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Araştırma Makalesi

Research on Consumption of Sugar-Sweetened Drinks and 100% Fruit Juices

Faruk URAK
Turkish Radio and Television Corporation (TRT), Erzurum Directorate, Erzurum
Sorumlu Yazar: farukurak.trt@gmail.com

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ABSTRACT

Measurement of consumption of sugar-sweetened and 100% fruit juice drinks is typically patchy and often nutritionally focused, particularly in developing countries such as Turkey, with limited public perception and awareness of the health risks associated with excessive SSB consumption, and a low stimulus level of 100% fruit juice intake. In the study, the effects of socio-demographic, economic, and lifestyle characteristics of individuals and households on their different consumption probabilities of pure fruit juice (100% FJ) and sugar-sweetened beverages (SSB) were determined using the random-effects bivariate probit model in the context of family heterogeneity in Turkey. A richer source of information was elicited by deriving different probabilities from the bivariate random effects probit model. The applied model was found to be more compatible with the data and all the correlation coefficients examined were statistically significant. While most of the variables were statistically significant, according to the regressor effect, the probability of consuming 100% fruit juice among sugar-sweetened intakers was found to be greater or less than the probability of consuming 100% fruit juice of a randomly selected individual from the population (e.g., marginal probability). In this context, we can expect that the implementation of distinct intervention health programs that will involve different population segments will contribute greatly to the development of ideal outcomes. In addition, policy recommendations were presented considering the effects of very important variables.

Key words: Bivariate random effects, individuals, pure juice, sugar-sweetened beverages, tobacco, obesity

Aile Bireylerinde Şeker Katkılı ve %100 Doğal Meyve Suları Tüketimi Üzerine Araştırma

ÖZ

Şeker ilaveli içeceklerin ve %100 meyve sularının tüketim ölçümleri genellikle eksik verilere sahip olup sıklıkla beslenme odaklı bir yaklaşım sergiler. Bu durum özellikle Türkiye gibi gelişmekte olan ülkelerde daha belirgin bir hal alır; zira aşırı şekerli içecek tüketiminin sağlık riskleri ile ilişkilendirilmesi halk arasında sınırlı farkındalığa ve bilince sahiptir. Aynı zamanda, %100 meyve suyu tüketimi düşük seviyelerde seyretmektedir. Bu çalışmada, Türkiye'de ailevi heterojenliğin bağlamında bireylerin ve hanelerin sosyo-demografik, ekonomik ve yaşam tarzı özelliklerinin saf meyve suyu (100% FJ) ve şeker ilaveli içecekler (Şİİ) tüketim olasılıkları üzerindeki etkileri rastgele etkiler ikili probit modeli kullanılarak incelenmiştir. Bu model sayesinde elde edilen farklı olasılıklar, daha kapsamlı bir veri kaynağı sunmaktadır. Uygulanan model, verilerle daha uyumlu sonuçlar elde etmekte olup incelenen tüm korelasyon katsayıları istatistiksel olarak anlamlı bulunmuştur. Değişkenlerin büyük bir kısmı istatistiksel olarak anlamlı iken, regresyon etkilerine göre, şekerli içecek tüketenler arasında %100 meyve suyu tüketme olasılığının, popülasyondan rastgele seçilmiş bir bireyin %100 meyve suyu tüketme olasılığından daha yüksek veya daha düşük olduğu belirlenmiştir (örneğin, marjinal olasılık). Bu bağlamda, farklı nüfus kesimlerini hedefleyen ayrı sağlık müdahale programlarının uygulanmasının, ideal sonuçların elde edilmesine büyük katkı sağlayacağı öngörülmektedir. Ayrıca, çok önemli değişkenlerin etkileri dikkate alınarak politika önerileri sunulmuştur.

Anahtar kelimeler: Bivariate random effects, bireyler, saf meyve suyu, şeker katkılı içecekler, tütün, obezite

