, it is greater than both constant terms of low income and middle income countries. As control variables were added, the constant term decreased. The addition of health expenditure, which is the last control variable, caused a slight increase.

4.3.5. Comparison of Results by Income Groups

In this subsection, the Driscoll-Kraay robust estimator results, which include all variables, will be compared according to income groups.

Table 37: Fixed Effects Model with Driscoll-Kraay Robust Standard Errors Estimation Results According to Different Income Groups

	Low Income	Middle Income	High Income
VARIABLES	obesity	obesity	obesity
loggdp	0.816***	5.026***	6.505***
	(0.204)	(0.484)	(0.391)
lurban_pop	5.425***	7.590***	12.01***
	(0.278)	(0.385)	(0.478)
education	-0.00370***	-0.00403	0.0510***
	(0.00125)	(0.00570)	(0.0174)
emp_industry	-0.0699***	-0.217***	-0.312***
	(0.00621)	(0.0351)	(0.0230)
health_exp	-0.0113	0.0766***	0.152***
	(0.00848)	(0.0130)	(0.0213)
Constant	-79.98***	-136.9***	-228.9***
	-3.094	-6.345	-4.608
Observations	380	1,325	766
Number of groups	26	93	49
R-sq	0.8406	0.6595	0.7650
F-value	F(5, 25)	F(5, 92)	F(5, 48)
	= 1535.75	= 1323.68	= 2594.67
Prob>F	0.000	0.000	0.000

Standard errors in parentheses

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

In our study, GDP per capita variable is found positive and significant in all income groups. According to the literature, this positive relation is an expected situation for low and middle income countries; however, some studies have found that the relationship is negative for high income countries. In our study, as can be seen from Figure 10, the relationship between GDP per capita and adult obesity rate is positive for high income countries as well. As a result, GDP per capita is observed to have a positive sign in all cases.

Urbanization has an increasing effect on the rate of obesity in adults in all income groups. As employment in industry increases, the rate of obesity in adults decreases for all income groups.

The education variable is generally found to be negatively related to the adult obesity rate in the literature. This negative relationship is seen in the work of Mirowsky, Ross (1998), Wardle, Waller, Jarvis (2002), Kim (2016), and Böckerman et al. (2017). In the study of Kinge et al. (2015), it is observed that obesity rate increases in low income countries and decreases in middle and high income countries, as the level of education increases. In our study, different results are observed for different income groups. The coefficient of education, which is positive and significant in high income groups, turns to negative and significant in low income groups. It is insignificant in middle income groups. This may have changed because the level of education used in our analysis is the primary school level. In addition, changes can be seen depending on the years, countries and the method chosen.

In the literature, different results can be observed in different studies for the health expenditure variable. According to Lawson, Murphy, and Williamson (2016), while the direction of the relationship was positive, Halicioglu (2013) found the relationship to be negative. In the light of our data, it is observed that public health expenditures have an additive effect on adult obesity rates in middle and high income countries, and the coefficient is found to be insignificant in low income countries.

The constant term was founded negative and significant for all income groups. It has been observed that as the income groups of countries increase, the constant term takes a lower value

5. CONCLUSION

In this study, the effect of income on obesity seen on adult individuals older than 18 years is searched. For this aim, an econometric estimation was made by using the panel data method for the time period of 1975-2016 for 189 countries. The same econometric study was repeated for every group by separating the countries into three groups according to their income groups. In 189 countries, 30 countries are included in the low income countries, 104 countries are included in the middle income countries, and 55 countries are included in the high income countries. The obesity prevalence in adults was used as the study's dependent variable. GDP per capita selected as the income indication was used as the variable of interest. The urbanization, education, employment in industry, and health expenditure variables were added as the control variables to the model. In the study for each group, the POLS model, random effects model, and fixed effects model analyses were applied at first. It was decided that the fixed effects model was available for all groups according to the results of F test, Breusch Pagan test, and Hausman test applied subsequently. The fixed effects model was estimated with Driscoll-Kraay robust standard errors for all groups by the result of the diagnostic tests made.

