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Testing obesity Kuznets curve for Türkiye

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ABSTRACT

Aim: This paper tests for the existence of Obesity Kuznets Curve (OKC); that is, an inverse U-shape pattern between income and obesity (as measured by Body Mass Index).
Methods: We employ linear probability model and logistic regression using cross-sectional data obtained from "2019 Türkiye Health Research" provided by the Turkish Statistical Institute (TUIK).
Results: Our findings reveal that OKC hypothesis holds for Türkiye such that the likelihood of obesity first increases as income rises and after reaching a maximum point, it starts to decrease. Furthermore, the study reveals that obesity differs according to gender, so women are more likely to be obese than men. Our empirical study also reveals that marriage, education, age, and physical activity are closely associated with the likelihood of being obese in Türkiye.
Conlusions: There is a non-linear relationship between income and obesity. The study also reveals that obesity differs according to gender and marriage, education, age, and physical activity are closely associated with the likelihood of being obese in Türkiye.

1. Introduction

The World Health Organization (WHO) defines overweight (body mass index – *BMI* > 25) and obesity (*BMI* > 30) as abnormal or excessive fat accumulation that may impair health and estimates that there were about 2 billion adults (39% of men and 40% of women, about 13% of the world's adult population) with overweight worldwide; of those, 650 million were obese (11% of men and 15% of women) in 2016. If current trends continue, it is estimated that 1 in 7 men and 1 in 5 women will be living with obesity, equating to over 1 billion people worldwide by 2030, according to the latest projections by the World Obesity Federation (World Obesity Atlas 2022). Overweight and obesity, previously seen as a problem only in high-income countries, have been increasing dramatically in low- and middle-income countries as well, particularly in urban settings.

According to the WHO, worldwide obesity has nearly tripled since 1975 and 2.8 million deaths yearly are attributable to being overweight or obese, putting the global population at increased risk for diseases including diabetes, cardiovascular diseases, and certain types of cancer. However, the impact of obesity is not limited just to public health concerns and has important personal, social, and economic consequences. Obesity-associated chronic diseases have major effects on the personal budgets of individuals and families and may impose a large economic burden on national economies by reducing the life expectancy and the quality of human capital as it reduces the labor force productivity, educational attainment, academic performance, workforce participation, and increasing disability and health expenditures, and thus, negatively affect the national income of a country, create fiscal pressure, and increase taxation (Tremmel et al., 2017; OECD, 2019).

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While numerous factors contribute to an increase in average population bodyweight, including environmental factors and genetic propensity, overweight and obesity primarily occur due to the high caloric intake from diet and low levels of physical activity levels (Withrow and Alter, 2011; Romieu et al., 2017; OECD, 2019). Globally, as globalization and urbanization have grown in the past few decades, diets and activity patterns have changed significantly, and there has been a significant decrease in physical activity and increases in sedentary behavior associated with the developments in technology and shift towards office jobs and more inactive modes of transport, but there has also been a shift in food consumption patterns towards more energy-dense foods associated with the increasing availability of calories, particularly for certain nutrients, such as sugar. (Popkin et al., 2012; OECD, 2019; Shekar and Popkin, 2020). Besides these primary reasons, the socioeconomic and environmental factors which are also mostly associated with diet and activity patterns such as income and education level, sex, age, ethnicity, socioeconomic status, living environment, and working conditions also affect overweight and obesity as the prevalence of obesity varies across countries, sexes, socioeconomic groups, regions, and social classes within countries (Branca et al., 2007; OECD, 2019). For example, global average data suggest that, in general, the prevalence of obesity and overweight among women is higher than that of men. On the other hand, in most countries, individuals with low levels of education and in the lowest income group are more likely to be overweight or obese than individuals with the highest education and income (OECD, 2019). Therefore, it can be argued that addressing the issue of obesity is complicated but also necessary given its significant health and economic costs, for designing well-targeted government policies to combat this epidemic. In this context, it is of vital importance to determine the link between obesity and its determinants. One of these determinants, which has received a great deal of attention in the theoretical and empirical literature, but whose effect on obesity requires a thorough analysis, is income.

From the theoretical perspective, at the individual level, the principal mechanism by which income induces obesity by affecting individuals' energy intake and expenditure is through its effect on food preferences, dietary habits, physical activity trends, lifestyle, and other behavioral and psychosocial effects. At the individual level, as incomes rise above the subsistence level, individuals can afford and generally prefer a higher-calorie diet and leisure, which leads to higher energy intake and less energy expenditure. On the other hand, it can be argued that individuals with low income generally live in an environment requiring less physical activity (Edwards and Tsouros, 2006; Heinrich et al., 2007; Armstrong et al., 2018) and are less likely to consume healthful foods and tend to spend a larger proportion of their income on less healthful foods (low price foods filled with excess calories) that lower the diet quality (French et al., 2019; Drewnowski and Specter, 2004), and thus, they are more likely to suffer from nutrition-related health problems such as overweight and obesity (Ren et al., 2019). As their incomes rise, they can access healthier foods and health services and have time for physical activities such as exercising regularly, which leads to lower energy intake and more energy expenditure (Zhang and Xiang, 2019). Therefore, the theoretical considerations (and empirical findings) regarding the income effect on obesity and overweight do not provide a persuasive answer as this effect may go either in a positive or negative direction. Although a large body of research agrees that there is a significant relationship between income and obesity, empirical results appear to be contradictory, and the relationship between the two remains mostly unclear, given the fact that the association between them is more complex than it seems (Ameye and Swinnen, 2019; Mathieu-Bolh, 2022). Besides, recent studies in the literature have shown that the effect of income on obesity is not uniform across countries and differs according to the level of economic development and global integration (Zhou, 2021). There are a number of studies suggesting a positive association between income and obesity in less developed countries as those with higher income are likely to be obese in this group of countries, and a negative relationship between the two in developed countries as obesity is highest among the least well-off groups in such societies (Popkin, 1998; Giskes et al., 2008; Sallis and Glanz, 2009; Dinsa et al., 2012; Wells et al., 2012; Pampel et al., 2012; Malik et al., 2013; Marteleto et al., 2017; Zhou, 2019, 2021; Ameye and Swinnen, 2019). The impact of economic growth on obesity is mostly explained by technological development shaping the structure of the economy, consumption patterns, changing overall price of food consumption, and lifestyle (Philipson and Posner, 1999; Cutler et al., 2003; Lakdawalla and Philipson, 2009; Minos et al., 2016; Ozyapi, 2019; Zhou, 2021). Furthermore, involvement in globalization may also condition the relationship between income and obesity by affecting consumption patterns, lifestyle, and cultural norms and perceptions. Global integration is expected to reduce obesity among more well-off than among poor ones (Zhou, 2021).