INTRODUCTION

Nutrition, one of the basic needs of human beings, is one of the most important factors affecting human health. While good eating habits are an important part of a healthy lifestyle (Wang et al., 2014), poor eating habits are a harbinger of chronic diseases (Irazusta et al., 2007). In addition to other nutritional intakes, sugar-sweetened beverages (SSB) and 100% fruit juices (100% FJ) have an important role in shaping human health with their pros and cons. While SSBs are liquids sweetened with various sugar forms, such as brown sugar, corn sweetener, corn syrup, dextrose, fructose, glucose, high-fructose corn syrup, honey, lactose, malt syrup, maltose, molasses, raw sugar, and sucrose, pure 100% FJs are obtained from pressed whole ripe fruits, which affects its aroma, color, acidity as well as the profile of innate sugars and aromatic compounds (Clemens et al., 2015). Although excessive and moderate consumption of sugar-sweetened beverages is generally accepted to pose adverse health effects (Micha et al., 2017; Stanhope et al., 2018), the findings regarding the consumption of pure fruit juices have been a topic of intense debate (Pepin et al., 2019). For example, frequent SSB consumption is associated with weight gain/obesity, hypertriglyceridemia, hypercholesterolemia, type 2 diabetes, heart disease, kidney disease, non-alcoholic liver disease, dental caries and cavities, and gout, a form of arthritis (Malik and Hu, 2019; Pepin et al., 2019; Valenzuela et al., 2021), whereas 100% FJ consumption is considered in many developed countries to be equivalent to one serving of fruit as it provides the body a source of nutrients and bioactive substances such as flavonoids, carotenoids, pectin, and vitamins (Pereira-Caro et al., 2014). Accordingly, in the 2015-2020 Dietary Guidelines for Americans (DGA) handbook, 100% FJ was highlighted as a nutrient-rich beverage that should be the primary choice, recognizing its role in health and meeting people’s recommended daily fruit intake (Byrd-Bredbenner et al., 2017). In studies on the subject, SSB consumption increases the risk of type 2 diabetes in Chinese women (Dhingra et al., 2007), while in other studies, it is associated with other health problems such as dental caries (Heller et al., 2001), and probably with hyperactivity and mental health problems (Lien et al., 2006). Also, high consumption of SSB is a well-known risk factor for obesity (Hebden et al., 2017) with its associative comorbidities and cardiometabolic diseases (Stanhope et al., 2018), and its intake is particularly high in children and has increased worldwide intake in recent years (Nielsen and Popkin, 2004; Vereecken et al., 2005). Despite the obvious detrimental effects of SSB on human health, specially packaged 100% FJ is a cost-effective food and is recognized both a way to provide year-round access to fruits, nutrients, and bioactive compounds (Clemens et al., 2015; Benton and Young, 2019) and an alternative to SSB consumption. Observational studies on nutritional adequacy have revealed positive correlations between 100% FJ and intake of whole fruit, vitamin C, vitamin A, vitamin B (such as folate), and minerals such as potassium (O’Neil et al., 2012; Drewnowski and Rehm, 2015; Hyson, 2015; Nicklas et al., 2015; Murray, 2020; Ruxton et al., 2021), as evidenced by the above phenomenon. In addition to these human health-related benefits, 100% FJ consumers were proved to have a lower body mass index (BMI), higher insulin sensitivity, and a lower probability of metabolic syndrome compared to their peers (e.g., non-100% FJ consumers) (Eshak et al., 2013; Hyson, 2015; Scheffers et al., 2020). Meanwhile, consumption of 100% FJ in women with intakes of less than 8 oz per day is not thought to help reduce the risk of hypertension or diabetes, as recommended in the Guidelines for Americans (DGA) (Auerbach et al., 2017) and 100% FJ intake has not been proven to cause obesity in children unless supplemented with additives (Rampersaud, 2007; Rampersaud and Valim, 2017) at a time when it is intended to maximize growth and developmental health in children (Davis et al., 2007).

Accessing worldwide per capita consumption data, regardless of the country’s level of development, to get an idea of the current trend in SSB and 100% FJ consumption will provide a useful insight to exploring the scope of current and future growth and obtaining a priori inference about both food consumption pattern. Despite the decline in total volume, the US consumed more than 6.7 billion liters of 100% FJ in 2015, corresponding to one-third of the world total. The US consumes 20.9 liters per capita per year, the fourth-highest globally after Canada (30.1), Norway (25.4), and Germany (21.7). On the contrary, despite its double-digit growth, China’s per capita consumption of 100% FJ remained very low at just 0.4 liters per capita per year, which indicates that the industry is still only scratching the surface of the opportunity (AIJN, 2019; Ruxton et al., 2021). Among the fastest-growing markets per capita between 2010 and 2015 are undoubtedly the countries in Africa, the Middle East, and Latin America (Popkin and Hawkes, 2016). While most of these started low, countries such as Brazil, Mexico, South Africa, and Saudi Arabia are leading the way, with some succeeding in emerging as key markets driving sales and innovation. While total fruit juice and nectar consumption per capita is 8.7 liters in Turkey in 2018, annual consumption per capita is around 30-32 liters in countries such as Germany, the USA, and Canada (Gıda Teknolojisi, 2018). On the other hand, according to Euromonitor International, a market research firm, global annual soft drink consumption averaged 91.1 liters per capita in 2018. Such a figure was 84.1 liters 5 years ago. While the per capita consumption of soft drinks in Turkey, which ranked 9th in the world consumption ranking in 2018, was 160.6 liters, the corresponding figure was 410.7, 356.8, 267.5, 267.5, 258.4, and 250.4 liters in the top five countries such as China, the USA, Spain, Saudi Arabia, and Argentina, respectively (BBC, 2018). These data show that these two drinks will have greater potential with the increase in per capita income in emerging countries such as Turkey.

Despite differential food intake disparities, expectations are lacking relating to the quality of accurate modeling to adapt to ideal dietary intakes and adequately respond to future dietary challenges. With the plethora of different and emerging methodologies and statistical techniques for modeling nutritional intake (Malik et al., 2013; Bernabé et al., 2014; Keller et al., 2015; WHO, 2015; WHO, 2016; Miller et al., 2019), it becomes increasingly difficult to choose the one that best fits the structure of the data for a given research objective (such as the presence of recurrent family members). Also, measurement of consumption of sugar-sweetened and 100% fruit juice drinks is typically patchy and often nutritionally focused, particularly in developing countries such as Turkey, with limited public perception and awareness of the health risks associated with excessive SSB consumption, and a low stimulus level of 100% fruit juice intake. In this study, which aims to associate the joint food intake probabilities with the different characteristics of the individual and the family, we aim to solve the above-mentioned problem by choosing the most suitable model among the existing models by applying the statistical benchmarks and evaluating the applicability of the selected model under different alternative scenarios. To our knowledge, there are no studies that take into account heterogeneity among family members and evaluate the joint likelihood of intake of sugar-sweetened beverages and 100% fruit juice with demographic or socio-demographic and health-related factors. The present study aims, therefore, to elicit attitude segregations by categorizing households according to certain criteria by revealing the causal relationship between the joint likelihood of SSB and 100% FJ consumption as well as various individual and household characteristics by controlling the heterogeneity between household members by using the random-effects bivariate probit model in Turkey. The present study also sought to fill the gap in the literature by generating key evidence based on different population categories (e.g., marginal, joint, and conditional probabilities) to inform public health efforts to mitigate SSB consumption on the one hand and boost plausible 100% juice intake on the other, through educative and regulatory interventions. In a situation where SSB and 100% FJ intake is becoming increasingly common with the increase in the income level and where interregional health inequalities are evident throughout the country; investigating multilevel factors affecting both different consumption probabilities, this study can shed light on the design of multi-level intervention programs/policies aimed at reducing SBB intake on the one hand and fostering conceivable 100% FJ intake on the other hand, for both the individual and the household. Also, the study can shed light on the relevant policies of other countries with the same socio-demographic and economic characteristics as Turkey.