The effect of GDP per capita variable used as the income indication on obesity was found positive and statistically significant for all countries. It was observed that sign and significance did not change by adding the control variables. Adding the control variables changed the coefficient of the GDP per capita variable, and the serious increases were observed in R^2, indicating that it is meaningless to take the GDP per capita as the only independent variable in the model. When we examine the countries by separating them into the income groups, it was observed that the GDP per capita variable had a positive and significant effect on adult obesity for all income groups. This case indicated that there was an increase at the rate of obesity on adults as long as the GDP per capita level increases, in other words, the obesity increases regardless of the income levels of the countries. The result found is consistent with most of the results found in the literature for all countries, the low income countries, and the middle income countries. According to literature, in most of the studies made for the high income countries, it is seen that the effect of the GDP per capita on obesity is negative. Differently than the literature findings, in our study, the sign of the high income countries was found positive and significant both in case the control variables were not added and also in case after the control variables were added. Also, the coefficient of the high income countries was found higher than both coefficient of the low income countries and also the coefficient of the middle income countries. The assets of households show increase along with the income increase. As technology develops, many inventions make our lives easier. These assets such as car, dishwasher, washing machine, lift, etc. decrease the physical activities of individuals substantially. Also, when it is thaught that food is a normal good, it is expected that the food expenses increase along with the increase in income. The intensive working hours and the intensive working conditions bring the income increase with it. However, timelessness causes individuals to devote less time to exercise while increasing their tendency to unhealthy foods that are consumed more easily and faster. All these makes increase in obesity seen on adults reasonable as income increases.

As urbanization increases, it is seen that individuals turn to a more sedentary life and unhealthy lifestyle. The occupation groups where the individuals living in cities are employed in general differ from those living in rural areas. The individuals living in the city generally work at desk-jobs with intensive working hours, requiring less physical activities. This both decreases the energy spent by them and the time spent on exercise. Also, the increases are seen in the income levels of individuals along with urbanization, and it was found that income is related to obesity positively. The opportunities provided by technology increase with urbanization, and using technological tools commonly decrease rates of spending energy by individuals substantially. It is inevitable to gain weight by the result of the unhealthy eating habits of the individuals who do not have enough time to prepare healthy meals because of the intensive tempo of the city.

Education is a factor affecting the living conditions, the occupation selections, the fields where they might work, and the incomes of the people. Individuals more likely to work in occupations yielding much more income, and it is seen that individuals are employed in the service sector mostly as the education level of them increases. Such occupation groups are known as the occupation groups causing inaction and having the intensive working hours. Nevertheless, education cannot be seen as a necessary means only to obtain more income. It is expected that an education performed in real terms makes individuals more well-informed and conscious of many subjects. Education shapes many decisions affecting the life qualities of individuals, such as obtaining healthy feeding habits, avoidance from habits decreasing the health level. According to literature, the effect of education to make people conscious about diseases and obesity and to turn people to the more healthy living is seen to be a more dominant effect than the effect of income increase caused by increased level of education. Therefore, in many studies, the effect of education on obesity was found negative. In our study, the rates of enrollment in a school at the primary level were used as the education measure. According to the results of the analysis, in the case containing all countries, the effect of education on obesity was found negative and statistically significant. This case is an indication of that awareness of individuals may be raised about obesity with education. When examined separately according to the income groups of countries, the relation was found negative and significant in the low income countries. It was found negative but not statistically significant in the middle income countries, positive and significant in the high income countries. This case indicates that the effect of education might change according to the income groups of the countries. In the developed countries having the high income level, it might be thaught that the increase in education increases obesity through increasing the income level. We may also note that, in developed countries, the individuals having the education level higher than the primary school level are seen more in comparison to the countries in the other income groups. Therefore, for further analysis, adult obesity analysis can also be repeated with higher education levels and interpreted in middle and high income countries.

Economies transform as urbanization, and education levels increase. The employment in the service sector that is not requiring too many physical movements, but having the intensive working hours increases, while the employment in the motion-intensive agricultural sector and the industry sector declines. The income of individuals increases along with these transitions, but at the same time, daily physical activities and time spend for exercise decline dramatically. Individuals should be aware of they being inactive at the working places and need to do exercise at a specific quantity daily even they have only a very little time. Our study shows that working in the industry sector decreases rates of obesity in both all countries and all income groups. The results are also consistent with the studies made previously.

In this study, it was observed that in some cases adding health expenditure variable may slightly lower the R^2 value. However, we need to note that adding this variable decreases the number of observations, and therefore needs to be treated carefully. It was seen that the increase seen in the public health expenditures results in an increase in obesity for the middle income and high income countries and all countries. In the low income countries, it was not found statistically significant. The positive relationship that we found is supported by the literature when we refer to the health expenditures spent by the public. The expenditures spent by the public may cause moral hazard problems. People tend to make the wrong selections more often when they think that poor health decisions do not have a cost to them because public health is free. These tests may be repeated with the health expenditures spent by the private sector and the general health expenditures and interpreted in more detail.

REFERENCES

Ameye, Hannah, Johan Swinnen. 2019. Obesity, Income and Gender: The Changing Global Relationship. **Global Food Security.** vol. 23: 267–281. https://doi.org/10.1016/j.gfs.2019.09.003.

Altunkaynak, Berrin Zuhal, Elvan Özbek. 2006. Obezite: Nedenleri ve Tedavi Seçenekleri. **Van Tıp Dergisi.** vol. 13. no. 4: 138–142.

