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Determining the Relationship Between Distinct Obesity Prevalence Groups and Risk Factors By Panel Random-Effect Ordered Probit Model in Turkey

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ABSTRACT

Objective: The aim of this study was to analyze the sociodemographic and economic characteristics of families or individuals that can affect the normal weight, overweight, obesity, and severe obesity of the individual determined by the body mass index using the panel random-effect ordered probit model in Turkey.

Methods: The analysis used the survey data from the 2016 Turkey Health Research created by the Turkish Statistical Institute. The choice of the random-effect model was confirmed by a statistical test.

Results: We found that many sociodemographic and economic factors of family members or family significantly affect the probability of obesity groups. For example, considering the change in the age scale of obesity, the probability of being at normal weight decreases as the ages of family members increase, and this condition triggers being overweight, obese, and severe obese as the age progresses. As the family income increases, the individuals become more obese, while the education level of the individuals and the time devoted to walking for more than an hour a day show that the individuals are successful in their maintaining a normal weight.

Conclusion: Obesity is an important problem in Turkey and should be tackled effectively. It has been determined that the sociodemographic and economic factors of the individual significantly affect the probability of obesity. Social risk groups that are positively associated with obesity should be identified, and awareness training should be given to each group with appropriate methods.

Keywords: Obesity, risk factors, TUIK, Turkey

INTRODUCTION

Obesity is generally defined as the excessive increase in the proportion of the fat mass of the body to lean mass as a result of excessive increase in body weight over the desired level. Fatty tissue constitutes 15%-18% of the body weight in adult men and 20%-25% of the body weight in women. Obesity occurs when this rate exceeds 25% in men and 30% in women.[1] According to the World Health Organization data, worldwide obesity has increased nearly 3 times since 1975. In 2016, more than 1.9 billion adults over the age of 18 and above were overweight (OW), accounting for 39% of the world's population, while more than 650 million of them were identified as obese (O), which corresponds to 13% of the global population.[2] Also, in 2016, 41 million children under the age of 5 and 340 million children between the ages of 5 and 19 were categorized in the OW or O class. In this context, while OW and obesity are an increasing threat to both adults and children worldwide, this upward trend is more pronounced especially in children.[2,3] On the other hand, while the country with the highest obesity rate was the USA, the highest OW population is found in Albania, Bosnia, and Herzegovina and England (Scotland region), respectively. In contrast, Turkmenistan and Uzbekistan are lucky countries in which the prevalence of obesity ranges as low as 5%-23% in men and 7%-36% in women.[1] On the one hand, concerns about the early prevention of OW and obesity epidemic in low- and middle-income countries, essentially malnutrition, morbidity, mortality, and impaired child development, remain persistent[3]; on the other hand, the double burden of malnutrition, OW, and obesity has also been a subject of concern in high-income countries.[4]

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Over the past 50 years, obesity is not only a global public health threat that affects the quality of life, increases the risk of disease, and triggers healthcare spending in countries,[5] but it is also a fatal risk factor leading to the development of many diseases.[6] Overweight and obesity are often reported as the main cause of various chronic diseases such as heart disease, stroke, diabetes, and cancers.[6] For example, though preventable, obesity is the second leading cause of death in the USA. Another frightening figure is that obesity has doubled the risk of death since 1980, and the number of people who died from obesity is higher than the number of people who died of starvation.[7] It is suggested that 5% of deaths in the world are associated with obesity, and in 2030, 1 out of every 2 people is expected to be O.[8] While obesity is content with its threatening feature to human health, if proper measures are not taken in place and on time, it will remain the driving force of a significant part of deaths in the world.

While physical inactivity is undoubtedly the main factor among the reasons for the increase in obesity in developed and developing countries,[9] other driving forces triggering OW and obesity include the way people eat, the increase in the participation of the women in the labor pool, the socioeconomic factors such as increasing urbanization, education, occupation, and income, and the increased time spent on television, video games, and the internet.[10] For example, it is emphasized that fast-food consumption has a strong relationship with weight gain and insulin resistance and also triggers the risk of type 2 diabetes,[11] while the increase in body mass index (BMI) in regions with high fruit and vegetable prices is higher compared to regions with low fruit and vegetable prices.[12] While access to physical activity is also limited in regions with low-income levels[13] and nexus between poverty and obesity remain on the agenda,[14] the prevalence of OW is also common in high-income families, given the food purchasing capacities (e.g., power).[4] At the same time, the individual's self-anxiety, avoidance of peer relationship, introversion, exclusion, and even depression and anxiety are associated with obesity.[1,15] Contrary to these triggering factors, smoking decreases obesity in individuals, and it has been reported that a 10% increase in taxes on cigarettes causes a 4%-5% increase in O population while decreasing cigarette consumption.[16]