MATERIAL and METHODS

The study includes cross-sectional data from the 2019 national health survey conducted by the Turkish Statistical Institute (TSI). Turkey Health Survey (THS) has been conducting fieldwork every two years in cooperation with the European Union Statistical Office (EUSO) since 2008. Surveys are applied in the last three months of the year (October, November, and December) to collect multi-level cross-sectional data by determining the monthly total number of observations in line with the modules determined by EUSO. Before collecting the data, 9470 household addresses were determined as the total sample size, of which a total of 8163 households were interviewed due to that some households opted to not participate in the survey by paying administrative fines while some households were not at home, moved to their relatives, or migrated to another place at the time of the survey, which, as a result, stands for a participation rate of 88%.

A very rich set of variables was used in the study. The variables were divided into three main categories: individual characteristics, household characteristics, and regional variables. Individual characteristics include variables such as gender, age category, marital status, education level, employment types, body mass index category, occupation types, walking, and sports activity types, tobacco and alcohol use, and the individual's history of depression. Family variables, on the other hand, include variables such as the income status of the household and the number of children and adults in different age ranges. The study finally includes twelve statistical regions included in the country's Classification of Statistical Regional Units (CSRU). Based on these regions, seven geographical regions identified with the country were built. Individual and household-specific descriptive statistics are not discussed here, as we provide comprehensive information on the statistical values of the variables in Table 1. Also, Variance Inflation Factor (VIF) shows that there is no multicollinearity problem among the individual and household-related characteristics (Table 1).

Random effects bivariate probit model consists of, households i = 1, ..., N, two heterogeneity parameters, α_1 and α_2, defined for the family members, j = 1, ..., M by the exogenous variables $\mathbf{x}_1$ and $\mathbf{x}_2$ and possibly correlated error terms ε_1 and ε_2, with unit variances, correlation coefficient, and two latent variables, y_1 and y_2, that are normally distributed:

$$
\begin{aligned}
y_{1,ij}^{*} &= x_{1,ij}'\beta_1 + \alpha_{1,i} + \varepsilon_{1,ij} \\
y_{2,ij}^{*} &= x_{2,ij}'\beta_2 + \alpha_{2,i} + \varepsilon_{2,ij}, \quad i = 1,...,N \ and \ j = 1,...,M
\end{aligned} \tag{1}
$$

where;

$$
\begin{aligned}
\varepsilon_{it} &= \begin{pmatrix} \varepsilon_{1,ij} \\ \varepsilon_{2,ij} \end{pmatrix} \approx i.i.d.N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}; \begin{pmatrix} 1 & \tau \\ \tau & 1 \end{pmatrix}\right] \\
\alpha_i &= \begin{pmatrix} \alpha_{1,i} \\ \alpha_{2,i} \end{pmatrix} \approx i.i.d.N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}; \begin{bmatrix} \sigma_1^2 & \rho\sigma_1\sigma_2 \\ \rho\sigma_1\sigma_2 & \sigma_2^2 \end{bmatrix}\right]
\end{aligned} \tag{2}
$$

where the coefficient τ is the degree of relationship between two latent variables, coefficients σ_i denotes the associated standard deviations of the two heterogeneous coefficients (α_i), and ρ represents the correlation coefficient between the two heterogeneous coefficients. β_i denotes the coefficients of regressors variables affecting the latent variables. Here, the determinants of each latent variable are assumed to be equal ($\mathbf{x}_1 = \mathbf{x}_2$). Having all this information presented, the observed model is:

$$
\begin{aligned}
y_{1,ij} &= 1\ (y_{1,ij}^{*} > 0) \\
y_{2,ij} &= 1\ (y_{2,ij}^{*} > 0)
\end{aligned} \tag{3}
$$

where, y_1 is coded as 1 if the individual consumes 100% FJ at least once a week, and 0 otherwise, similarly, y_2 is coded as 1 if the individual consumes SSB at least once a week, and 0 if not.

The classical transformation of the observed variables and the corresponding conditional composite likelihood functions are defined respectively as:

$$
\begin{aligned}
q_{1,ij} &= 2y_{1,ij} - 1 \\
q_{2,ij} &= 2y_{2,ij} - 1 \\
\ell_i(y_i \mid x_{ij}, \beta, \sigma_i^2, \rho) &= \int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty} f_i(y_i \mid x_i, \alpha_i, \beta, \tau) * g\left(\alpha_i \mid \sigma_1^2, \sigma_1^2, \rho\right) d\alpha_{1,i} d\alpha_{2,i}
\end{aligned} \tag{4}
$$

While some studies made use of simulations to optimize the above likelihood function (Lee and Oguzoglu, 2007; Kano, 2008), the Gauss-Hermite quadrature technique (Raymond et al., 2007, 2010; Mulkay, 2017) was used in this study. The random-effects bivariate probit model is essentially identical to the bivariate random parameters probit model only when the constant parameter is predicted randomly*.