Baltagi, Badi H. 2005. **Econometric Analysis of Panel Data.** 3. ed. England: John Wiley & Sons, Ltd.

Born, Benjamin, Jörg Breitung. 2014. Testing for Serial Correlation in Fixed-Effects Panel Data Models. **Econometric Reviews.** vol. 35. no. 7: 1290-1316. https://doi.org/10.1080/07474938.2014.976524.

Böckerman, Petri, Jutta Viinikainen, Laura Pulkki-Råback, Christian Hakulinen, Niina Pitkänen, Terho Lehtimäki, Jaakko Pehkonen, Olli T. Raitakari. 2017. Does Higher Education Protect against Obesity? Evidence using Mendelian Randomization. **Preventive Medicine.** vol. 101: 195–198. https://doi.org/10.1016/j.ypmed.2017.06.015.

Breusch, Trevor, Adrian Pagan. 1980. The Lagrange Multiplier Test and its Applications to Model Specification in Econometrics. **The Review of Economic Studies.** vol. 47. no. 1: 239-253.

Brunello, Giorgio, Pierre-Carl Michaud, and Anna Sanz-de-Galdeano. 2008. The Rise in Obesity Across the Atlantic: An Economic Perspective. **RAND Labor and Population Working Paper Series.**
https://doi.org/10.7249/wr586.

Cawley, John. 2010. The Economics of Childhood Obesity. **Health Affairs.** vol. 29. no. 3: 364–371.
https://doi.org/10.1377/hlthaff.2009.0721.

Crowle, Jacqueline, Erin Turner. 2010. **Childhood Obesity: An Economic Perspective.** Melbourne: Australian Government Productivity Commission Staff Working Paper.
ISBN: 978-1-74037-325-8.

Dicker, Dror. 2018. How to Stop the Obesity Tsunami?. 9. Ulusal Obezite Kongresi, 22- 25 November 2018. Ankara.

Driscoll, John, Aart Kraay. 1998. Consistent Covariance Matrix Estimation with Spatially Dependent Panel Data. **The Review of Economics and Statistics.** vol. 80. no. 4: 549–560.

Egger, Garry, Boyd Swinburn, F. M. Amirul Islam. 2012. Economic Growth and Obesity: An Interesting Relationship with World-Wide Implications. **Economics and Human Biology.** vol. 10. no. 2: 147–153. https://doi.org/10.1016/j.ehb.2012.01.002.

Eleuteri, Betsy. 2004. Income and Obesity in OECD Countries. The College of New Jersey.

Erlat, Haluk, 2008. **Panel Data: A Selective Survey.** 2. ed. Discussion Paper Series. no. 97- 04. Middle East Technical University, Ankara.

Ersoy, Canan. 2018. Obezite Tek Başına mı? Hipertansiyon. **9. Ulusal Obezite Kongresi Bildiriler, 22- 25 November 2018.** Ankara: Türk Diabet ve Obezite Vakfı: 39-40.

Fayissa, Bichaka, Paulos Gutema. 2005. Estimating A Health Production Function for Sub-Saharan Africa (SSA). **Applied Economics.** vol. 37. no. 2: 155–164. https://doi.org/10.1080/00036840412331313521.

Fox, Ashley, Wenhui Feng, Victor Asal. 2019. What is Driving Global Obesity Trends? Globalization or 'Modernization'?. **Globalization and Health.** vol. 15. no. 32: 1-16.
https://doi.org/10.1186/s12992-019-0457-y.

Frees, Edward W. 2004. **Longitudinal and Panel Data Analysis and Applications in the Social Sciences**. United States of America: Cambridge University Press.

Goryakin, Yevgeniy, Marc Suhrcke. 2014. Economic Development, Urbanization, Technological Change and Overweight: What Do We Learn from 244 Demographic and Health Surveys?. **Economics and Human Biology.** vol. 14: 109–27.
https://doi.org/10.1016/j.ehb.2013.11.003.

Greene, William H. 2003. **Econometric Analysis.** 5. ed. New Jersey: Prentice Hall. ISBN: 0-13-066189-9.

Gujarati, Damodar N. 2004. **Basic Econometrics.** 4. ed. New York: McGraw-Hill.

Gujarati, Damodar N., Dawn C. Porter. 2009. **Basic Econometrics.** 5. ed. New York: McGraw-Hill.

Gürel, F. Serdar, Gülten İnan. 2001. Çocukluk Çağı Obezitesi Tanı Yöntemleri, Prevalansı ve Etyolojisi. **ADÜ Tıp Fakültesi Dergisi.** vol. 2. no. 3: 39–46.

Habertürk. [08.06.2020]. Türkiye'nin Obezite Haritası Çıkarıldı!. https://www.haberturk.com/saglik/haber/1250882-turkiyenin-obezite-haritasi-cikarildi.