Many obesity-related diseases such as heart disease, cancer, hypertension, diabetes, and hyperlipidemia have a significant economic burden on both states and individuals.[17] It is well known that obesity affects economies directly and indirectly through cost channels. For example, loss of productivity in labor force caused by obesity, social and psychological constraints caused by the disease, and exclusion from certain job opportunities constitute indirect costs, while patient care fee, physician fee, and medical expenses are among the direct costs due to obesity.[18] The share of the fight against obesity in health expenditures in European Union countries can reach up to 6%.[19] In the USA, the medical costs of obesity of pediatric outpatients and inpatients are approximately $14.1 billion and $238 million, respectively, while the expenditure on combating obesity and OW was $147 billion in 2009,[12] reaching $1.42 trillion in 2014.[20] Besides, obesity is estimated to account for 2.8% of the global gross domestic product.[8]

Not only adult and childhood obesity have become an important and worrisome health problem in Turkey as in the world, but also the rapid increase in the obesity prevalence throughout the country in the last 3 years has caused policymakers to worry and start searching for remedies.[1] An O individual has 41.5% more health spending per capita than a normal weight (NW) adult, accounting for 16.5% of Turkey's health expenditures.[8] While scanning the studies in the literature in detail, it has been found that obesity not only poses a significant threat to human health but also imposes a huge financial burden on the economies of the country. However, studies on obesity in Turkey in which the heterogeneity of individuals within the family was ruled out have remained scant and unfortunately have not brought any novelty beyond simple analysis.[1,21] In this regard, it is of great importance to provide a more robust foresight to the health sector and policymakers in the country on the subject, by conceptualizing the behavioral responses of families toward the prevalence of obesity with controlling heterogeneity among family members in the light of the up-to-date data set and rich factors. In this study, the relationship between the sociodemographic and economic factors of family and family members and the prevalence of obesity [NW, OW, O, and severe obese (SO)] are analyzed using the panel random-effect ordered probit model. As it is known, the effect of obesity on explicit groups (e.g., intra-family heterogeneity), through perceptions about behavioral responses to food culture among family members, is known to be distinct and larger than the effect of differentiation between families on obesity. Accordingly, the effects of an inter-family factor on obesity prevalence in this study were performed by controlling behavioral heterogeneity among family members. Also, the unitary (marginal) effects in the sociodemographic and economic factors of family members and family are determined by analyzing them on each obesity group.

This study consists of 4 chapters, including the introduction. The second part introduces the empirical methods and data sets applied to the variables. The following part reports the empirical results of the study. The last part presents policy suggestions from the study.

METHODS

The analysis used the survey data from the 2016 Turkey Health Research (THR) created by the Turkish Statistical Institute (TSI) with the official permission of the institution (application number: 01202000000001B24). The data from Turkey Health Interview Surveys conducted in households in Turkey between January 1 and December 31, 2016, by the TSI were used in the study. The sample size included 8325 families and 17 242 individuals after the exclusion of missing observations and outliers. Descriptive definitions and statistical values of sociodemographic and economic characteristics of family members and family are given in Table 1.

In the present study, it is determined that 43% of individuals are NW, 35.2% are OW, 15.8% are O, and 6% are SO. Also, 44.5% of individuals are male, 69.1% are married, 34.5% are primary school graduates, 10.2% are university graduates, 10.1% have a green card, and 16.8% are retired. The average monthly income of 16.1% of families is more than Turkish lira (TL) 2540, and 53.1% and 61.8% of individuals eat fruits and vegetables at 1 or more meals per day, respectively. About 43.6% of individuals smoke cigarettes and 5.2% of them drink alcohol. It is found that 13.1% of individuals walk more than an hour a day. The variance inflation factor reveals that there is no multicollinearity problem among the independent variables. In addition, other descriptive statistics will not be given here, considering the page limit.