Very different levels of probabilities can be derived from a random-effect bivariate probit model. For example, probabilities such as the probability of consuming 100% FJ or artificially sweetened beverages (marginal probability), the probability of consuming both foods together (joint probability), and the probability of consuming one beverage while the other beverage is already being consumed (conditional probability) can be derived for a randomly selected individual from the population. The expected values of the marginal (e.g., individual), joint, and conditional probabilities of 100% FJ and SSB uptake are:

* All analyzes were performed in the NLOGIT-6 statistics software.

$$
\begin{aligned}
\Pr\left[y_{k,ij}=1 \mid x_{k,ij}\right] &= \Phi\left(x'_{k,ij}\hat{w}_k\right),\ k=1,2 \\
\Pr\left[y_{1,ij}=1, y_{2,ij}=1 \mid x_{k,ij}\right] &= \Phi_2\left(x'_{1,ij}\hat{w}_1, x'_{2,ij}\hat{w}_2;\tau\right) \\
\Pr\left[y_{k,ij}=1 \mid y_{m,ij}=1\right] &= \frac{\Pr\left[y_{1,ij}=1, y_{2,ij}=1 \mid x_{k,ij}\right]}{\Pr\left[y_{m,ij}=1 \mid x_{k,ij}\right]},\ k\neq m
\end{aligned} \tag{5}
$$

where $\hat{w}_k=\frac{\hat{\beta}_k}{\sqrt{1+\hat{\sigma}_k^2}}$ and Φ and Φ_2 are univariate and bivariate cumulative density functions, respectively. For any continuous regressor, the marginal (unitary) effect is obtained by differentiating each corresponding probability value, while the marginal effect of a discrete regressor is obtained by taking the difference between the corresponding probability in the presence of the variable in question and the corresponding probability in the absence of the variable in question, holding other variables at mean levels. The standard deviations of the marginal effects were obtained using the delta method.

RESULTS and DISCUSSION

Table 1 shows the descriptive statistics for dependent and confounding variables. Consumption rates of one or more servings per day were 25% for 100% fruit juice and 36% for sugar-sweetened drinks. Daily SSBs intake is, unfortunately, higher than 100% FJ intakes. In general, the intake of 100% FJ and SSBs depends on the person’s preference, taste, and psychological state at the time of drinking or eating the meal. In addition, approximately 12% of individuals consume both beverages together (Table 3). Approximately 34% of those consuming one or more servings of SSB per day consume 100% FJ, while approximately 49% of those consuming one or more servings of 100% FJ consume SSB. The habit of consuming 100% FJs in those consuming SSBs is lower than the probability of consuming SSB in those consuming 100% FJs. In addition, the combined intake of both nutrients is very low (12%). Interestingly, it was surprising that those who consumed 100% FJ had a very high intake of SSB because those who consume 100% FJ are generally known as economically high-income people and individuals who are fond of their health. However, intervention initiatives are needed in the country to increase 100% FJ intake among artificial sweetener consumers as part of daily life in individuals and to mitigate each SSB intake.

Table 1. Means and VIF scores of dependent and explanatory variables

Variables	**Descriptive**	**Mean (SD)**	**VIF**
Dependent Variables			
100% FJ	The probability of consuming at least one or more 100% fruit juice per week	0.248 (0.432)	–
SSB	The probability of consuming at least one or more soft drink per week	0.358 (0.479)	–
Independent Variables			
Gender	1 if male, 0 otherwise	0.456 (0.498)	1.898
Married	1 if married, 0 otherwise	0.686 (0.464)	1.468
No school	1 if no school, 0 otherwise (reference group, r.g.)	0.128 (0.335)	–
Elementary school	1 if elementary school diploma,0 otherwise	0.329 (0.470)	2.532
Secondary school	1 if secondary school diploma,0 otherwise	0.174 (0.379)	2.253
High school	1 if high school diploma,0 otherwise	0.190 (0.392)	2.308
Community college	1 if a two-year community college, 0 otherwise	0.055 (0.227)	1.538
College	1 if college degree including post-graduate, 0 otherwise	0.125 (0.331)	2.295
Student & Military	1 if the individual is a student or in military service, 0 otherwise	0.076 (0.265)	–
Wage Job	1 if the person is payed, 0 otherwise	0.287 (0.453)	4.817
Employer	1 if the individual is the employer, 0 otherwise	0.095 (0.294)	2.859
Job seekers	1 if the person seeks a job, 0 otherwise	0.059 (0.235)	1.855
Retired	1 if retired, 0 otherwise	0.143 (0.350)	4.721
Housing job	1 if the person works as housewife, 0 otherwise	0.340 (0.474)	5.738
Normal weight	1 if the individual has a normal weight,0 otherwise (r.g.)	0.419 (0.494)	–