Theoretically, the relationship between individual (or national) income and obesity prevalence could take the form of inverted-U, which is generally called as obesity Kuznets curve (OKC) hypothesis in the literature (Lakdawalla and Philipson 2009). According to the hypothesis, at the individual level, obesity first inreases as incomes rise since higher incomes allow people to afford excess food and nutrients more than they need, reduce physical activity and induce sedentary behavior, so the income-obesity curve is upward sloping. However, beyond a certain income threshold, higher income allows individuals to shift their consumption towards healthier food, raises awareness of health benefits from proper weight and health-related activities, and thus leads to a negative association between income and obesity, and the income-obesity curve becomes sloping downward (Akee et al., 2013; Grecu and Rotthoff, 2015; Windarti et al., 2019; Talukdar et al., 2020; Mathieu-Bolh, 2022). The OKC hypothesis has been investigated through a variety of econometric methods and data sets in the literature; nevertheless, the number of empirical studies with a specific focus on the hypothesis, especially in the micro context, is still fairly limited. Windarti et al. (2019) investigate the relationship between economic development and weight-related health statuses using panel data on 130 countries for the period 1975–2010. Using static panel data models and two-step system GMM estimation to account for endogeneity, the study confirms the OKC for both genders. The results from analyses indicate that the weight-related health status deteriorates as incomes increase in low-income countries and improve as incomes increase in high-income countries. Deuchert et al. (2014), using Demographic and Health Surveys providing anthropometric measurements (weight and height) for women (age 15–49 years) in 52 countries for the period 1990–2008, test the main aggregated predictions that health inequality and average body weight are associated with economic development. The results from the regression analysis imply that the rates of obesity (and overweight) and the average BMI increase significantly with economic development.

The findings also suggest a pattern of the OKC with a turning point at $2800. Similarly, Grecu and Rotthoff (2015) test the hypothesis of OKC using state-level data from the USA for the period 1991–2010. Utilizing a differences-in-differences strategy, they find evidence of an obesity Kuznets curve for white females, peaking at $15192. In another study on the US, Alola and Bekun (2021) explore the validity of the OKC and the U-shaped relationship between ecological footprint and obesity for the period 1975–2016. Employing an autoregressive distributed lag (ARDL) model, they find supportive evidence of the OKC as a higher income per capita leads to an increase in obesity until a certain threshold, with an estimated turning point of $10391. The empirical evidence also suggests that an increase in ecological footprint decreases the prevalence of obesity until a minimum threshold; then, the prevalence of obesity becomes severe as the ecological footprint continues to rise.

Relying on longitudinal data from the China Health and Nutrition Survey covering the period 1991–2011, Clement (2017) attempts to reveal the relationship between income and adult body size in urban China. Using parametric and semi-parametric methods, the study finds that the relationship between the two is gender-specific and nonlinear. The empirical findings provided by the parametric estimate show that the relationship between income and body shape goes from positive to negative for both genders, while the semi-parametric estimate suggests that this is the case only for women, with a turning point just above the median income. Aydin (2019), using a bounds testing approach within ARDL framework, examines the relationship between economic growth and obesity in the top 20 obese countries for the period 1991–2016. The empirical findings confirm the validity of OKC hypothesis in Türkiye, Oman, the United Arab Emirates, and Saudi Arabia. On the other hand, Talukdar et al. (2020) systematically examine the strength and pattern of the relationship between national income and obesity prevalence as well as the macro-environmental moderators of this relationship using an extensive dataset covering 147 countries over the period 1975–2014. Relying on a Bayesian hierarchical model, they find a positive association between national obesity prevalence and national income. However, the findings do not support the obesity Kuznets curve hypothesis as the relationship does not turn negative at higher income levels.

Among the others, geographic distribution, gender (Ogden et al., 2018; Ameye and Swinnen, 2019; Zhou, 2021), and education level (Monteiro et al., 2001; Ogden et al., 2018; Mosli et al., 2020; Zhou, 2021) may also condition the relationship between income and obesity. For example, Ameye and Swinnen (2019) identify important gender differences in the relationship between the two. Their study shows that females are more obese in low- and middle-income countries, while this gap disappears in high-income countries. They also show that the geographic concentration of obesity also changes with income growth. The study finds that obesity is higher in urban areas than in rural areas in low-income countries, whereas the rural-urban obesity gap is reversed in high-income countries. Mosli et al. (2020), on the other hand, find that individuals in the highest income bracket with lower levels of education in Saudi Arabia may be more vulnerable to obesity. Moreover, Monteiro et al. (2001) find that education does not affect male obesity rates in lower income groups in Brazil, while the obesity rate declines for men with higher income as the education level rises. Their findings, on the other hand, show that education has a much more significant effect on obesity for women, regardless of which income group they belong to (Ozyapi, 2019).

In light of these arguments, this study aims to extend the income-obesity analysis in Türkiye with an emphasis on the OKC hypothesis. Although there are a number of studies attempting to measure OKC, to the best our knowledge, none of these studies have focused on Türkiye, particularly in micro context. According to the data from the Nutrition, Health and Food Consumption Research, individuals' energy intake provided by carbohydrates and fat-based foods in 1974 was 64% and 24%, respectively (Köksal, 1977), while, in 2017, these figures were 50.2% and 34.5%, respectively (Ministry of Health of Türkiye, 2019). During the same period, there was no significant change in the amount of energy that individuals received from protein-derived foods, which implies that the dietary habits of individuals in Türkiye switched from carbohydrate-based foods to fat-based foods. The change in eating habits is also confirmed by the study of Foodservice Monitor conducted by the Association of Out-of-Home Consumption Suppliers and Ipsos Research Company in 2016. According to the study, due to an increase in urban population, the rising role of women in work life, and changes in lifestyle, expenditure in restaurants and fast food places constituted about half of the out-of-home consumption expenditures of individuals in Türkiye. The same period can also be characterized by increasing rates of overweight and obesity. According to the data from Türkiye Health Survey (2019), the overweight (pre-obesity) and obesity rates showed a significant rise in the last decade (17.9 percent), reaching 56.1 percent in 2019, compared to 47.6 percent in 2008, and obese individuals accounted for 21.1 percent of the total population in 2019 (15.2 percent in 2008 and 19.6 percent in 2016). Although this increase is observed in both male and female populations, it is more evident in the female population, with the rate of overweight and obesity increasing by 20.3 percent in the last decade (45.9 percent in 2008 and 55.2 percent in 2019). This figure is 15.9 for the male population, reaching from 49.2 percent in 2008 to 57 percent in 2019. According to the survey, the prevalence of obesity was higher among women, while the prevalence of overweight was higher among men for all data points. The distribution of individuals' BMI by gender is summarized for the period 2008–2019 in Table 1.

Furthermore, according to the results of the Turkey Childhood Obesity Surveillance Initiative (COSI-TUR 2016) (2019), 24.5% of primary school 2nd-grade children (6–9 years old) in Türkiye were overweight and obese in 2016 (24.9% in boys, 24.2% in girls).

2. Materials and methods

Many empirical studies have used several functional forms to test the Kuznets' hypothesis. Our strategy is to estimate Obesity Kuznets Curve (OKC) in its simplest quadratic form which can be formulated as follows:

$$BMI_i = \beta_0 + \beta_1 y_i + \beta_2 y_i^2 + \beta_3 z_i + \varepsilon_i \quad (1)$$

Table 1
Distribution of Individuals' BMI by Gender (15+ age), 2008–2019.