Table 1. Descriptive Statistics of Variables

Variable	Descriptive	Mean	SD	VIF
Normal weight	1 if BMI ≤ 25 (RG)	0.430	0.495	–
Overweight	1 if BMI > 25 and BMI ≤ 30, 0 otherwise	0.352	0.478	–
Obese	1 if BMI > 30 and BMI ≤ 35, 0 otherwise	0.158	0.365	–
Severe obese	1 if BMI > 35, 0 otherwise	0.060	0.237	–
Gender	1 if the individual is male, 0 otherwise	0.445	0.497	0.000
Age <30	1 if the individual is less than 30 years old, 0 otherwise (RG)	0.250	0.433	–
Age 30-44	1 if the individual is between 30 and 44 years old, 0 otherwise	0.293	0.455	1.588
Age 45-64	1 if the individual is between 45 and 64 years old, 0 otherwise	0.312	0.463	2.301
Age >64	1 if the individual is older than 64 years, 0 otherwise	0.146	0.353	2.908
Marital status	1 if the individual is married, 0 otherwise	0.691	0.462	2.601
Employment	1 if the individual is currently employed, 0 otherwise	0.464	0.499	1.496
No school	1 if the individual has no school diploma, 0 otherwise (RG)	0.154	0.361	–
Elementary school	1 if the individual has an elementary school diploma, 0 otherwise	0.345	0.475	2.661
Secondary school	1 if the individual has a secondary school diploma, 0 otherwise	0.173	0.378	2.582
High school	1 if the individual has a high school diploma, 0 otherwise	0.227	0.419	3.027
College	1 if the individual has a college degree including master and doctorate, 0 otherwise	0.102	0.302	2.383
Green card	1 if the individual has green-card health insurance, 0 otherwise	0.101	0.301	1.262
Entrepreneurial income	1 if the individual is an entrepreneurial income, 0 otherwise	0.078	0.268	1.272
Real estate	1 if the individual has an income from securities and real estate assets, 0 otherwise	0.035	0.184	1.098
Pension income	1 if the individual receives a pension income, 0 otherwise	0.168	0.373	1.533
Income group 1	1 if the household income is less than 1814 Turkish lira (TL), 0 otherwise (RG)	0.486	0.500	–
Income group 2	1 if the household income is between 1814 and 2540 TL, 0 otherwise	0.354	0.478	1.294
Income group 3	1 if the household income is greater than 2540 TL, 0 otherwise	0.161	0.367	1.521
Tobacco	1 if the individual smokes, 0 otherwise	0.436	0.496	1.336
Alcohol	1 if the individual smokes, 0 otherwise	0.052	0.222	1.038
Walking time	1 if the individual walks more than an hour a day, 0 otherwise	0.131	0.337	1.054
Sports	The time an individual devotes to sports in a week (minutes)	0.218	1.206	1.052
Heavy work	1 if the individual works in heavy duty, 0 otherwise	0.053	0.225	1.080
Fruit consumption	1 if eating 1 or more servings of fruit a day, 0 otherwise	0.531	0.499	1.482
Vegetable consumption	1 if eating 1 or more servings of vegetables a day, 0 otherwise	0.618	0.486	1.447
Depression	1 if the individual is diagnosed with depression, 0 otherwise	0.082	0.274	1.050
Physician	Number of physician visits in the last 12 months	0.920	2.090	1.047
Household size	Household size	3.349	1.686	1.367
Northeastern Anatolia	1 if residing in the northeastern Anatolia region, 0 otherwise (RG)	0.022	0.148	–
Istanbul	1 if the individual resides in Istanbul, 0 otherwise	0.133	0.340	2.480
Western Marmara	1 if residing in the western Marmara region, 0 otherwise	0.103	0.304	2.196
Aegean	1 if residing in the Aegean region, 0 otherwise	0.058	0.233	1.706
Eastern Marmara	1 if residing in the eastern Marmara region, 0 otherwise	0.044	0.204	1.558
Middle east Anatolia	1 if residing in the middle east Anatolia region, 0 otherwise	0.023	0.151	1.296
Mediterranean	1 if residing in the Mediterranean region, 0 otherwise	0.097	0.296	2.129
Central Anatolia	1 if residing in the central Anatolia region, 0 otherwise	0.145	0.352	2.596
Western Black Sea	1 if residing in the western Black Sea region, 0 otherwise	0.078	0.268	1.995
Eastern Black Sea	1 if residing in the eastern Black Sea region, 0 otherwise	0.203	0.402	3.108
Southeastern Anatolia	1 if residing in the southeastern Anatolia region, 0 otherwise	0.043	0.202	1.548
Number of households sampled			8325	
Number of total observations			17 242	

BMI, body mass index; RG, reference group; TL, Turkish lira; VIF, variance inflation factor.

Econometric Method

Consider the latent variable y_{ij}^{*} for individual *j* in family cluster *i* and the observed ordinal categorical variable y_{ij} corresponding to its latent response variable y_{ij}^{*}. The ordinal categorical models can be shown in terms of the latent response variable y_{ij}^{*} as follows:

$$y_{ij}^{*} = \theta_{ij} + \varepsilon_{ij}, y_{ij} = \kappa_{ik} \text{ if } \psi^{m_{ik-1}} < y_{ij}^{*} < \psi^{m_{ik}}$$
$$\text{where} \theta_{ij} = \beta_0 + \sum_{p=1}^{P} \beta_p x_{pij} \text{ and } \varepsilon_{ij} = \eta_i + v_{ij} \quad (1)$$

where x_{pij} represents a vector of explanatory variables, including household income and individual characteristics, β_p is the vector of parameter estimates corresponding to these variables, and ψ is the vector of all threshold parameters (e.g., $\psi^0 < \psi^1 < \psi^2 < \ldots < \psi^K, \psi^0 = -\infty, \psi^1 = 0, \psi^K = +\infty$). ε_{ij} is a standard normal error term uncorrelated across families *i*, but it may be correlated across individuals within a family *i* for which we assume the error term, ε_{ij}, can be written as the sum of family effect η_i and an idiosyncratic term v_{ij}, where $\eta_{ij} | x_{ij} \psi N(0, \sigma^2)$. As it is indicated above, observations across families are not correlated, while 2 observations for the same family *i* are then correlated because of the common term η_i.[22]

The maximum simulated likelihood estimation of the random effects can be constructed as follows. Let the probability of the observed vector κ_i of the sequence of ordinal choices ($\kappa_{i1}, \kappa_{i2}, \kappa_{i3}, \ldots, \kappa_{iK}$) for a family *i* conditional on the heterogeneity term η_i be:

$$\text{Prob}(\kappa_i) | \eta_i = \prod_{k=1}^{K} \left\{ f\left(\psi^{\kappa_{ik}} - \theta_{ij} - \eta_{ij}\right) - f\left(\psi^{\kappa_{ik-1}} - \theta_{ij} - \eta_{ij}\right) \right\} \quad (2)$$