Overweight	1 if BMI > 25and BM I≤ 30, 0 otherwise	0.358 (0.479)	1.323
Obese	1 if BMI > 30and BMI ≤ 35, 0 otherwise	0.165 (0.371)	1.305
Morbidly obese	1 if BMI > 35, 0 otherwise	0.058 (0.235)	1.156
General health insurance	1 general health coverage, 0 otherwise	0.921 (0.270)	0.946
Private health insurance	1 pays health expenses out of pocket, 0 otherwise	0.037 (0.190)	1.125
Cycling	Cycling for 10 minutes at least a day a week, 0 otherwise	0.049 (0.216)	1.054
Walking <10 min	1 if the person walks less than 10 minutes on a normal day, 0 otherwise	0.171 (0.377)	–
Walking 10-29 min	1 if the person walks less than 10-29 minutes on a normal day, 0 otherwise	0.392 (0.488)	2.010
Walking 30-59 min	1 if the person walks less than 30-59 minutes on a normal day, 0 otherwise	0.269 (0.444)	1.949
Walking 1-2 hours	1 if a person walks for 1-2 hours on a normal day, 0 otherwise	0.118 (0.323)	1.566
Walking >2 hours	1 if the person walks for more than 2 hours on a normal day, 0 otherwise	0.050 (0.218)	1.291
Resting	1 if the person sits and rests less than 4 hours are a day, 0 otherwise	0.356 (0.479)	1.085
Light physical job	1 if the person works in a mostly sitting or standing job, 0 otherwise (r.g.)	0.636 (0.481)	–
Moderate physical job	1 if the person works in a job that often requires walking or moderate physical strength, 0 otherwise	0.323 (0.468)	1.146
Heavy physical job	1 if the person works in jobs that require heavy work or physical strength, 0 otherwise	0.040 (0.196)	1.131
Low income	1 household income less than 992₺, 0 otherwise	0.047 (0.211)	1.058
Middle income	1 household income between 992–8913₺, 0 otherwise (r.g.)	0.898 (0.303)	–
High income	1 household income greater than 8913₺, 0 otherwise	0.056 (0.229)	1.153
Eastern Anatolia	1 the Eastern Anatolia resident, 0 otherwise (r.g.)	0.072 (0.259)	–
Marmara	1 Marmara resident, 0 otherwise	0.284 (0.451)	3.164
Aegean	1 Central Aegean resident, 0 otherwise	0.055 (0.228)	1.575
Mediterranean	1 Mediterranean region resident, 0 otherwise	0.101 (0.301)	2.027
Black Sea	1 Black Sea region resident, 0 otherwise	0.284 (0.451)	3.144
Central Anatolia	1 Central Anatolia region resident, 0 otherwise	0.161 (0.368)	2.469
Southeastern Anatolia	1 Southeastern Anatolia region resident, 0 otherwise	0.042 (0.201)	1.447
Age	Age of the person in years	43.95 (17.67)	2.441
Sports Time	Time devoting sports on a day	0.264 (1.355)	1.054
Tobacco	Amount of packs used per day	0.223 (0.447)	1.193
Alcohol	Number of glasses used per day	1.800 (3.159)	1.246
Number of children under 7	The number of children between the ages of 0–6	0.343 (0.674)	1.248
Number of kids ages 7-14	The number of children between the ages of 7–14	0.434 (0.767)	1.113
Number of adults	The number of persons 15 years or older	2.561 (1.137)	0.963
# of individuals, # of families		17084	8166

Descriptive statistics of the model are given in Table 1. For example, if we talk about the averages of some independent variables; 45.6% of the individuals were male, 68.6% married, 12.5% four-year university graduates, 35.8% overweight, 16.5% obese, and 5.8% morbidly obese. The lowest income group (<992₺) makes up 4 percent, while the highest family income group (>8913₺) makes up about 5 percent of the survey. This information is extremely important in terms of eliciting the attitudes of the very poor and the very rich families towards their beverage consumption, which are two extreme values to form policies for the formation of ideal target groups in health. While individuals smoke 0.22 packs of cigarettes a day, they consume 1.8 glasses of alcohol. Individuals are on average 44 years old. While the family consists of approximately 3 adults, the average number of children under 7 and between the ages of 7 and 14 is 0.34 and 0.43, respectively. The calculated variance inflation factor (VIF) shows that there was no multicollinearity among the independent variables.

The estimates of the maximum likelihood function are presented in Table 2. The correlation coefficient (τ) showing the relationship between the intake decision of the two beverages was positive and statistically significant (Table 2). In this context, when uncontrollable factors affect the probability of 100% FJ intake, they probably also affect the probability of artificially sweetened beverage intake. The correlation coefficient (ρ), an indication of heterogeneity between the probability of 100% FJ intake and the probability of receiving artificially sweetened beverages, was negative and statistically significant. For example, heterogeneity in 100% FJ intake probability has an inverse effect on uptake probability heterogeneity of artificially sweetened beverages. Interestingly, the two food intake patterns are positively affected by uncontrollable variables among families, while negatively affected among family members. This is a very important result because the triggering of family members is different from the relationship between families. The Likelihood Ratio (LR) test (LR = 273.45, degrees of freedom (df) = 2, $p<0.000$) rejected the hypothesis that both correlation coefficients were jointly zero, meaning that the fit of the bivariate random effects probit model to the data was superior to the binary random effects probit models fitted to the data. Also, when the Lagrangian Multiplier (LM) test (LM= 1902.81, df=4, $p<0.000$) was used, the goodness of fit of the proposed bivariate random effects probit model outperformed the conventional bivariate probit model[2], which ignored all intra-familial heterogeneities. The following discussion will focus on the proposed model. Moreover, the overlap between the actual values and the estimated values at all calculated probabilities is strong evidence of the suitability of the method used in data analysis (Table 3).