Year and sex		Total	Underweight (%)	Normal weight (%)	Pre-obese (%)	Obese (%)
2008	*Total*	100	4.2	48.2	32.4	15.2
	Male	100	2.7	48.1	36.9	12.3
	Female	100	5.9	48.2	27.4	18.5
2010	*Total*	100	4.7	45.5	33.0	16.9
	Male	100	3.5	46.1	37.3	13.2
	Female	100	5.9	44.7	28.4	21.0
2012	*Total*	100	3.9	44.2	34.8	17.2
	Male	100	2.7	44.7	39.0	13.7
	Female	100	5.1	43.6	30.4	20.9
2014	*Total*	100	4.2	42.2	33.7	19.9
	Male	100	2.8	43.7	38.2	15.3
	Female	100	5.5	40.7	29.3	24.5
2016	*Total*	100	4.0	42.1	34.3	19.6
	Male	100	2.5	43.8	38.6	15.2
	Female	100	5.6	40.4	30.1	23.9
2019	*Total*	100	3.8	40.1	35.0	21.1
	Male	100	2.7	40.3	39.7	17.3
	Female	100	4.9	40.0	30.4	24.8

Note: Numbers in the table may not add up due to rounding.
Source: Turkish Statistical Institute (2020). Türkiye Health Survey – 2019.

where *BMI* refers to Body Mass Index. In this paper, we also use an indicator variable with the help of BMI, describing whether a person is obese or not. y_i refers to personal income level which is hypothesized to follow a quadratic relationship (y_i^2); z_i relates to other variables which potentially affect obesity such as sex, age, educational level, marital status, sport activities; ε_i is an error term. This specification allows testing whether there exists an inverted-U-shaped relationship between obesity and income such that $\beta_1 > 0$ and $\beta_2 < 0$. It is also possible to have $\beta_1 = \beta_2 = 0$ (indicating no relationship exists) and monotonic relationship in case of $\beta_1 > 0$ *and* $\beta_2 = 0$. The turning point can easily be obtained by the formula below:

$$y^* = \frac{-\beta_1}{2\beta_2}$$

This is the level of income where BMI or obesity (whichever the dependent variable in the econometric specification) stops increasing and begin to decrease.

We use two different approaches to estimate Eq. (1). We estimate the equation using logistic regression and ordinary least squares (OLS) to report the results as our dependent variable is binary, which takes 1 for those whose BMI is equal and greater than 30 and 0 otherwise.

Regarding the independent variables, the following socio-economic and demographic factors were included, based on the literature: gender, marital status, income, education, level of physical activity. Table 2 summarizes descriptive statistics for the sample. The analyses were performed with *Obese* as the dependent variable.

The grouping given in the income level variable in the Turkish Health Survey (THS) is determined according to the 5% income groups of the Income and Living Conditions Survey (ILCS) conducted by TurkStat. For the household income groups in the reference period of the THS, the results of the most recently released ILCS are used. For the calculation of the ILCS, household disposable net income is defined as the sum of personal annual disposable income (salaries, wages, wages, entrepreneurial income, pensions, widows' and orphans' pensions, payments to the elderly, unpaid scholarships, etc.) received by each member of the household. It is calculated by subtracting taxes paid during the income reference period and regular transfers to other households or individuals from the sum of the sum of annual household income (real estate rental income, unrequited aid to the household, income earned by individuals under the age of 15, etc.). Households are sorted from smallest to largest according to household disposable income or equivalent household disposable income of all individuals in the household, and household/individual groups of 5 percent are formed by dividing into 20 groups, 10 percent by dividing into 10 groups or 20 percent by dividing into 5 groups. The shares of these groups in total income provide information on income inequality. For the purpose of our study, we combined some of these groups and we conducted the analysis using these six new groups.

21.3% of respondents are obese. While 51.7% of all respondents are female, 69% of them are married. We use income as categorical variable from 0 to 1500 TL to 8913 TL and over. *Age*, *education* and *daily walking time* were also categorized as shown in Table 1.

For the purpose of the study, we use cross-sectional data obtained from "2019 Türkiye Health Research" provided by the Turkish Statistical Institute (TUIK). The data were obtained by face-to-face interviews with 23,199 persons from 8166 households living in the Republic of Türkiye between September and December 2019. In the collection of data, questionnaires including questions for children aged 0–14 were used together with the modules recommended by the European Union Statistical Office (Eurostat). The four modules used in data collection are health status, health care use, health determinants, and socio-economic background variables. We exclude individuals under the age of 15 as the data set does not include the height and weight data for them. There are also some missing data

Table 2
Descriptive statistics.

	Variable	N	%	Description
Status of Obesity	Obese	13,249	21.3	1 if obese, 0 otherwise
Gender	Female	13,249	51.7	1 when female, 0 otherwise
Marital status	Married	13,249	69	1 when married, 0 otherwise
Income level	0-1500 TL	1833	11.74	Categorical variable (1–6)
	1501-2424 TL	3749	24.02	
	2425-3695 TL	3692	23.65	
	3696-5784 TL	3654	23.41	
	5785-8912 TL	1759	11.27	
	8913 TL and over	922	5.91	
Age	15–24	2713	17.38	Categorical variable (1–7)
	25–34	2975	19.06	
	35–44	3230	20.69	
	45–54	2707	17.34	
	55–64	2212	14.17	
	65–74	1249	8.00	
	75 and over	523	3.35	
Education status	No school degree	822	5.27	Categorical variable (1–5)
	Primary school	5585	35.78	
	Secondary school	2952	18.91	
	High school	3224	20.65	
	University	3026	19.39	
Daily Walking time	10–29 min	6112	46.13	Categorical variable (1–5)
	30–59 min	4396	33.18	
	1–2 h	1935	14.60	
	2–3 h	463	3.49	
	3+ hours	343	2.59	

for 105 individuals aged 15 and over. Hence, the data of 13,249 individuals aged 15 and over in total were included in the analyses. The data set provides demographic information such as age, gender, educational status, and income as well as data on height-weight, and active lifestyles.

Since BMI values for individuals are not directly included in the data set, these values were calculated using the height and weight data of the individuals. Specifically, BMI value is calculated by dividing the weight in kilograms by the square of the height in meters (Centers for Disease Control and Prevention, 2022). According to the WHO (2022), as stated earlier, individuals with a BMI greater than 25 are defined as overweight while individuals with a BMI greater than or equal to 30 are considered as obese.

In this study, using regression analysis, we specifically test the following hypotheses for the case of Türkiye.

H1. There is a nonlinear relationship between obesity and income such that the probability of being obese firstly increases as income rises and then begins to fall after reaching a peak.

H2. Males and females differ in the rates of obesity. Accordingly, females are more likely to be obese than males.

H3. Marital status is a factor affecting being obese.

H4. Older people tend to be more obese than younger people.

H5. More educated people are less likely to be obese.

H6. Daily physical activities reduce the risk of being obese.

3. Results

Table 3 presents the regression results. Column (1) reports the OLS estimates while column (2) and (3) show the logit coefficients and odd ratios, respectively. The final column presents confidence intervals at the 95% level. We observe that there is a non-linear relationship between income and obesity status. The likelihood of being obese increases as income rises and after reaching a peak point, higher income leads to a fall in the likelihood of being obese. Our results indicate that BMI increases with income at a decreasing rate. These income variables are jointly significant and peak at an income category between 3 and 4. This nearly corresponds to an income level between 3145 and 3398 TL in our database. Hence, we argue that individuals earning more than 3398 TL are more likely to be obese in Türkiye.

Females tend to be more obese than males. For instance, women are 1.24 times more likely to be obese than men. We do not find any link between marital status and obesity as its coefficient is not significant neither in linear probability model (OLS) nor in logistic regression. When a person gets older, the probability of being obese increases since reference group is people with age of 15–24. For instance, people whose age between 25 and 34 years are 2.45 times more likely to be obese compared to 15–24 years category. The highest probability of being obese occur between the ages of 55–64. After peaking at those ages, obesity ratios start to decrease. Individuals with lower education tend to exhibit higher levels of a greater probability of being obese. The same goes for sedentary or

Table 3
OLS and Logistic estimates.