Halicioglu, Ferda. 2013. Dynamics of Obesity in Finland. **Journal of Economic Studies.** vol. 40. no. 5: 644–657. https://doi.org/10.1108/JES-01-2012-0007.

Hoechle, Daniel. 2007. Robust Standard Errors for Panel Regressions with Cross-Sectional Dependence. **The Stata Journal.** vol. 7. no 3: 281–312. https://doi.org/10.1177/1536867X0700700301.

Hsiao, Cheng. 2014. **Analysis of Panel Data.** 3. ed. United States of America: Cambridge University Press.

Johnston, Jack, John Dinardo. 1997. **Econometric Methods.** 4. ed. New York: McGraw-Hill Higher Education.

Kara, Cengiz. 2018. Pediatrik Obezitenin Önemi: Obezitesi Olan Çocuk daha Obez Erişkin mi Olacak?. **9. Ulusal Obezite Kongresi Bildiriler, 22- 25 November 2018.** Ankara: Türk Diabet ve Obezite Vakfı: 41-44.

Kennedy, Peter. 2008. **A Guide to Econometrics.** 6. ed. United Kingdom: Blackwell Publishing

Keser, Alev. 2018. Diyet ve Yaşam Tarzının Obezite Tedavisine Etkisi. **9. Ulusal Obezite Kongresi Bildiriler, 22- 25 November 2018.** Ankara: Türk Diabet ve Obezite Vakfı: 23-25.

Kim, Jong Hae. Multicollinearity and Misleading Statistical Results. 2019. **Korean Journal of Anesthesiology.** vol. 72. no. 6: 558–569. https://doi.org/10.4097/kja.19087.

Kim, Young-Joo. 2016. The Long-Run Effect of Education on Obesity in the US. **Economics and Human Biology.** vol. 21: 100–109. https://doi.org/10.1016/j.ehb.2015.12.003.

Kinge, Jonas Minet, Bjørn Heine Strand, Stein Emil Vollset, Vegard Skirbekk. 2015. Educational Inequalities in Obesity and Gross Domestic Product: Evidence from 70 Countries. **Journal of Epidemiol Community Health.** vol. 69: 1141–1146. https://doi.org/10.1136/jech-2014-205353.

Komlos, John, Patricia K. Smith, Barry Bogin. 2004. Obesity and the Rate of Time Preference: Is There a Connecition?. **Journal of Biosocial Science.** vol. 36. no. 2: 209–219. https://doi.org/10.1017/S0021932003006205.

Lawson, Robert A., Ryan H. Murphy, Claudia R. Williamson. 2016. The Relationship between Income, Economic Freedom, and BMI. **Public Health.** vol. 134: 18–25.
https://doi.org/10.1016/j.puhe.2016.01.020.

Loureiro, Maria L., Rodolfo M. Nayga Jr. 2005. International Dimensions of Obesity and Overweight Related Problems: An Economics Perspective. **American Journal of Agricultural Economics.** vol. 87 no. 5: 1147–1153.

Lewis, Sharon L, Shannon Ruff Dirksen, Margaret McLean Heitkemper, Linda Bucher. 2014. **Medical-Surgical Nursing: Assessment and Management of Clinical Problems.** 9. ed. United Stattes of America: Elsevier Inc.

Mankiw, N. Gregory. 2018. **Principles of Economics.** 8. ed. United States of America: Cengage Learning.

Masood, Mohd, Daniel D. Reidpath. 2017. Effect of National Wealth on BMI: An Analysis of 206,266 Individuals in 70 Low-, Middle-and High-Income Countries. **Plos One.** vol. 12. no. 6.
https://doi.org/10.1371/journal.pone.0178928.

Ministry of Health. 2010. **Türkiye Obezite (Şişmanlık) ile Mücadele ve Kontrol Programı (2010-2014).** Ankara: T.C. Sağlık Bakanlığı Temel Sağlık Hizmetleri Genel Müdürlüğü Beslenme ve Fiziksel Aktiviteler Daire Başkanlığı.
ISBN: 978-975-590-311-8

———. [03.12.2019]. Türkiye'de Obezitenin Görülme Sıklığı.
https://hsgm.saglik.gov.tr/tr/obezite/turkiyede-obezitenin-gorulme-sikligi.html.

Minos, Dimitrios. 2016. **Overweight and Obesity in Low- and Middle-Income Countries: A Panel-Data Analysis.** Georg-August-University, Göttingen.

Mirowsky, John, Catherine E. Ross. 1998. Education, Personal Control, Lifestyle and Health: A Human Capital Hypothesis. **Research on Ageing.** vol. 20. no. 4: 415–449.
https://doi.org/10.1177/0164027598204003.

Nişancı Kılınç, Fatma. 2018. Obezitenin Tedavisinde Ketojenik Diyet Faydalı mı?. **9. Ulusal Obezite Kongresi Bildiriler, 22- 25 November 2018.** Ankara: Türk Diabet ve Obezite Vakfı: 51-54.