Table 2. Maximum likelihood estimates from the panel random-effects bivariate probit model

Variable	**100% FJ**		**SSB**	
	Coefficient	**Standard Error**	**Coefficient**	**Standard Error**
Constant	-1.670 ***	0.136	0.691 ***	0.110
Gender	0.051	0.039	0.409 ***	0.035
Married	-0.086 **	0.037	-0.170 ***	0.032
Elementary school	0.237 ***	0.056	-0.226 ***	0.045
Secondary school	0.302 ***	0.067	-0.231 ***	0.054
High school	0.371 ***	0.064	-0.274 ***	0.053
Community college	0.368 ***	0.083	-0.453 ***	0.070
College	0.291 ***	0.073	0.494 ***	0.061
Wage Job	0.037	0.064	0.073	0.058
Employer	-0.080	0.078	0.013	0.067
Job seekers	-0.039	0.081	0.062	0.069
Retired	-0.013	0.087	0.056	0.076
Housing job	0.073	0.071	0.063	0.062
Overweight	-0.073 **	0.034	-0.004	0.030
Obese	-0.069	0.044	0.016	0.038
Morbidly obese	-0.138 **	0.069	0.104 *	0.058
General health insurance	-0.145 ***	0.052	-0.156 ***	0.045
Private health insurance	0.112	0.076	-0.142 **	0.068
Cycling	0.331 ***	0.059	0.042	0.054
Walking 10-29 min	-0.081 *	0.043	0.112 ***	0.036
Walking 30-59 min	-0.021	0.046	0.101 ***	0.039
Walking 1-2 hours	-0.065	0.055	0.073	0.047
Walking >2 hours	0.034	0.076	0.096	0.062
Resting	-0.099 ***	0.025	-0.006	0.026
Moderate physical job	0.095 ***	0.027	0.058 **	0.027
Heavy physical job	-0.029	0.063	0.078	0.063
Low income	-0.524 ***	0.061	-0.156 ***	0.060
High income	0.176 ***	0.055	0.193 ***	0.058
Marmara	0.779 ***	0.051	0.226 ***	0.052
Aegean	1.369 ***	0.070	-0.126 *	0.072

[2] The estimates of this model and their associated marginal effects are presented in the online appendix section. We refer the interested reader there.

Mediterranean	0.799 ***	0.059	0.001	0.061
Black Sea	0.549 ***	0.052	0.214 ***	0.052
Central Anatolia	0.360 ***	0.055	0.004	0.057
Southeastern Anatolia	0.155	0.075	0.188 **	0.073
Age	-0.007 ***	0.001	-0.034 ***	0.001
Sports Time	0.053 ***	0.009	-0.032 ***	0.008
Tobacco	-0.023	0.029	0.207 ***	0.029
Alcohol	-0.013 **	0.004	0.008 *	0.004
Number of children under 7	-0.002	0.021	0.006	0.020
Number of kids ages 7-14	-0.076 ***	0.017	-0.007	0.016
Number of adults	0.030	0.011	0.072 ***	0.011
σ^2	1.589 ***	0.025	1.065 ***	0.017
ρ	-0.304 ***	0.012	–	–
τ	0.245 ***	0.019	–	–

Note: *** p< 0.01, ** p< 0.05, * p< 0.10

The next discussionis presented in two groups; the first of which constituted statistically significant marginal impacts of discrete (e.g., binary) variables, while the second group included marginal effects of variables with statistical significance. Different marginal effects of socio-demographic, economic, and lifestyle factors of individuals and households that affect 100% FJ and SSB consumption probabilities are given in Table 3.

Focusing on the distinct marginal impacts of discrete variables; males are more likely than females to consume 100% FJ and SSB beverages, but the effect on 100% FJ intake is statistically insignificant. Also, very interestingly, when focusing on the comparison between the two drinks, men are almost 10 times more likely to consume SSB than 100% FJ. Similarly, while the joint (e.g., combined) intake of the two products is important, the intake of 100% fruit juices among SSB drinkers is unfortunately insignificant and negative. On the other hand, among 100% FJ intakers, unfortunately, they are more likely to consume sugar-sweetened beverages than a person randomly selected from the population is to consume a sugar-sweetened beverage (e.g., marginal). Such an attitude probably indicates that those who are addicted to consuming both beverages together see the product consumption as complementary rather than a substitute for each other and are in the habit of consuming both products, with the intake of sugar-sweetened beverages suppressing 100% FJ intake. Such results are consistent with expectations because more physically active men often need intense energy intake. But when looking at the glass half full, women are generally more health conscious than men and are more likely to consume fewer SSB drinks than men (Malisova et al., 2015; Pollard et al., 2016), but given the fact that their intake of 100% FJ is less than men, the importance of adequate 100% FJ intake should be emphasized in some educational programs such as basic education curricula, pregnancy follow-up health institutions, and TV health talks. Our findings are also in agreement with international findings, which Barrett et al. (2017) reported that the daily prevalence of SSB was positively associated with being male in the United Kingdom, while, on the other hand, the average frequency of juice intake in women is lower than in men (Rosinger et al., 2017; Heng et al., 2019).

As compared to their unmarried peers, married individuals are less likely to consume both beverages in all explored segments, but only 100% FJ consumers are statistically insignificant among sugar-sweetened drinkers. Interestingly, in the choice between two food consumptions, married individuals consumed almost two and a half times less SSB beverages (-4.27%) compared to 100% fruit juices (-1.42%), while among 100% FJ drinkers, they consume less artificially sweetened drinks (-4.39%), but the good news is that they stay away from sugar-sweetened beverages, even if only slightly. Contrary to our findings, single individuals were found to be unrelated to SSB consumption (Mullie et al., 2012; Barrett et al., 2017), while in India, widowed/divorced/separated individuals were less likely to consume aerated drinks than married individuals (Mathur et al., 2020). As a counterfactual analysis, when evaluated with their married peers, unmarried individuals especially never-married peers are likely freer to consume both food types as they are freer in terms of economic constraints and food consumption behavior.