VARIABLES	(1) Obese OLS	(2)Obese Logistic (Coefficients)	(3) Obese Logistic Odd ratios	(4) 95% CI
Income	0.030***	0.182**	1.20	[1.08–1.46]
	(0.011)	(0.081)		
$Income^2$	−0.004**	−0.025**	0.97	[0.94–0.98]
	(0.001)	(0.012)		
Female	0.031***	0.218***	1.24	[1.13–1.36]
	(0.006)	(0.047)		
Married	0.007	0.099	1.10	[0.98–1.25]
	(0.009)	(0.063)		
Age 25-34	0.064***	0.897***	2.45	[1.92–3.07]
	(0.012)	(0.119)		
Age 35-44	0.134***	1.448***	4.25	[3.38–5.34]
	(0.013)	(0.117)		
Age 45-54	0.211***	1.845***	6.32	[5.05–8.00]
	(0.013)	(0.118)		
Age 55-64	0.214***	1.859***	6.41	[5.09–8.12]
	(0.01)	(0.119)		
Age 65-74	0.164***	1.614***	5.02	[3.89–6.47]
	(0.016)	(0.130)		
Age 75 and over	0.055**	0.991***	2.69	[1.88–3.88]
	(0.024)	(0.185)		
Primary School	−0.024	−0.156	0.85	[0.70–1.03]
	(0.016)	(0.097)		
Secondary School	−0.105***	−0.547***	0.58	[0.46–0.72]
	(0.018)	(0.114)		
High School	−0.120***	−0.683***	0.50	[0.41–0.63]
	(0.018)	(0.111)		
University	−0.157***	−1.006***	0.36	[0.30–0.48]
	(0.018)	(0.118)		
Daily walking 30–59min	−0.029***	−0.191***	0.82	[0.74–0.91]
	(0.007)	(0.051)		
Daily walking 1–2 h	−0.055***	−0.390***	0.67	[0.58–0.78]
	(0.010)	(0.072)		
Daily walking 2–3 h	−0.046**	−0.337**	0.71	[0.54–0.93]
	(0.018)	(0.139)		
Daily walking 3+ hours	−0.046**	−0.324**	0.72	[0.53–0.97]
	(0.021)	(0.156)		
Constant	0.123***	−2.581***	0.07	[0.05–0.10]
	(0.024)	(0.178)		
Observations	13,249	13,249		
R-squared	0.086	0.092		

Standard errors in parentheses, Pseudo R-square is shown in logistic regression. Reference categories: Age:15–24, no school finished, walking 10–29 min a day. ***p < 0.01, **p < 0.05, *p < 0.1.

physically low active individuals who have higher expected levels of obesity than non-sedentary/active individuals. This means that each additional increase of walking time is associated with a decrease in the odds of being obese. To put it more clearly, daily 1–2 h of walking is associated with a %33 decrease in the odds of being obese compared to walking 10–29 min a day[†]. From all these results, we show that all the hypotheses above hold except H3 which say that marital status is a factor determining obesity.

When we split the sample in terms of gender, the findings still support the OKC for both males and females. The results presented in Table 4 suggest evidence of a Kuznets curve with income cut-off points differing across genders. The cut-off points for females and males are 2215–2424 TL and 3399–3695 TL, respectively. This means that the likelihood of being obese begins at lower level of income for females than males as income increases. Furthermore, we obtain some notable results regarding the effect of marital status on obesity rates across genders. For example, being married for males increases the likelihood of obese than it does for females. The odd ratio of 1.29 indicates that the likelihood of obesity is 29% greater for males who are married while the odd ratio is just 1.15 for females. The effect of aging on obesity also differs across genders. However, it is important to highlight that the most obese age range for women is 55–64 (odd ratio: 8.40), while for men it is 45–54 (odd ratio: 4.85). Our findings are just about the same for both genders in regard to education and daily walking time. However, it should be noted that university graduate women are less likely to be obese than men (0.30 < 0.46).

[†] To illustrate the distribution of BMI across different groups defined by age, and physical activity levels, we also provide the presentation of our data by including intuitive graphical formats using box plots in the appendix section. These visualizations provide a clear, immediate understanding of the data and highlight the central tendencies and variances within each group. We also compare BMI differences between groups using Analysis of Variance (ANOVA) which we provide in the appendix section to assess the impact of age and physical activity on BMI.

Table 4
Logistic estimates for females and males.

Variables	(1) Obese Female	Odds	(2) Obese Male	Odds
Income	0.262**	1.30	0.210*	1.23
	(0.108)		(0.113)	
$Income^2$	−0.0473***	0.95	−0.0282*	0.97
	(0.0165)		(0.0166)	
Married	0.140*	1.15	0.255**	1.29
	(0.0842)		(0.107)	
Age 25-34	0.889***	2.43	0.798***	2.22
	(0.166)		(0.174)	
Age 35-44	1.456***	4.29	1.267***	3.55
	(0.160)		(0.177)	
Age 45-54	1.930***	6.88	1.580***	4.85
	(0.161)		(0.181)	
Age 55-64	2.128***	8.40	1.391***	4.02
	(0.163)		(0.184)	
Age 65-74	1.941***	6.96	1.194***	3.30
	(0.181)		(0.197)	
Age 75 and over	1.456***	4.29	0.497*	1.64
	(0.262)		(0.270)	
Primary School	0.00401	1.00	−0.299	0.74
	(0.114)		(0.198)	
Secondary School	−0.464***	0.62	−0.579***	0.56
	(0.144)		(0.211)	
High School	−0.686***	0.50	−0.621***	0.53
	(0.138)		(0.209)	
University	−1.191***	0.30	−0.769***	0.46
	(0.158)		(0.214)	
Daily walking 30–59min	−0.211***	0.80	−0.128*	0.88
	(0.0713)		(0.0759)	
Daily walking 1–2 h	−0.388***	0.68	−0.350***	0.70
	(0.110)		(0.0979)	
Daily walking 2–3 h	−0.356	0.70	−0.306*	0.73
	(0.237)		(0.172)	
Daily walking 3+ hours	−0.194	0.82	−0.327*	0.72
	(0.323)		(0.179)	
Constant	−2.584***	0.07	−2.511***	0.08
	(0.226)		(0.281)	
Observations	6676		6573	

Standard errors in parentheses. Reference categories: Age:15–24, no school finished, walking 10–29 min a day. ***p < 0.01, **p < 0.05, *p < 0.1.

4. Discussion

This study tests the validity of the OKC hypothesis in Türkiye controlling for socio-economic factors and physical activity. To do so, we employ linear probability model and logistic regression benefitting from the Türkiye Health Research 2019 dataset. Our findings reveal that OKC hypothesis holds for Türkiye such that the likelihood of obesity first increases as income rises and after reaching a maximum point, it starts to decrease. In other words, there is a non-linear relationship between income and obesity. This result proves the validity of OKC for Türkiye. These results are in line with other studies in the literature (Ameye and Swinnen, 2019; Aydin, 2019; Grecu and Rotthoff, 2015; Mathieu-Bolh, 2022; Windarti et al., 2019). We also find that the more educated individuals are less likely to be obese.