The unconditional likelihood of the observed choice sequence can be then obtained by integrating out the heterogeneity term, η_i :

$$L_i(\psi,\beta,\sigma)=\int_{v=-\infty}^{\infty}\left[\prod_{k=1}^{K}\left\{f\left(\psi^{\kappa_{ik}}-\theta_{ij}-\eta_{ij}\right)-f\left(\psi^{\kappa_{ik-1}}-\theta_{ij}-\eta_{ij}\right)\right\}\phi(v)dv \quad (3)$$

where $v=\eta_i/\sigma$ and f and are univariate standard normal cumulative and density function, respectively. The corresponding log-likelihood function can be written as:

$$\log L(\psi,\beta,\sigma)=\sum_i \log L_i(\psi,\beta,\sigma) \quad (4)$$

This log-likelihood function can be maximized either using Gauss–Hermite quadrature or using a simulated method. Here, we used the Gauss–Hermite quadrature method to obtain relevant parameter estimates of the log-likelihood function. Also, by taking the derivatives of Equation (2) with respect to the independent variables, the unitary (marginal) effects on the ordinal categorical probabilities were then achieved. Delta method was used to obtain the standard error of the abovementioned marginal effects.

RESULTS

Parameter estimates of the maximum likelihood panel random-effect ordered probit model are given in Table 2. The choice of the independent variables used in the ordered probit model has been confirmed (=242.838 and P=.000). Along with the constant coefficient, the other 2 threshold parameters (and) were found to be statistically significant, remarking that the transitions between obesity groups had profound distinct features. The fact that the parameter of the heterogeneous factor (e.g., σ) is statistically significant confirms our choice of the random effect and reflects a superiority against the pool model. On the other hand, unitary (marginal) effects of family members and family's sociodemographic and economic factors derived from the panel random-effect ordered probit model are given in Table 3. The next discussion will take place on these marginal effects.

Table 2. Maximum Likelihood Estimates of the Panel Random-Effects Ordered Probit Model

Variable	Parameters	SE	*z*-Value	95% Lower CI	95% Upper CI
Constant	−0.318***	0.061	−5.190	−0.439	−0.198
Gender	−0.030	0.024	−1.230	−0.077	0.018
Age 30-44	0.717***	0.032	22.180	0.654	0.781
Age 45-64	1.066***	0.035	30.220	0.997	1.135
Age >64	0.813***	0.043	18.820	0.729	0.898
Marital status	0.253***	0.025	10.060	0.204	0.303
Employment	−0.047**	0.023	−2.030	−0.093	−0.002
Elementary school	−0.138***	0.031	−4.420	−0.200	−0.077
Secondary school	−0.383***	0.041	−9.450	−0.463	−0.304
High school	−0.428***	0.040	−10.720	−0.506	−0.350
College	−0.540***	0.050	−10.880	−0.637	−0.443
Green card	−0.164***	0.038	−4.280	−0.239	−0.089
Entrepreneurial income	0.032	0.038	0.830	−0.043	0.107
Real estate	0.036	0.056	0.640	−0.074	0.146
Pension income	−0.055*	0.030	−1.820	−0.115	0.004
Income group 2	.087***	0.025	3.500	0.038	0.135
Income group 3	0.012	0.036	0.330	−0.058	0.081
Tobacco	−0.068***	0.022	−3.050	−0.112	−0.024
Alcohol	−0.092**	0.044	−2.120	−0.178	−0.007
Walking time	−0.159***	0.031	−5.120	−0.220	−0.098
Sports	−0.003	0.009	−0.370	−0.021	0.014
Heavy work	−0.010	0.045	−0.210	−0.097	0.078
Fruit consumption	0.102***	0.024	4.290	0.055	0.149
Vegetable consumption	−0.033	0.025	−1.340	−0.081	0.015
Depression	0.126***	0.034	3.690	0.059	0.192
Physician	0.019***	0.004	4.360	0.010	0.027
Household size	−0.022***	0.008	−2.800	−0.037	−0.007
Istanbul	0.065	0.049	1.320	−0.032	0.162
Western Marmara	0.068	0.051	1.330	−0.032	0.168
Aegean	0.229***	0.057	4.000	0.117	0.341
Eastern Marmara	.110*	0.062	1.780	−0.011	0.232
Middle east Anatolia	0.014	0.082	0.170	−0.148	0.175
Mediterranean	0.049	0.051	0.950	−0.052	0.149
Central Anatolia	0.050	0.047	1.060	−0.043	0.143
Western Black Sea	−0.050	0.057	−0.870	−0.163	0.062
Eastern Black Sea	0.055	0.046	1.190	−0.036	0.145
Southeastern Anatolia	−0.109	0.067	−1.620	−0.241	0.023
ψ_1			1.079*** (0.011)		
ψ_2			1.927*** (0.016)		
Sigma (σ)			0.478*** (0.020)		
Log-likelihood function			−18 730.285		
Restricted log-likelihood			−18 851.704		
χ^2_{36}			242.838***		
AIC			37 540.600		

***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively. AIC: Akaike Information Criterion; CI: Confidence Interval.