Park, Hun Myoung. 2011. **Practical Guides to Panel Data Modeling: A Step-by-step Analysis Using Stata.** Tutorial Working Paper. Graduate School of International Relations, International University of Japan.

Pesaran, M. Hashem. 2015. **Time Series and Panel Data Econometrics.** United Kingdom: Oxford University Press.

Pickett, Kate E., Shona Kelly, Eric Brunner, Tim Lobstein, Richard G. Wilkinson. 2005. Wider Income Gaps, Wider Waistbands? An Ecological Study of Obesity and Income Inequality. **Journal of Epidemiology and Community Health.** vol. 59. no.8: 670–674. https://doi.org/10.1136/jech.2004.028795.

Pisa, Pedro T., Noleen M. Pisa. 2016. Economic Growth and Obesity in South African Adults: An Ecological Analysis between 1994 and 2014. **European Journal of Public Health.** 27 (3): 404–409. https://doi.org/10.1093/eurpub/ckw119.

Saruç, Naci Tolga. 2015. **Obezite Ekonomisi.** Ankara: Seçkin Yayıncılık. ISBN: 978-975-02-3314-2.

Seddighi, Hamid R. 2012. **Introductory Econometrics A Practical Approach**, New York: Routledge.

Şahin, İbrahim. 2018. Obezitede Tanıda Bireyselleştirme, Antropometrik Ölçümler Yeterli mi?. 9. Ulusal Obezite Kongresi, 22- 25 November 2018. Ankara.

Thornton, James. 2002. Estimating a Health Production Function for The U.S: Some New Evidence. **Applied Economics.** vol. 34. no.1: 59–62. https://doi.org/10.1080/00036840010025650.

Wardle, Jane, Jo Waller, Martin J. Jarvis. 2002. Sex Differences in the Association of Socioeconomic Status with Obesity. **American Journal of Public Health.** vol. 92. no. 8: 1299–1304. https://doi.org/10.2105/AJPH.92.8.1299.

Windarti, N., Su Wah Hlaing, Makoto Kakinaka. 2019. Obesity Kuznets Curve: International Evidence. **Public Health.** vol. 169: 26–35. https://doi.org/10.1016/j.puhe.2019.01.004.

Wooldridge, Jeffrey M. 2010. **Econometric Analysis of Cross Section and Panel Data.** 2. ed. United States of America: The MIT Press. ISBN: 978-0-262-23258-6.

_____. 2018. **Introductory Econometrics: A Modern Approach.** 7. ed. United States of America: Cengage. ISBN: 9781337558860.

World Health Organization. 2000. **Obesity: Preventing and Managing the Global Epidemic.** WHO Technical Report Series 894. Geneva, Switzerland. ISBN: 92-4-120894-5.

_____. [06.06.2020]. Global Strategy on Diet, Physical Activity and Health. https://www.who.int/dietphysicalactivity/childhood_what/en/.

_____. [13.06.2020]. Obesity and Overweight. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight.

Yerdelen Tatoğlu, Ferda. 2018. **Panel Veri Ekonometrisi.** 4. ed. İstanbul: Beta Yayıncılık.
ISBN: 978-605-242-281-6.

APPENDIX

Annex 1. Countries Used in Analysis

Table 38: Low Income Countries in the Analysis

LOW INCOME COUNTRIES		
Afghanistan	Benin	Burkina Faso
Burundi	Central African Republic	Chad
Congo Democratic Republic	Eritrea	Ethiopia
The Gambia	Guinea	Guinea-Bissau
Haiti	Democratic People's Republic of Korea	Liberia
Madagascar	Malawi	Mali
Mozambique	Nepal	Niger
Rwanda	Sierra Leone	Somalia
Syrian Arab Republic	Tajikistan	Tanzania
Togo	Uganda	Yemen

Table 39: Middle Income Countries in the Analysis

MIDDLE INCOME COUNTRIES		
Albania	Algeria	Angola
Argentina	Armenia	Azerbaijan
Bangladesh	Belarus	Belize
Bhutan	Bolivia	Bosnia and Herzegovina
Botswana	Brazil	Bulgaria
Cabo Verde	Cambodia	Cameroon
China	Colombia	Comoros
Congo	Costa Rica	Cote d'Ivoire
Cuba	Djibouti	Dominica
Dominican Republic	Ecuador	Egypt, Arab Republic
El Salvador	Equatorial Guinea	Eswatini
Fiji	Gabon	Georgia
Ghana	Grenada	Guatemala
Guyana	Honduras	India
Indonesia	Iran Islamic Republic	Iraq
Jamaica	Jordan	Kazakhstan
Kenya	Kiribati	Kyrgyz Republic