Furthermore, the study reveals that obesity differs according to gender, so women are more likely to be obese than men, which is also supported by other studies (Ameye and Swinnen, 2019; Garawi et al., 2014; Kapoor et al., 2021; Khan et al., 2021; Jonikas et al., 2016). However, the turning point of OKC in women is lower than in men. In other words, although women enter the obesity process earlier than men, they exit the obesity process earlier due to increased income. This might be explained by the fact that women with an increasing income attach more importance to their health than men do (Windarti et al., 2019), as well as the fact that BMI values have a stronger effect on body image in women than it has in men (Algars et al., 2009). Moreover, it is stated in the literature that there is a linear relationship between women's BMI values and body dissatisfaction (Algars et al., 2009; Chithambo and Huey, 2013; Dunkel et al., 2010; Swami et al., 2015).

Our empirical study reveals that married men were more likely to be obese than married women. This finding is in line with Liu et al. (2021), Liao et al. (2018), and Teachman (2016). The reason for this situation is thought to be the emergence of more meal consumption with a regular family life brought by marriage and the adoption of a less active lifestyle (Burke et al., 2004; Mata et al., 2015). As the level of education increases, the obesity rate decreases. According to Lawrence (2017), the reason for this is that university graduates exhibit healthier behaviors and have a better socio-economic status.

Age is also another factor affecting obesity. According to the results obtained in the study, obesity rates are more in middle-aged people than in higher-aged ones. In other words, obesity rates increase from the 15–24 age range to the 55–64 age range. Accordingly, the participants with the highest obesity rate are those between 55 and 64. Obesity rates begin to decrease for participants 65 years old and over. The low obesity rate in old age may be because the diet in old age is different from the diet in young and middle age, as well as the changing work and living conditions with the development of technology. Namely, with the development of technology, a sedentary lifestyle prevails both in business and social life and positively affects obesity (Woessner et al., 2021). However, health problems may occur due to nutrition in old age, which may negatively affect obesity, with the transformation of the diet in young and middle-aged periods into a healthier diet (Granic et al., 2018).

We also examined the relationship between walking time and obesity in this study. The findings reveal that the probability of being obese in individuals with increased walking time is lower compared to less active individuals. Physical activity and an active lifestyle are proven methods of treating obesity (Niemiro et al., 2022). The Centers for Disease Control and Prevention (CDC) treats walking as one of the most effective methods of physical activity (CDC, 2022b). Our results are supported by Jakicic et al. (2018) and Kim et al. (2017) which found physical activity has a negative effect on obesity.

The main aim of this study is to test the validity of the OKC hypothesis for Türkiye. Therefore, it is worth mentioning its importance in terms of health economics. Because obesity is mainly caused by an imbalance between energy intake and energy expenditure, the importance of income, eating habits, and an active lifestyle comes to the fore (Wyszyńska et al., 2020). Although there is a strong relationship between eating habits and obesity (Birch and Fisher, 1998; Branen and Fletcher, 1999; Manios et al., 2004), one of the most important factors affecting nutritional habits is food consumption and, therefore, income status affecting food preference (Konttinen et al., 2021; Giacobone et al., 2021). French et al. (2019) show that the amount of out-of-home consumption increases depending on income rise. Hence the number of calories and energy taken from the consumption of ready-made and processed foods or fast foods is multiplied, causing obesity (Ameye and Swinnen, 2019; Grecu and Rotthoff, 2015).

Along with the benefits of technological developments to society, the significant restrictions on active lifestyle causes obesity and health problems associated with obesity (Woessner et al., 2021). At high-income levels, individuals have become more aware of obesity and the health problems associated with obesity (Butler-Wall, 2016). In addition, the level of awareness about personal health and external appearance increases in individuals whose income continues to increase (Zhou, 2019). As a result, individuals can reduce their obesity levels by allocating their income to healthier food consumption and an active lifestyle (Grecu and Rotthoff, 2015).

The negative externality problem of obesity emerges in terms of health economics (Bhattacharya and Sood, 2007; McCormick and Stone, 2007). This situation requires public intervention against obesity. In this manner, the prevention of obesity is crucial in terms of easing the economic burden on both governments and individuals. Accordingly, obese individuals may have higher health insurance premium payments or standing contribution payments to reduce negative externality than non-obese individuals (Bernard et al., 2019; Woolford et al., 2013). Thus, individual efforts will be encouraged to overcome obesity. For example, taxes on high-calorie and sugary beverages in some countries decrease consumption of these products (Pedraza et al., 2019; Redondo et al., 2018). In this way, additional taxation can be applied to such products to reduce the consumption of high-calorie and unhealthy nutrition. However, such deterrent measures alone may not be sufficient to combat obesity. Along with these measures, particularly to prevent childhood obesity and adult obesity in the following years, compulsory physical education lessons should be included in the curriculum of schools, and the duration of these lessons should be increased (Wyszyńska et al., 2020). Besides these policies, obesity awareness levels among children and parents might be increased, and healthy eating and an active lifestyle should be encouraged to combat the obesity prevalence among the society.

Although cross-sectional data provides insightful views into the interaction between variables at a given time, its main purpose is to serve as a starting point for more in-depth and dynamic study. The conclusions drawn from our study can inform hypotheses for future research and can also highlight potential targets for interventions. Future research could focus on longitudinal studies to better understand the interaction between income and obesity. Such studies could help to verify the existence of the OKC over time and in different settings.

Insights from the OKC can guide the development of health education programs that address dietary habits and physical activity, tailored to different income levels. Furthermore, understanding at what income levels the risk of obesity is highest can help public health officials to design targeted interventions for those income groups, which may be more cost-effective. The OKC theory suggests that economic policies aimed at reducing poverty could also impact obesity rates. This might include efforts to provide better access to healthy foods and promoting jobs that require physical activity. The findings can inform healthcare providers about the need for more proactive screening and intervention strategies in populations that are emerging into higher income brackets. The intersection of economics and health indicated by the OKC implies a need for collaboration between different sectors – such as healthcare, finance, education, and urban planning – to address the multifaceted determinants of obesity.

5. Conclusion

Our results indicate that there is a non-linear relationship between income and obesity. The study reveals that obesity differs according to gender and marriage, education, age, and physical activity are closely associated with the likelihood of being obese in Türkiye.

Ethical approval

This study does not require ethical approval since it involves information freely available in the public domain and the analysis of the data relies on database upon request.

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CRediT authorship contribution statement

Muhammed Benli: Writing – review & editing, Writing – original draft, Supervision, Investigation, Conceptualization. **Yasin Acar:** Writing – review & editing, Writing – original draft, Software, Methodology, Formal analysis, Data curation, Conceptualization. **Semih Baş:** Writing – original draft, Visualization, Investigation, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

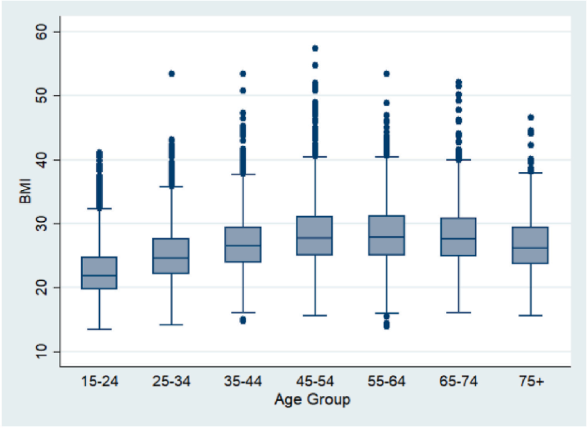

Fig. A1. Box Plot (BMI – Age Groups).