Table 3. Marginal Effects of Exogenous Variables on the Obesity Groups

	Normal Weight		Overweight		Obese		Severe Obese	
Variable	Partial Effect	z-Value	Partial Effect	z-Value	Partial Effect	z-Value	Partial Effect	z-Value
Gender	0.011	1.220	−0.003	−1.220	−0.005	−1.220	−0.002	−1.230
Age 30-44	−0.241***	−24.220	0.049***	19.650	0.119***	22.080	0.073***	17.290
Age 45-64	−0.347***	−35.530	0.055***	15.730	0.173***	31.200	0.120***	21.760
Age > 64	−0.260***	−22.330	0.024***	6.480	0.136***	20.090	0.100***	13.290
Marital status	−0.090***	−10.080	0.031***	9.060	0.040***	10.290	0.019***	10.630
Employment	0.017**	2.030	−0.005**	−2.020	−0.008**	−2.030	−0.004**	−2.030
Elementary school	0.049***	4.420	−0.016***	−4.210	−0.022***	−4.470	−0.011***	−4.560
Secondary school	0.137***	9.500	−0.054***	−7.980	−0.058***	−10.220	−0.025***	−11.380
High school	0.153***	10.830	−0.059***	−9.170	−0.065***	−11.510	−0.028***	−12.570
College	0.193***	11.140	−0.084***	−8.900	−0.077***	−12.700	−0.031***	−15.270
Green card	0.058***	4.270	−0.021***	−3.830	−0.026***	−4.440	−0.012***	−4.760
Entrepreneurial income	−0.011	−0.830	0.003	0.860	0.005	0.830	0.002	0.810
Real estate	−0.013	−0.640	0.004	0.660	0.006	0.630	0.003	0.620
Pension income	0.020*	1.810	−0.006*	−1.750	−0.009*	−1.830	−0.004*	−1.870
Income group 2	−0.031***	−3.510	0.009***	3.610	0.014***	3.480	0.007***	3.420
Income group 3	−0.004	−0.330	0.001	0.330	0.002	0.330	0.001	0.330
Tobacco	0.024***	3.060	−0.008***	−3.020	−0.011***	−3.060	−0.005***	−3.070
Alcohol	0.033**	2.110	−0.011**	−1.960	−0.015**	−2.160	−0.007**	−2.270
Walking time	0.057***	5.100	−0.020***	−4.610	−0.025***	−5.270	−0.012***	−5.610
Sports	0.001	0.370	−0.001	−0.370	−0.001	−0.370	−0.001	−0.370
Heavy work	0.003	0.210	−0.001	−0.210	−0.002	−0.220	−0.001	−0.220
Fruit consumption	−0.036***	−4.290	0.011***	4.260	0.017***	4.290	0.008***	4.280
Vegetable consumption	0.012	1.340	−0.004	−1.350	−0.006	−1.340	−0.003	−1.330
Depression	−0.044***	−3.740	0.012***	4.270	0.021***	3.620	0.011***	3.410
Physician	−0.007***	−4.360	0.002***	4.330	0.003***	4.350	0.002***	4.350
Household size	0.008***	2.800	−0.002***	−2.770	−0.004***	−2.800	−0.002***	−2.810
Istanbul	−0.020	−1.330	0.007	1.410	0.011	1.310	0.005	1.270
Western Marmara	−0.024	−1.330	0.007	1.420	0.011	1.310	0.006	1.270
Aegean	−0.079***	−4.120	0.019***	5.890	0.039***	3.900	0.021***	3.460
Eastern Marmara	−0.039*	−1.800	0.011**	2.060	0.018*	1.750	0.009*	1.650
Middle east Anatolia	−0.005	−0.170	0.002	0.170	0.002	0.170	0.002	0.160
Mediterranean	−0.017	−0.950	0.005	1.000	0.008	0.940	0.004	0.920
Central Anatolia	−0.018	−1.060	0.005	1.110	0.008	1.050	0.004	1.030
Western Black Sea	0.018	0.870	−0.006	−0.840	−0.008	−0.880	−0.004	−0.900
Eastern Black Sea	−0.019	−1.190	0.006	1.230	0.009	1.180	0.005	1.160
Southeastern Anatolia	0.039	1.610	−0.014	−1.470	−0.017*	−1.660	−0.008*	−1.750

***, **, and * show significance at 1%, 5%, and 10% levels, respectively.

According to the results we obtained, it has been found that sociodemographic and economic factors of family members and family affect the probability of obesity. The study conducted in Serbia reported that increased age, being male, living in the countryside, being married, having a low level of education, and having high income were more likely to be associated with obesity. In the study, they emphasized that age and income groups, education level, and smoking were significantly related to body weight.[23,24] They also reported that lifestyle, diet behavior, social status, and other sociodemographic factors affected BMI differently in distinct weight categories. In the same study, it was reported that education, employment, and income variables had a strong effect on the possibility of being OW and O. Individuals with low education, profession, or income levels tend to have more obesity than individuals with very high social welfare.[25]