Table 39 – continued

Lao PDR	Lebanon	Lesotho
Libya	Malaysia	Maldives
Marshall Islands	Mauritania	Mauritius
Mexico	Micronesia	Moldova
Mongolia	Montenegro	Morocco
Myanmar	Namibia	Nauru
Nicaragua	Nigeria	North Macedonia
Pakistan	Papua New Guinea	Paraguay
Peru	Philippines	Romania
Russian Federation	Samoa	Sao Tome and Principe
Senegal	Serbia	Solomon Islands
South Africa	Sri Lanka	St. Lucia
St. Vincent and the Grenadines	Sudan	Suriname
Thailand	Timor-Leste	Tonga
Tunisia	Turkey	Turkmenistan
Tuvalu	Ukraine	Uzbekistan
Vanuatu	Venezuela, RB	Vietnam
Zambia	Zimbabwe	

Table 40: High Income Countries in the Analysis

HIGH INCOME COUNTRIES		
Andorra	Antigua and Barbuda	Australia
Austria	The Bahamas	Bahrain
Barbados	Belgium	Brunei Darussalam
Canada	Chile	Croatia
Cyprus	Czech Republic	Denmark
Estonia	Finland	France
Germany	Greece	Hungary
Iceland	Ireland	Israel
Italy	Japan	Korea Republic
Kuwait	Latvia	Lithuania
Luxembourg	Malta	Netherlands
New Zealand	Norway	Oman
Palau	Panama	Poland
Portugal	Qatar	Saudi Arabia
Seychelles	Singapore	Slovak Republic
Slovenia	Spain	St. Kitts and Nevis
Sweden	Switzerland	United Arab Emirates
United Kingdom	United States	Uruguay
Trinidad and Tobago		

Annex 2. Means of Prevalence of Obesity among Adults Data for All Countries of the World Separately between 1975 and 2016

Table 41: Means of Prevalence of Obesity among Adults Data for All Countries of the World Separately between 1975 and 2016

Country Name	Mean
Nauru	53,04286
Palau	42,08095
Marshall Islands	40,45476
Tuvalu	35,08095
Tonga	33,88571
Samoa	33,65952
Micronesia, Fed. Sts.	31,99524
Kiribati	31,20476
Kuwait	28,03571
Qatar	24,26667
Jordan	23,45238
Saudi Arabia	23,14524
United States	22,94048
Lebanon	22,00238
Malta	21,77381
The Bahamas	21,62619
Libya	21,58571
Bahrain	21,29048
United Arab Emirates	21,02857
Egypt, Arab Rep.	20,7619
Iraq	20,59048
Andorra	20,49524
Lithuania	20,17857
Czech Republic	20,01667
New Zealand	19,74524
Turkey	19,62143
Israel	19,57381
Argentina	19,12143
Chile	19,07619
Uruguay	19,00238
Fiji	18,82619
Mexico	18,78333
Hungary	18,74048
Australia	18,57619
Canada	18,55714

Table 41 – continued

Latvia	18,44048
Russian Federation	18,35714
South Africa	18,03095
Ukraine	18,02619
Venezuela, RB	17,56667
Bulgaria	17,30714
Belarus	17,27381
United Kingdom	17,22381
Suriname	17,12381
Greece	17,04524
Dominica	16,84048
Syrian Arab Republic	16,77143
Spain	16,76667
Estonia	16,74762
Poland	16,5
Tunusia	16,3381
Croatia	16,32857
Belgium	15,85238
Cuba	15,71667
Algeria	15,71429
North Macedonia	15,6619
Oman	15,35952
Belize	15,16905
Morocco	15,07381
Iran, Islamic Rep.	14,99524
Germany	14,9881
Dominican Republic	14,88333
Romania	14,87381
Iceland	14,67619
France	14,64048
Jamaica	14,62143
Luxembourg	14,56905
Norway	14,53333
Finland	14,49286
Ireland	14,4881
Cyprus	14,3
Serbia	14,27857
Slovak Republic	14,24286
Nicaragua	14,24048
Barbados	14,23095
Montenegro	14,21905

Table 41 – continued

Vanuatu	14,02381
Slovenia	13,95714
El Salvador	13,89048
Colombia	13,85714
Italy	13,85714
Costa Rica	13,52619
Sweden	13,49286
St. Kitts and Nevis	13,31667
St. Vincent and the Grenadines	13,28333
Panama	13,19524
Armenia	13,15476
Moldova	13,13571
Kazakhstan	12,93333
Denmark	12,90238
Brazil	12,88333
Georgia	12,88095
Austria	12,82381
Albania	12,44524
Peru	12,4119
Grenada	12,30238
Portugal	12,2619
Solomon Islands	12,19762
Papua New Guinea	12,06429
Switzerland	11,93571
Azerbaijan	11,87619
Netherlands	11,84286
Ecuador	11,76429
Guatemala	11,75238
Bolivia	11,6881
Bosnia and Herzegovina	11,54286
St. Lucia	11,49524
Antigua and Barbuda	11,47381
Honduras	11,41429
Guyana	11,17857
Mongolia	11,07857
Paraguay	10,99762
Botswana	10,60952
Turkmenistan	10,49048
Haiti	10,25
Trinidad and Tobago	9,659524