Table A1
ANOVA Analysis (Age Groups)

Source	SS	df	MS	F	P-value
Between Groups	67690.533	6	11281.756	548.44	0.000
Within Groups	320943.174	15,602	20.571		
Total	388633.707	15,608	24.9		
No. Of obs.	15,609	R-squared	0.174		
Root MSE	4.535	Adj. R-squared	0.174		

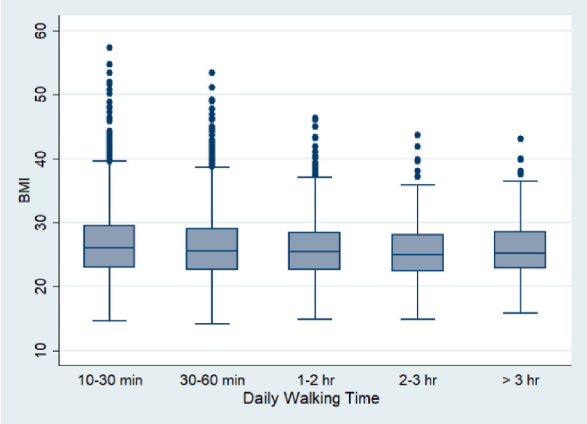

Fig. A2. Box Plot (BMI – Physical Activity).

Table A2
ANOVA Analysis (Physical Activity)

Source	SS	df	MS	F	P-value
Between Groups	1722.51	4	430.627	18.01	0.000
Within Groups	316659.168	13,244	23.61		
Total	318381.678	13,248	24.9		
No. Of obs.	13,249	R-squared	0.005		
Root MSE	4.89	Adj. R-squared	0.005		

References

Akee, R., Simeonova, E., Copeland, W., Angold, A., Costello, E.J., 2013. Young adult obesity and household income: effects of unconditional cash transfers. Am. Econ. J. Appl. Econ. 5 (2), 1–28. https://doi.org/10.1257/app.5.2.1.

Algars, M., Santtila, P., Varjonen, M., Witting, K., Johansson, A., Jern, P., Sandnabba, N.K., 2009. The adult body: how age, gender, and body mass index are related to body image. J. Aging Health 21 (8), 1112–1132. https://doi.org/10.1177/089826430934802.

Alola, A.A., Bekun, F.V., 2021. Obesity Kuznets curve and the reality of eco-income ellipsoids (EIE). Eur. J. Health Econ. 22 (7), 1095–1101. https://doi.org/10.1007/s10198-021-01308-x.

Ameye, H., Swinnen, J., 2019. Obesity, income and gender: the changing global relationship. Global Food Secur. 23, 267–281. https://doi.org/10.1016/j.gfs.2019.09.003.

Armstrong, S., Wong, C.A., Perrin, E., Page, S., Sibley, L., Skinner, A., 2018. Association of physical activity with income, race/ethnicity, and sex among adolescents and young adults in the United States: findings from the National Health and Nutrition Examination Survey, 2007-2016. JAMA Pediatr. 172 (8), 732–740. https://doi.org/10.1001/jamapediatrics.2018.1273.

Aydin, M., 2019. The effect of economic growth on obesity for the most obese countries: new evidence from the obesity Kuznets curve. Eur. J. Health Econ. 20 (9), 1349–1358. https://doi.org/10.1007/s10198-019-01099-2.

Bernard, M., Riedel-Heller, S.G., Luck-Sikorski, C., 2019. Weigh more, pay more? Public opinion on varying health insurance contributions among divergent weight groups. Obes. Facts 12, 509–517. https://doi.org/10.1159/000502799.

Bhattacharya, J., Sood, N., 2007. Health insurance and the obesity externality. Adv. Health Econ. Health Serv. Res. 17, 279–318. https://doi.org/10.1016/S0731-2199(06)17011-9.

Birch, L.L., Fisher, J.O., 1998. Development of eating behaviours among children and adolescents. Pediatrics 101 (3), 539–549. https://doi.org/10.1542/peds.101.S2.539.

Branca, F., Nikogosian, H., Lobstein, T. (Eds.), 2007, The Challenge of Obesity in the WHO European Region and the Strategies for Response: Summary. World Health Organization.

Branen, L., Fletcher, J., 1999. Comparison of college students' current eating habits and recollections of their childhood food practices. J. Nutr. Educ. 31 (6), 304–310. https://doi.org/10.1016/S0022-3182(99)70483-8.

Burke, V., Beilin, L.J., Dunbar, D., Kevan, M., 2004. Changes in health-related behaviours and cardiovascular risk factors in young adults: associations with living with a partner. Prev. Med. 39, 722–730. https://doi.org/10.1016/j.ypmed.2004.02.038.

Butler-Wall, K., 2016. Feeling Healthy: Media, Affect, and the Governance of Health. University of Minnesota Digital Conservancy. http://hdl.handle.net/11299/182202.

Centers for Disease Control and Prevention, 2022. Defining Adult Overweight & Obesity. https://www.cdc.gov/obesity/basics/adult-defining.html.

Centers for Disease Control and Prevention, 2022b. Physical Activity - Walking. https://www.cdc.gov/physicalactivity/walking/index.htm.

Chithambo, T.P., Huey, S.J., 2013. Black/white differences in perceived weight and attractiveness among overweight women. Journal of Obesity 2013, 1–4. https://doi.org/10.1155/2013/320326.

Clement, M., 2017. The income-body-size gradient among Chinese urban adults: a semiparametric analysis. China Econ. Rev. 44, 253–270. https://doi.org/10.1016/j.chieco.2017.05.003.

Cutler, D.M., Glaeser, E.L., Shapiro, J.M., 2003. Why have Americans become more obese? J. Econ. Perspect. 17 (3), 93–118. https://doi.org/10.1257/089533003769204371.

Deuchert, E., Cabus, S., Tafreschi, D., 2014. A short note on economic development and socioeconomic inequality in female body weight. Health Econ. 23 (7), 861–869. https://doi.org/10.1002/hec.2968.

Dinsa, G.D., Goryakin, Y., Fumagalli, E., Suhrcke, M., 2012. Obesity and socioeconomic status in developing countries: a systematic review. Obes. Rev. 13 (11), 1067–1079. https://doi.org/10.1111/j.1467-789X.2012.01017.x.

Drewnowski, A., Specter, S.E., 2004. Poverty and obesity: the role of energy density and energy costs. Am. J. Clin. Nutr. 79 (1), 6–16. https://doi.org/10.1093/ajcn/