Considering the change in the age scale of obesity, the probability of being NW within a family decreases as the ages of family members increase, and this condition triggers being OW, O, and SO as the age progresses. There was a similar relationship between individuals' age and social status and being OW in the literature.[26] Another important result is that this situation is riskier, especially in middle-aged individuals (the probability of NW decreases by 34.7 points, while the probability of being OW, O, and SO increases 5.5, 17.3, and 12 points, respectively). On the other hand, we found that individuals with NW (individuals aged 30-44, 45-64, and over 64 were negatively affected by 24.1, 34.7, and 26 points, respectively) were most affected by the age factor. This result is expected to have a tendency from NW to O with the decrease in physical activity and energy needs of the body as the age progresses, overlapping with the results we previously obtained. Our results are also compatible with international findings.[21,27]

Married individuals are less likely to be of NW than single individuals within a family, and this increases the likelihood of married people falling into the category of OW, O, and SO. It has been observed that married individuals are responsive to a NW of approximately 2.5-5 times more than single individuals. Besides, it has been found that married individuals are the least responsive group to becoming SO (1.9 points) compared to single individuals. This situation can be explained by the fact that married individuals have more regular and monotonous lives than single individuals. While the risk of married individuals being O compared to singles was suggested to be 2 times more in 1 study,[21] it was stated that in another study, they tended to be 0.8% more O than single or widowed individuals.[1]

The fact that individuals work in any job increases the probability of individuals being at NW by 1.7 points, while the probability of being OW, O, and SO is decreased by 0.5, 0.8, and 0.4 points, respectively. While the most responsive group in working individuals within a family was the normal group with 1.7 points, the least responsive group was observed to be the SO group with 0.4 points. Based on these results, it could be emphasized that there is a negative relationship between the working status of individuals and OW, O, and SO. Since the working individuals being physically active increases mobility, the emergence of such a result is

in line with the expectations. Based on all these results, the existence of healthier generations can be ensured by expanding more business areas throughout the country.

It is observed that there is a negative relationship between the education level of individuals and being OW, O, and SO within a family. In addition, as the education levels of individuals increase, the risk of obesity decreases, while the probability of being at NW increases. People with education and higher education are less likely to be O or OW.[1,28] Another result obtained especially with the individuals who have university-level education indicates that the risk of obesity is much lower than individuals with other education levels (primary school). It has been found that individuals who are university graduates are approximately 4 times more responsive to obesity than individuals who graduated from other education groups. Kuntz and Lampert[25] reported that men in the lowest education level were 1.5 times more likely to be O than men in the highest education level group. Having a university or higher education degree reduces the likelihood of obesity by 7.4%.[1] In most of the studies, it was suggested that women without university education were OW and O than women with a university degree.[29] On the other hand, it was found that the group that was the least responsive to the education level was an SO group and the group that was the most responsive was the NW group. For example, individuals with a university degree decreased their probability of obesity by 3.1 points compared to individuals who were primary school graduates, while the probability of staying at NW increased by 19.3 points. This can be explained by the more conscious and healthy nutrition of people as the level of education advances. Education increases people's awareness of health and nutrition and their attention to health and consequently reduces the incidence of obesity.[30,31] In similar studies, researchers obtained evidence of a negative relationship between individuals' education levels and obesity.[21,26,27]

While individuals who have a green card are less likely to suffer from obesity, they are more likely to be at a NW. The individuals having a green card are likely to boost the probability of NW by 5.8 points, while the probability of being OW, O, and SO is decreased by 2.1, 2.6, and 1.2 points, respectively. The probability of O individuals with green-card health insurance decreases by 8.3%.[1] Also, individuals with green cards are responsive to the NW group with a maximum of 5.8 points, while they are responsive to an SO group with a minimum of 1.2 points. It could be noted that positive features of having a green-card assurance such as not having any obstacle to go to the doctor and receiving the necessary treatments reduce the likelihood of individuals being O in cases of illness caused by some environmental and hereditary factors (such as unhealthy diet, depression, and congenital obesity). Meanwhile, since green-card ownership is an indicator of poverty, it could be noted that individuals holding green cards are in the low-income group. Therefore, green-card ownership reduces the likelihood of these individuals becoming O by limiting both fast-food and other consumption expenditures. People with higher incomes are at higher risk for obesity. This might be due to higher energy foods as well as greater socioeconomic access to food.[28,32] Although this seems like a desirable outcome, it should not be overlooked that these individuals face unbalanced nutrition because they can live on a very low income. An additional nutrition assistance program such as the food stamp program in the USA that provides balanced nutrition by purchasing healthy food should be implemented in Turkey, too.

While the probability of individuals receiving a pension to be at NW increases, the probability of being OW, O, and SO decreases. Besides, the most responsive group among individuals who receive a pension is the NW group with 2 points, while the least responsive group is observed to be the SO group with 0.4 points. Income level is an important factor affecting consumer behavior. The prevalence of obesity is directly related to consumption habits and behaviors. Although individuals who receive pensions descend from a certain income level to a lower income level (there is a loss of income due to retirement), it is an expected result that their probability of becoming O will decrease as a result of the decrease in consumption expenditures.