Table 41 – continued

Eswatini	9,62619
Uzbekistan	9,25
Zimbabwe	9,230952
Kyrgyz Republic	9,157143
Lesotho	8,969048
Namibia	8,866667
Djibouti	8,535714
Yemen	8,214286
Seychelles	7,957143
Gabon	7,911905
Tajikistan	7,757143
Brunei Darussalam	6,666667
Malaysia	6,535714
Mauritius	6,238095
Mauritania	5,885714
Sao Tome and Principe	5,628571
Cabo Verde	5,419048
Cameroon	5,290476
Ghana	5,035714
Liberia	5,035714
Congo	4,735714
Cote d’lvoire	4,683333
Benin	4,497619
The Gambia	4,361905
Senegal	4,314286
Singapore	4,240476
Zambia	4,085714
Sierra Leone	4,07381
Guinea-Bissau	3,940476
Somalia	3,830952
Equatorial Guinea	3,82381
Togo	3,790476
Comoros	3,778571
Korea, Dem. People’s Rep.	3,752381
Thailand	3,738095
Nigeria	3,709524
Pakistan	3,688095
Sudan	3,638095
Central African Republic	3,614286
Mali	3,611905

Table 41 – continued

Tanzania	3,569048
Guinea	3,428571
Angola	3,414286
Mozambique	3,22381
Maldives	3,061905
Kenya	3,057143
Congo, Dem. Rep.	2,92619
Philippines	2,907143
Chad	2,72381
Malawi	2,488095
Indonesia	2,485714
Korea, Rep.	2,419048
Niger	2,380952
Bhutan	2,361905
China	2,302381
Burundi	2,261905
Uganda	2,245238
Rwanda	2,240476
Afghanistan	2,190476
Myanmar	2,180952
Madagascar	2,17619
Eritrea	2,140476
Japan	2,116667
Burkina Faso	2,104762
Sri Lanca	2,059524
Ethiopia	1,85
Lao PDR	1,780952
India	1,545238
Nepal	1,52619
Cambodia	1,433333
Timor-Leste	1,347619
Bangladesh	1,290476
Vietnam	0,6904762

Table 42: Means of Prevalence of Obesity among Adults Data for All Low Income Countries of the World Separately between 1975 and 2016

Country Name	**Mean**
Syrian Arab Republic	16,7714
Haiti	10,25
Yemen	8,21429
Tajikistan	7,75714

Table 42 – continued

Liberia	5,03571
Benin	4,49762
The Gambia	4,36191
Sierra Leone	4,07381
Guinea-Bissau	3,94048
Somalia	3,83095
Togo	3,79048
Korea, Dem. People's Rep.	3,75238
Central African Republic	3,61429
Mali	3,61191
Tanzania	3,56905
Guinea	3,42857
Mozambique	3,22381
Congo, Dem. Rep.	2,92619
Chad	2,72381
Malawi	2,4881
Niger	2,38095
Burundi	2,26191
Uganda	2,24524
Rwanda	2,24048
Afghanistan	2,19048
Madagascar	2,17619
Eritrea	2,14048
Burkina Faso	2,10476
Ethiopia	1,85
Nepal	1,52619

Table 43: Means of Prevalence of Obesity among Adults Data for All Middle Income Countries of the World Separately between 1975 and 2016

Country Name	**Mean**
Nauru	53,04286
Marshall Islands	40,45476
Tuvalu	35,08095
Tonga	33,88571
Samoa	33,65952
Micronesia, Fed. Sts.	31,99524
Kiribati	31,20476
Jordan	23,45238
Lebanon	22,00238
Libya	21,58571

Table 43 – continued

Egypt, Arab Rep.	20,7619
Iraq	20,59048
Turkey	19,62143
Argentina	19,12143
Fiji	18,82619
Mexico	18,78333
Russian Federation	18,35714
South Africa	18,03095
Ukraine	18,02619
Venezuela, RB	17,56667
Bulgaria	17,30714
Belarus	17,27381
Suriname	17,12381
Dominica	16,84048
Tunisia	16,3381
Cuba	15,71667
Algeria	15,71429
North Macedonia	15,6619
Belize	15,16905
Morocco	15,07381
Iran, Islamic Rep.	14,99524
Dominican Republic	14,88333
Romania	14,87381
Jamaica	14,62143
Serbia	14,27857
Nicaragua	14,24048
Montenegro	14,21905
Vanuatu	14,02381
El Salvador	13,89048
Colombia	13,85714
Costa Rica	13,52619
St. Vincent and the Grenadines	13,28333
Armenia	13,15476
Moldova	13,13571
Kazakhstan	12,93333
Brazil	12,88333
Georgia	12,88095
Albania	12,44524
Peru	12,4119
Grenada	12,30238