79.1.6.
Dunkel, T.M., Davidson, D., Qurashi, S., 2010. Body satisfaction and pressure to be thin in younger and older muslim and non-muslim women: the role of Western and non-Western dress preferences. Body Image 7 (1), 56–65. https://doi.org/10.1016/j.bodyim.2009.10.003.
Edwards, P., Tsouros, A.D., 2006. Promoting Physical Activity and Active Living in Urban Environments: the Role of Local Governments. WHO Regional Office Europe.
French, S.A., Tangney, C.C., Crane, M.M., Wang, Y., Appelhans, B.M., 2019. Nutrition quality of food purchases varies by household income: the SHoPPER study. BMC Publ. Health 19, 231. https://doi.org/10.1186/s12889-019-6546-2.
Garawi, F., Devries, K., Thorogood, N., Uauy, R., 2014. Global differences between women and men in the prevalence of obesity: is there an association with gender inequality? Eur. J. Clin. Nutr. 68 (10), 1101–1106. https://doi.org/10.1038/ejcn.2014.86.
Giacobone, G., Tiscornia, M.V., Guarnieri, L., Castronuovo, L., Mackay, S., Allemandi, L., 2021. Measuring cost and affordability of current vs. healthy diets in Argentina: an application of linear programming and the INFORMAS protocol. BMC Publ. Health 21 (1). https://doi.org/10.1186/s12889-021-10914-6.
Giskes, K., Van Lenthe, F.J., Turrell, G., Kamphuis, C.B., Brug, J., Mackenbach, J.P., 2008. Socioeconomic position at different stages of the life course and its influence on body weight and weight gain in adulthood: a longitudinal study with 13-year follow-up. Obesity 16 (6), 1377–1381. https://doi.org/10.1038/oby.2008.54.
Granic, A., Mendonça, N., Hill, T., Jagger, C., Stevenson, E., Mathers, J., Sayer, A., 2018. Nutrition in the very old. Nutrients 10 (3), 269. https://doi.org/10.3390/nu10030269.
Grecu, A.M., Rotthoff, K.W., 2015. Economic growth and obesity: findings of an obesity Kuznets curve. Appl. Econ. Lett. 22 (7), 539–543. https://doi.org/10.1080/13504851.2014.955251.
Heinrich, K.M., Lee, R.E., Suminski, R.R., Regan, G.R., Reese-Smith, J.Y., Howard, H.H., Ahluwalia, J.S., 2007. Associations between the built environment and physical activity in public housing residents. Int. J. Behav. Nutr. Phys. Activ. 4 (1), 1–9. https://doi.org/10.1186/1479-5868-4-56.
Jakicic, J.M., Rogers, R.J., Davis, K.K., Collins, K.A., 2018. Role of physical activity and exercise in treating patients with overweight and obesity. Clin. Chem. 64 (1), 99–107. https://doi.org/10.1373/clinchem.2017.272443.
Jonikas, J.A., Cook, J.A., Razzano, L.A., Steigman, P.J., Hamilton, M.M., Swarbrick, M.A., Santos, A., 2016. Associations between gender and obesity among adults with mental illnesses in a community health screening study. Community Ment. Health J. 52, 406–415. https://doi.org/10.1007/s10597-015-9965-2.
Kapoor, N., Arora, S., Kalra, S., 2021. Gender disparities in people living with obesity - an unchartered territory. J. Mid-life Health 12 (2), 103–107. https://doi.org/10.4103/jmh.jmh_48_21.
Khan, S., Nauman, H., Saher, S., Imtiaz, H.A., Bibi, A., Sajid, H., Khan, T.M., Mumtaz, M., Bibi, S., 2021. Gender difference in obesity prevalence among general population of Lahore, Pakistan. European Journal of Medical and Health Sciences 3 (3), 55–58. https://doi.org/10.24018/ejmed.2021.3.3.878.
Kim, B.Y., Choi, D.H., Jung, C.H., Kang, S.K., Mok, J.O., Kim, C.H., 2017. Obesity and physical activity. Journal of Obesity & Metabolic Syndrome 26 (1), 15–22. https://doi.org/10.7570/jomes.2017.26.1.15.
Köksal, O., 1977. Türkiye 1974 Beslenme, Sağlık Ve Gıda Tüketimi Araştırması. Hacettepe University, Ankara.
Konttinen, H., Halmesvaara, O., Fogelholm, M., Saarijärvi, H., Nevalainen, J., Erkkola, M., 2021. Sociodemographic differences in motives for food selection: results from the LoCard cross-sectional survey. Int. J. Behav. Nutr. Phys. Activ. 18, 71. https://doi.org/10.1186/s12966-021-01139-2.
Lakdawalla, D., Philipson, T., 2009. The growth of obesity and technological change. Econ. Hum. Biol. 7 (3), 283–293. https://doi.org/10.1016/j.ehb.2009.08.001.
Lawrence, E.M., 2017. Why do college graduates behave more healthfully than those who are less educated? J. Health Soc. Behav. 58 (3), 291–306. https://doi.org/10.1177/0022146517715671.
Liao, C., Gao, W., Cao, W., Lv, J., Yu, C., Wang, S., Li, L., 2018. Association of educational level and marital status with obesity: a study of Chinese twins. Twin Res. Hum. Genet. 21 (2), 126–135. https://doi.org/10.1017/thg.2018.8.
Liu, J., Garstka, M.A., Chai, Z., Chen, Y., Lipkova, V., Cooper, M.E., Mokoena, K.K., Wang, Y., Zhang, L., 2021. Marriage contributes to higher obesity risk in China: findings from the China health and nutrition survey. Ann. Transl. Med. 9 (7), 564. https://doi.org/10.21037/atm-20-4550.
Malik, V.S., Willett, W.C., Hu, F.B., 2013. Global obesity: trends, risk factors and policy implications. Nat. Rev. Endocrinol. 9 (1), 13–27. https://doi.org/10.1038/nrendo.2012.199.
Manios, Y., Dimitriou, M., Moschonis, G., Kocaoglu, B., Sur, H., Keskin, Y., Hayran, O., 2004. Cardiovascular disease risk factors among children of different socioeconomic status in Istanbul, Türkiye: directions for public health and nutrition policy. Lipids Health Dis. 4 (3), 11. https://doi.org/10.1186/1476-511X-3-11.
Marteleto, L.J., Gama, L.C., Dondero, M., Brown, L.E., 2017. The weight of inequality: socioeconomic status and adolescent body mass in Brazil. Soc. Forces 95 (4), 1637–1666. https://doi.org/10.1093/sf/sox028. 10.1093/sf/sox028.
Mata, J., Frank, R., Hertwig, R., 2015. Higher body mass index, less exercise, but healthier eating in married adults: nine representative surveys across Europe. Soc. Sci. Med. 138, 119–127. https://doi.org/10.1016/j.socscimed.2015.06.001.
Mathieu-Bolh, N., 2022. The elusive link between income and obesity. J. Econ. Surv. 36, 935–968. https://doi.org/10.1111/joes.12458.
McCormick, B., Stone, I., 2007. Economic costs of obesity and the case for government intervention. Obes. Rev. 8 (s1), 161–164. https://doi.org/10.1111/j.1467-789x.2007.00337.x.
Ministry of Health of Türkiye, 2019. Türkiye Beslenme Ve Sağlık Ve Araştırması. General Directorate of Public Health, Ankara.
Minos, D., Butzlaff, I., Demmler, K.M., Rischke, R., 2016. Economic growth, climate change, and obesity. Current Obesity Reports 5 (4), 441–448. https://doi.org/10.1007/s13679-016-0234-7.
Monteiro, C.A., Conde, W.L., Popkin, B.M., 2001. Independent effects of income and education on the risk of obesity in the Brazilian adult population. J. Nutr. 131 (3), 881S–881S886S. https://doi.org/10.1093/jn/131.3.881S.
Mosli, H.H., Kutbi, H.A., Alhasan, A.H., Mosli, R.H., 2020. Understanding the interrelationship between education, income, and obesity among adults in Saudi Arabia. Obes. Facts 13 (1), 77–85. https://doi.org/10.1159/000505246.
Niemiro, G.M., Revane, A., Algotar, A.M., 2022. Exercise and Fitness Effect on Obesity. StatPearls Publishing, Treasure Island (FL). [Updated 2022 Jun 5]. In: StatPearls [Internet].
OECD, 2019. The Heavy Burden of Obesity: The Economics of Prevention, OECD Health Policy Studies. OECD Publishing, Paris. https://doi.org/10.1787/67450d67-en.
Ogden, C.L., Carroll, M.D., Fakhouri, T.H., Hales, C.M., Fryar, C.D., Li, X., Freedman, D.S., 2018. Prevalence of obesity among youths by household income and education level of head of household—United States 2011–2014. MMWR (Morb. Mortal. Wkly. Rep.) 67 (6), 186. https://doi.org/10.15585/mmwr.mm6706a3.
Ozyapi, S., 2019. An Empirical Investigation of Obesity & Income and Education. MPRA Paper 98727.
Pampel, F.C., Denney, J.T., Krueger, P.M., 2012. Obesity, SES, and economic development: a test of the reversal hypothesis. Soc. Sci. Med. 74 (7), 1073–1081. https://doi.org/10.1016/j.socscimed.2011.12.028.
Pedraza, L.S., Popkin, B.M., Batis, C., Adair, L., Robinson, W.R., Guilkey, D.K., Taillie, L.S., 2019. The caloric and sugar content of beverages purchased at different store-types changed after the sugary drinks taxation in Mexico. Int. J. Behav. Nutr. Phys. Activ. 16, 103. https://doi.org/10.1186/s12966-019-0872-8.
Philipson, T., Posner, R., 1999. The Long-Run Growth in Obesity as a Function of Technological Change. National Bureau of Economic Research, Cambridge, MA. https://doi.org/10.3386/w7423. National Bureau of Economic Research Working Paper 7423.
Popkin, B.M., 1998. The nutrition transition and its health implications in lower-income countries. Publ. Health Nutr. 1 (1), 5–21. https://doi.org/10.1079/phn19980004.
Popkin, B.M., Adair, L.S., Ng, S.W., 2012. Global nutrition transition and the pandemic of obesity in developing countries. Nutr. Rev. 70 (1), 3–21. https://doi.org/10.1111/j.1753-4887.2011.00456.x.
Redondo, M., Hernández-Aguado, I., Lumbreras, B., 2018. The impact of the tax on sweetened beverages: a systematic review. Am. J. Clin. Nutr. 108 (3), 548–563. https://doi.org/10.1093/ajcn/nqy135.
Ren, Y., Li, H., Wang, X., 2019. Family income and nutrition-related health: evidence from food consumption in China. Soc. Sci. Med. 232, 58–76. https://doi.org/10.1016/j.socscimed.2019.04.016.
Romieu, I., Dossus, L., Barquera, S., Blottière, H.M., Franks, P.W., Gunter, M., et al., 2017. Energy balance and obesity: what are the main drivers? Cancer Causes Control 28 (3), 247–258. https://doi.org/10.1007/s10552-017-0869-z.
Sallis, J.F., Glanz, K., 2009. Physical activity and food environments: solutions to the obesity epidemic. Milbank Q. 87 (1), 123–154. https://doi.org/10.1111/j.1468-0009.2009.00550.x.