Having a monthly income between 1814 and 2540 TL decreases the probability of being a NW in individuals by 3.1 points while increasing the probability of being OW, O, and SO, respectively, by 0.9, 1.4, and 0.7 points when compared to the families with a monthly income of 1814 TL. Among the groups, the normal response group gives the highest response to the income group in question (3.1 points), while the least response is given by the O group (0.7 points). It is seen that obesity is most responsive to individuals with middle-income levels among income groups.

It is emphasized that the probability of becoming O increases with an increase in the income of individuals.[21] As the income level of individuals increases, total energy and total fat intake increase, leading to the risk of weight and obesity.[33] In the study conducted in the USA, it has been found that consumers with an average annual income of $40 000 and above spend 28% higher for fresh fruit and 25% higher for fresh vegetable compared to consumers with an annual income of $20 000-29 999.[34] A study conducted in Adana, Turkey, has revealed that households spend more for fresh fruits and vegetables as their income increases; another study from Nigeria[35] has reported that higher income status makes consuming fresh fruit and vegetables more possible, while studies from Canada,[36,37] Australia,[38] and Gana[39] have shown that income increases fruit and vegetable consumption. Based on these results, a possible increase in income may increase the risk of obesity as individuals tend to consume more food (total energy and total fat intake increases). On the other hand, some studies evaluating the high-income level as a protective shield for obesity consider the existence of an inverse relationship between these 2 variables. They interpret it as an increasing incidence of economic access to healthy foods, thereby preventing obesity.[25,40,41] In the emergence of these different results in the literature, it has been observed that studies in developed countries find that an increase in income provides more access to healthy foods, while studies in developing countries find that an increase in income increases total energy and total fat intake.

One of the important results of our study is that fruit consumption has a positive relationship with obesity. Results indicated that individuals who consume more than one serving of fruit per day reduce the probability of being at NW by 4 points while increasing the likelihood of being OW, O, and SO. The OW and O groups are especially affected more than the SO group. It is underlined that eating fruit more than 4 times a week increases the risk of obesity in individuals.[28] Similarly, it is reported that those who eat fruit twice or more a day are 3.6% more likely to be O.[1] A fructose intake >10-15 g/day is predicted to be harmful to the proper functioning of glucose metabolism and increased weight with calories may become inevitable as the fructose content of a fruit increases. The 2018-2022 strategic plan of the Ministry of

Health, Turkey, states that consuming fruit more than once per day increases obesity.[1]

There is a negative relationship between smoking individuals and being O. While the probability of smokers within a family to be at NW increases by 2.4 points, the probability of being OW, O, and SO decreases by 0.8, 1.1, and 0.5 points, respectively. It has been determined that individuals with NW are approximately 5 times more responsive to smoking than individuals who are SO. Similar results were obtained for alcohol consumption. Smokers are up to 6.6% less likely to be O.[1] This can be explained by the decrease in regular eating habits that starts with the loss of appetite in smokers and alcohol drinkers. The results of this study coincide with findings from similar studies, indicating that smokers are less likely to have higher body weight than non-smokers.[23,42,43]

The walking variable that was included in the model as a physical activity affecting obesity prevalence was found statistically significant. People who walk more than an hour a day are more likely to be at a NW, while they are 5 times less likely to be OW, O, and SO. It is suggested that one of the most important variables in reducing obesity is physical activity.[21,24,25] Individuals who walk more than an hour a day increase their probability of being at NW by 5.7 points, while the probability of being O decreased by 2.5 points. Our results are in line with expectations. Individuals who regularly walk are less likely to become O by 0.3%.[1] The prevalence of obesity or OW is lower in individuals who exercise more than 5 times per week than others.[28] In this context, regardless of gender and age group, such activities should be encouraged by the relevant health institutions through visual and written media, including views of healthcare professionals about the positive effects of daily walking on human health. Also, local governments should offer public walking areas.

While the probability of individuals diagnosed with depression to be at NW decreases, they are more likely to be OW, O, and SO. In other words, it has been observed that there is a similar relationship between individuals diagnosed with depression and obesity. Among the groups, individuals at a NW are the most responsive to depression with 4.4 points, while those in the SO group are the least responsive with 1.1 points. Based on these results, the depression effect of the individuals in the NW group will be 4 times more pronounced than the individuals in the SO group. The increased probability of being O is an expected result in the individuals diagnosed with depression because they both tend to consume more food and are more passive in physical activity. The most important psychological problem with obesity is depression. It is stated that O people overeat in response to anxiety and depression, and about 50% of those with an eating disorder such as obesity have clinical depression.[44] In addition to medical problems, many psychological and social problems have also been associated with obesity.[45] Self-esteem, avoidance of peer relationships, introversion, exclusion, and depression are associated with obesity.[15]

While the probability of individuals working physically in heavy jobs to be at NW decreases by 0.7 points, the probability of being OW, O, and SO is increased by 0.2, 0.3, and 0.2 points, respectively. Individuals with NW within the groups are the most responsive to heavy work with 0.7 points, while individuals in the OW and O group are the least responsive with 0.2 points. Individuals in the OW and O group will have an effect of working in heavy jobs approximately 3 times less than those in the NW group. Since individuals working in heavy jobs mostly work with muscle strength, their physical needs increase accordingly. Therefore, the probability of individuals who work in heavy jobs becoming O increases in line with expectations and overlaps with our study findings since these individuals both consume more food and are more passive in terms of physical activity.