Table 43 – continued

Solomon Islands	12,19762
Papua New Guinea	12,06429
Azerbaijan	11,87619
Ecuador	11,76429
Guatemala	11,75238
Bolivia	11,6881
Bosnia and Herzegovina	11,54286
St. Lucia	11,49524
Honduras	11,41429
Guyana	11,17857
Mongolia	11,07857
Paraguay	10,99762
Botswana	10,60952
Turkmenistan	10,49048
Eswatini	9,62619
Uzbekistan	9,25
Zimbabwe	9,230952
Kyrgyz Republic	9,157143
Lesotho	8,969048
Namibia	8,866667
Djibouti	8,535714
Gabon	7,911905
Malaysia	6,535714
Mauritius	6,238095
Mauritania	5,885714
Sao Tome and Principe	5,628571
Cabo Verde	5,419048
Cameroon	5,290476
Ghana	5,035714
Congo	4,735714
Cote d’lvoire	4,683333
Senegal	4,314286
Zambia	4,085714
Equatorial Guinea	3,82381
Comoros	3,778571
Thailand	3,738095
Nigeria	3,709524
Pakistan	3,688095
Sudan	3,638095
Angola	3,414286
Maldives	3,061905

Table 43 – continued

Kenya	3,057143
Philippines	2,907143
Indonesia	2,485714
Bhutan	2,361905
China	2,302381
Myanmar	2,180952
Sri Lanka	2,059524
Lao PDR	1,780952
India	1,545238
Cambodia	1,433333
Timor-Leste	1,347619
Bangladesh	1,290476
Vietnam	0,690476

Table 44: Means of Prevalence of Obesity among Adults Data for All High Income Countries of the World Separately between 1975 and 2016

Country Name	**Mean**
Palau	42,081
Kuwait	28,0357
Qatar	24,2667
Saudi Arabia	23,1452
United States	22,9405
Malta	21,7738
The Bahamas	21,6262
Bahrain	21,2905
United Arab Emirates	21,0286
Andorra	20,4952
Lithuania	20,1786
Czech Republic	20,0167
New Zealand	19,7452
Israel	19,5738
Chile	19,0762
Uruguay	19,0024
Hungary	18,7405
Australia	18,5762
Canada	18,5571
Latvia	18,4405
United Kingdom	17,2238
Greece	17,0452

Table 44 - continued

Spain	16,7667
Estonia	16,7476
Poland	16,5
Croatia	16,3286
Belgium	15,8524
Oman	15,3595
Germany	14,9881
Iceland	14,6762
France	14,6405
Luxembourg	14,5691
Norway	14,5333
Finland	14,4929
Ireland	14,4881
Cyprus	14,3
Slovak Republic	14,2429
Barbados	14,231
Slovenia	13,9571
Italy	13,8571
Sweden	13,4929
St. Kitts and Nevis	13,3167
Panama	13,1952
Denmark	12,9024
Austria	12,8238
Portugal	12,2619
Switzerland	11,9357
Netherlands	11,8429
Antigua and Barbuda	11,4738
Trinidad and Tobago	9,65952
Seychelles	7,95714
Brunei Darussalam	6,66667
Singapore	4,24048
Korea, Rep.	2,41905
Japan	2,11667

CURRICULUM VITAE

BÜŞRA KESİCİ

İstanbul University, Faculty of Economics, Beyazıt Campus, Besim Ömerpasa Cd.

No:19, 34116 Fatih/İstanbul, Turkey

E-mail: kesici.busra@istanbul.edu.tr

Education

09/2017 – Present **Yıldız Technical University, Istanbul, Turkey**
M.A. in Economics

09/2012 – 06/2017 **Hacettepe University, Ankara, Turkey**
B. Sc. In Economics

Academic Positions

08/2018 – Present **Istanbul University, Istanbul, Turkey**
Faculty of Economics
Economic Theory/Department of Economics
Full-Time Research Assistant

10/2017 – 08/2018 **Nişantaşı University, Istanbul, Turkey**
Full-Time Research Assistant

Languages

English – Fluent

Turkish – Native

Computer Skills

STATA, R, EViews, MS Office Applications

Presentations in International Conferences

Kesici, B., Çırpıcı, Y.A. (2020), Obezitenin İktisadi Belirleyicileri. İKSAD 5 th International Congress of Social Sciences, Tokat, Turkey, March 2020.