Table 3. Marginal effects of explanatory variables on drinking one or more servings of 100% FJ and SSB in Turkey using the bivariate random-effects probit model

Variable|	**Prob(y1=1)**		**Prob(y2=1)**		**Prob (y1=1, y2=1)**		**Prob (y1=1|y2=1)**		**Prob (y2=1|y1=1)**	
	ME*100	**Std. Err.**	**ME*100**	**Std. Err.**	**ME*100**	**Std. Err.**	**ME*100**	**Std. Err.**	**ME*100**	**Std. Err.**
Gender	0.846	0.642	10.846 ***	0.880	3.089 ***	0.369	-0.793	0.780	11.185 ***	0.976
Married	-1.422 **	0.614	-4.272 ***	0.803	-1.715 ***	0.341	-0.935	0.729	-4.390 ***	0.890
Elementary school	3.927 ***	0.925	-5.663 ***	1.138	0.068	0.495	5.632 ***	1.120	-7.234 ***	1.281
Secondary school	5.014 ***	1.102	-5.807 ***	1.360	0.468	0.594	6.944 ***	1.330	-7.659 ***	1.524
High school	6.153 ***	1.064	-6.885 ***	1.329	0.638	0.576	8.479 ***	1.285	-9.132 ***	1.495
Community college	6.111 ***	1.369	-11.368 ***	1.767	-0.578	0.750	9.211 ***	1.663	-14.091 ***	1.981
College	4.835 ***	1.204	-12.389 ***	1.523	-1.365 **	0.657	7.881 ***	1.465	-14.912 ***	1.712
Wage Job	0.612	1.057	1.838	1.445	0.738	0.608	0.403	1.246	1.889	1.592
Employer	-1.331	1.292	0.314	1.691	-0.452	0.724	-1.629	1.525	0.673	1.869
Job seekers	-0.653	1.344	1.546	1.732	0.151	0.741	-1.042	1.594	1.873	1.922
Retired	-0.212	1.451	1.411	1.896	0.292	0.809	-0.496	1.717	1.616	2.099
Housing job	1.211	1.183	1.568	1.551	0.907	0.666	1.159	1.395	1.443	1.711
Overweight	-1.203 **	0.562	-0.106	0.740	-0.513 *	0.314	-1.405 **	0.666	0.175	0.818
Obese	-1.137	0.727	0.390	0.954	-0.354	0.407	-1.412 *	0.859	0.710	1.055
Morbidly obese	-2.291 **	1.150	2.618 **	1.450	-0.223	0.622	-3.167 **	1.371	3.461 **	1.616
General health insurance	-2.406 ***	0.870	-3.912 ***	1.141	-2.016 ***	0.481	-2.162 **	1.035	-3.751 ***	1.269
Private health insurance	1.863	1.258	-3.562 **	1.701	-0.202	0.698	2.825 **	1.505	-4.403 **	1.896
Cycling	5.496 ***	0.985	1.044	1.361	2.494 ***	0.578	6.317 ***	1.156	0.182	1.496
Walking 10-29 min	-1.352 **	0.713	2.817 ***	0.910	0.209	0.389	-2.090 ***	0.849	3.452 ***	1.013
Walking 30-59 min	-0.343	0.764	2.543 ***	0.986	0.542	0.420	-0.850	0.908	2.903 ***	1.095
Walking 1-2 hours	-1.073	0.911	1.833	1.181	0.058	0.501	-1.589	1.081	2.293 *	1.312
Walking >2 hours	0.562	1.258	2.418	1.566	0.873	0.695	0.242	1.481	2.544	1.727
Resting	-1.636 ***	0.491	-0.150	0.651	-0.699 ***	0.278	-1.909 ***	0.580	0.233	0.720
Moderate physical job	1.581 ***	0.522	1.455 **	0.656	1.026 ***	0.292	1.615 ***	0.618	1.228	0.758
Heavy physical job	-0.487	1.258	1.957	1.571	0.327	0.695	-0.917	1.483	2.288	1.734
Middle income	-8.698 ***	1.293	-3.922 ***	1.510	-4.553 ***	0.688	-9.601 ***	1.531	-2.229 ***	1.685
High income	2.921 ***	1.050	-4.831 ***	1.452	-0.115	0.615	4.297 ***	1.237	-6.067 ***	1.593
Marmara	12.938 ***	1.081	5.677 ***	1.303	6.731 ***	0.586	14.309 ***	1.287	3.142 **	1.467
Aegean	22.732 ***	1.358	-3.153 **	1.796	8.316 ***	0.792	27.434 ***	1.647	-9.033 ***	2.023
Mediterranean	13.266 ***	1.229	0.009	1.533	5.348 ***	0.678	15.687 ***	1.469	-3.222 **	1.716
Black Sea	9.120 ***	1.092	5.375 ***	1.304	5.112 ***	0.585	9.848 ***	1.296	3.736 ***	1.459
Central Anatolia	5.975 ***	1.181	0.094	1.422	2.433 ***	0.636	7.050 ***	1.402	-1.351	1.582

Variable|	Prob(y1=1)		Prob(y2=1)		Prob (y1=1, y2=1)		Prob (y1=1|y2=1)		Prob (y2=1|y1=1)	
	ME*100	**Std. Err.**	**ME*100**	**Std. Err.**	**ME*100**	**Std. Err.**	**ME*100**	**Std. Err.**	**ME*100**	**Std. Err.**
Southeastern Anatolia	2.573	1.619	4.722 ***	1.842	2.299 ***	0.848	2.218	1.917	4.608 ***	2.050
Age	-0.113 ***	0.024	-0.842 ***	0.032	-0.271 ***	0.014	0.013 ***	0.031	-0.905 ***	0.036
Sports Time	0.879 ***	0.162	-0.783 ***	0.210	0.145 **	0.088	1.176 ***	0.196	-1.082 ***	0.236
Tobacco	-0.374	0.572	5.187 ***	0.723	1.237 ***	0.311	-1.348 **	0.686	5.842 ***	0.806
Alcohol	-0.208 ***	0.083	0.207 **	0.109	-0.029	0.047	-0.282 ***	0.098	0.280 ***	0.121
Number of children under 7	-0.031	0.402	0.148	0.491	0.027	0.216	-0.062	0.477	0.171	0.546
Number of kids ages 7-14	-1.264 ***	0.338	-0.170	0.406	-0.555 ***	0.182	-1.466 ***	0.401	0.120	0.452
Number of adults	0.497 **	0.216	1.814 ***	0.283	0.686 ***	0.120	0.271	0.257	1.890 ***	0.314
Actual/Expected probability values	0.247/0.247		0.356/0.366		0.119/0.119		0.333/0.332		0.466/0.466	