As the number of individuals in the household increases, the probability of individuals being at NW increases by 0.8 points, while the probability of being OW, O, and SO decreases. Obesity or OW has a significant and negative relationship with the size of the family. It is indicated that people with more family members have less risk of obesity.[28] Since the amount of food consumption per individual will decrease as the number of individuals in the family increases, this result is in line with expectations and overlaps with our findings.

When families in the North-eastern Anatolia region are taken as reference, the probability of people living in the Aegean and eastern Marmara regions to be at NW decreases while they are more likely to get O. On the other hand, it has been observed that individuals living in the southeastern Anatolia region are less likely to become O and SO. While the probability of individuals living in the Aegean region to be at NW decreases by 7.9 points, the probability of being OW, O, and SO increases by 1.9, 3.9, and 2.1 points, respectively. The effect of living in the Aegean region will be about 4 times more pronounced in individuals at a NW within the groups compared to individuals in the OW and SO groups. On the other hand, the probability of individuals living in the eastern Marmara region to be at NW decreases by 3.9 points, while those in the OW, O, and SO groups have an increased likelihood. The individuals who are most responsive to living in the eastern Marmara region are individuals in the NW group with 3.9 points, while individuals in the SO group are the least responsive group with 0.9 points. Considering the response of individuals in NW, OW, O, and SO groups to living in the regions, it is observed that they are most responsive to living in the Aegean region. The fact that the probability of the individuals living in the southeastern Anatolian region being O is in contrast to those living in the Aegean and eastern Marmara regions can be explained by the fact that individuals living in southeastern Anatolia are employed less at desk jobs and employed more at jobs with higher physical mobility (jobs are very common in agricultural areas).

DISCUSSION

This study analyzes the sociodemographic and economic characteristics of families or individuals that can affect the NW, OW, O, and SO determined by the BMI using the panel random-effect ordered probit model. Since the panel random-effect model provides intra-family heterogeneity, it is superior to pooled data models and produces unbiased, consistent, and ultimately efficient parameter estimates.

We found that sociodemographic and economic factors of family members or family significantly affect the probability of obesity groups. It is observed that married individuals are 5 times more likely to be O than singles within a family. Strong negative relationships are found between the probability of being OW, O, and SO, and the individual's level of education, employment status, green-card ownership, pension, smoking and alcohol consumption, household size, and physical activity status. Especially the individual being a university graduate and walking more than an hour a day reduces the chance of obesity significantly. Household

income, which is one of the economic status variables of individuals, increases the probability of individuals becoming OW, O, and SO.

It is suggested that the risk of obesity will be greatly reduced with awareness-raising activities to be conducted on obesity in Turkey, and significant policies must be identified and implemented accordingly. It is assumed that obesity will greatly reduce among the individuals who walk over an hour a day, and individuals must especially be informed in this regard in the country. Another important consideration from the 2018-2022 strategic plans of the Ministry of Health of Turkey (MHT), which requires attention from policymakers, is identifying the regions which lack peripheral circumstances for walking (rural areas) and constructing walking routes in such regions or increasing the facilities for the individuals to perform physical activities. The 2018-2022 strategic plans of MHT also require special packaging on fast-food-style foods which may increase obesity prevalence to discourage the habit of consuming such foods and to stress the importance of health and warn the people that obesity is lethal. For the Aegean and eastern Marmara regions, the MHT should conduct more inspections in the enterprises using materials that probably trigger obesity. The state should impose a new obesity tax (in line with the policies implemented by countries that have greatly reduced obesity) to significantly reduce the obesity rate, which is almost 30% across the country. Accordingly, studies available in the literature predict that when the tax burden on all foods triggering obesity is increased, it will prevent unhealthy nutrition of the consumer in the country as in other countries. It could also be highlighted that if policymakers encourage the working situation of individuals, it will positively affect both the country's economy and the health status of individuals.

On the other hand, obesity is an important problem in Turkey and must be combated effectively. The social risk groups that are positively associated with obesity should be identified, and awareness training should be provided to each group using appropriate methods. The objective of such a program is to encourage individuals to have adequate and balanced nutrition and regular physical exercise and to inform them about the negative effects of obesity on health (e.g., cardiovascular disease, diabetes, some types of cancer, and hypertension).

Considering the limitations of the present study, the sociodemographic and economic factors of the family and family members should also cover the children, who are also at risk of OW, O, and SO. However, since the BMI is not calculated for the people under the age of 15 due to the data set used in the analysis, it is recommended to research children in future studies to determine the sociodemographic and economic characteristics that lead to OW, O, and SO.

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