Shekar, M., Popkin, B., 2020. Obesity: Health and Economic Consequences of an Impending Global Challenge. World Bank Publications. https://www.worldbank.org/en/topic/nutrition/publication/obesity-health-and-economic-consequences-of-an-impending-global-challenge (Accessed 15 September 2022).
Swami, V., Tran, U.S., Stieger, S., Voracek, M., 2015. Associations between women's body image and happiness: results of the YouBeauty.com Body Image Survey (YBIS). J. Happiness Stud. 16 (3), 705–718. https://doi.org/10.1007/s10902-014-9530-7.
Talukdar, D., Seenivasan, S., Cameron, A.J., Sacks, G., 2020. The association between national income and adult obesity prevalence: empirical insights into temporal patterns and moderators of the association using 40 years of data across 147 countries. PLoS One 15 (5), e0232236. https://doi.org/10.1371/journal.pone.0232236.
Teachman, J., 2016. Body weight, marital status, and changes in marital status. J. Fam. Issues 37 (1), 74–96. https://doi.org/10.1177/0192513x13508404.
Tremmel, M., Gerdtham, U.G., Nilsson, P.M., Saha, S., 2017. Economic burden of obesity: a systematic literature review. Int. J. Environ. Res. Publ. Health 14 (4), 435. https://doi.org/10.3390/ijerph14040435.
Turkish Statistical Institute, 2020. Türkiye Health Survey - 2019. https://data.tuik.gov.tr/Bulten/Index?p=Türkiye-Saglik-Arastirmasi-2019-33661 (Accessed 12 September 2022).
Türkiye Childhood (Primary School, 2nd Grade Students) Obesity Surveillance Initiative (COSI-TUR 2016), 2019. Ministry of Health Publication No: 1125.
Wells, J.C., Marphatia, A.A., Cole, T.J., McCoy, D., 2012. Associations of economic and gender inequality with global obesity prevalence: understanding the female excess. Soc. Sci. Med. 75 (3), 482–490. https://doi.org/10.1016/j.socscimed.2012.03.029.
WHO, 2022. Obesity and Overweight. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight (Accessed 22 August 2022).
WHO, (--). Obesity. https://www.who.int/health-topics/obesity#tab=tab_1..
Windarti, N., Hlaing, S.W., Kakinaka, M., 2019. Obesity Kuznets curve: international evidence. Publ. Health 169, 26–35. https://doi.org/10.1016/j.puhe.2019.01.004.
Withrow, D., Alter, D.A., 2011. The economic burden of obesity worldwide: a systematic review of the direct costs of obesity. Obes. Rev. 12 (2), 131–141. https://doi.org/10.1111/j.1467-789X.2009.00712.x.
Woessner, M.N., Tacey, A., Levinger-Limor, A., Parker, A.G., Levinger, P., Levinger, I., 2021. The evolution of technology and physical inactivity: the good, the bad, and the way forward. Front. Public Health 9, 655491. https://doi.org/10.3389/fpubh.2021.655491.
Woolford, S.J., Clark, S.J., Butchart, A., Geiger, J.D., Davis, M.M., Fagerlin, A., 2013. To pay or not to pay: public perception regarding insurance coverage of obesity treatment. Obesity 21 (12), E709–E714. https://doi.org/10.1002/oby.20387.
World Obesity Atlas, 2022. https://www.worldobesity.org/resources/resource-library/world-obesity-atlas-2022. (Accessed 4 October 2022).
Wyszyńska, J., Ring-Dimitriou, S., Thivel, D., Weghuber, D., Hadjipanayis, A., Grossman, Z., Mazur, A., 2020. Physical activity in the prevention of childhood obesity: the position of the European childhood obesity group and the European academy of pediatrics. Frontiers in Pediatrics 8, 535705. https://doi.org/10.3389/fped.2020.535705.
Zhang, S., Xiang, W., 2019. Income gradient in health-related quality of life—the role of social networking time. Int. J. Equity Health 18 (1), 1–10. https://doi.org/10.1186/s12939-019-0942-1.
Zhou, M., 2019. The shifting burden of obesity: changes in the distribution of obesity in China, 2010–2015. Int. Sociol. 34 (3), 347–367. https://doi.org/10.1177/0268580919832734.
Zhou, M., 2021. The shifting income-obesity relationship: conditioning effects from economic development and globalization. SSM-Population Health 15, 100849. https://doi.org/10.1016/j.ssmph.2021.100849.