Note: *** p< 0.01, ** p< 0.05, * p< 0.10. ME shows marginal effects.

As expected, there is a positive relationship between the education levels of individuals and the odds of 100% FJ intake, and a negative relationship between SSB beverages. As the education levels of individuals increase, the rate of benefiting from 100% FJ drink increases, on the contrary, increasing education levels prevent the individual from consuming artificially sweetened drinks. For example, when compared to individuals randomly selected from the population (e.g., marginal probabilities) without holding a diploma; individuals holding a primary, secondary, high school, or undergraduate degree were found to consume 3.93%, 5.01%, 6.15%, 6.11% and 4.84% more 100% FJ, and 5.66%, 5.81%, 6.89%, 11.37%, and %12.39 less SSB, respectively. While 100% FJ shows a regular increase in the gradual increase in education level, there is almost a double fall in sugar-sweetened beverages, especially in the transition to university. While the joint intake of the two products appears to be statistically insignificant, 100% FJ intake among customers of sugar-sweetened beverages increases with increasing education levels, which are more than 100% FJ intakes of a randomly selected individual (e.g., marginal) from the population. (e.g., marginal). On the other hand, there are incredibly low intake of sugar-sweetened beverages among intakers of %100 FJ, which is lower than the levels of sugar-sweetened beverages in a randomly selected individual from the population (e.g., marginal). Consistent with the above findings, there is an almost five-point drop in artificially sweetened beverages at the transition to tertiary education, particularly among those who receive 100% FJ. Such results infer that the level of impact will boost if students are given elective courses on the effects of artificial foods on human health in higher education curricula. Our findings also accord with the results reported in the literature. Participants with higher education levels had a significantly lower prevalence of SSB consumption at all-time points compared to participants with lower education levels (Barrett et al., 2017; Bolt-Evensen et al., 2018). Also, it has been reported that individuals with a parent in California with an education level beyond a high school diploma are less likely to consume any SSB (Beck et al., 2013). However, when evaluating organic beverages, education level has a positive effect on organic food consumption (Stobbelaar et al., 2007; Hassan et al., 2009). In a study on children and adults in the United States, the highest levels of whole fruit intake were also associated with higher education, compared with other education groups. The studies conducted by Terin et al. (2019) and Küçük et al. (2023) have also yielded congruent results, thereby providing additional empirical support for the previously mentioned findings. In contrast, 100% FJ consumption did not show a strong positive change in education, although a 100% FJ association with higher education was only reported among older adults (Drewnowski and Rehm, 2015).

Interestingly, intake of 100% FJ decreases as body mass index (BMI) levels increase in individuals, while intake of artificially sweetened beverages increases excessively, especially in morbidly obese individuals. On the other hand, while the intake of 100% FJ decreases with increasing body mass index levels in artificially sweetened beverage intakers, unfortunately, the probability of consumption of artificially sweetened beverages peaks among 100% FJ consumers, especially in morbidly obese individuals. Although excessive consumption of artificial and naturally occurring sugary beverages is inevitable to cause excess weight (Rampersaud, 2007; Hebden et al., 2017; Rampersaud and Valim, 2017), increased BMI levels will trigger the consumption of artificial sweeteners in particular. The presence of a negative relationship between 100% FJ consumption and obesity is consistent with literature studies. For example, Wang et al. (2012) reported that among US adults who participated in a cross-sectional NHANES survey, pure orange juice consumers had a lower BMI, waist circumference, and body fat percentage than non-consumers. 100% FJ consumers were also reported to be at lower risk for obesity and metabolic syndrome compared to non-consumers (Pereira and Fulgoni, 2010). On the other hand, Barrett et al. (2017) reported that obese or overweight adults were more likely to consume SSB than normal-weight adults in the United Kingdom. A cohort study among young children in the USA found a negative relationship between 100% FJ intake and BMI (Skinner and Carruth, 2001), which is consistent with previous studies (Skinner et al., 1999). High levels of SSB consumption are a well-recognized risk factor for obesity (Stanhope et al., 2018). Peer-reviewed literature studies collectively indicate that 100% FJ intake does not contribute to clinically significant weight gain (O'Neil et al., 2012; Crowe-White et al., 2016; Auerbach et al., 2017), does not cause dental caries (Nicklas et al., 2015) and nor did it show any compromise in total dietary fiber intake in children or adults (O'Neil et al., 2012). Taking into account the negative effects of SSB on human health, daily consumption of recommended amounts of 100% FJ can be encouraged and consumption of SSB can be reduced with the introduction of policies discouraging SSB consumption, including negative taxation policies and marketing restrictions for children. Furthermore, authorized health institutions can develop policies for transmitting awareness on the effects of SSB on excess calorie intake and obesity to children and parents. For example, these topics can be frequently covered in printed and visual media as well as in school curricula. Moreover, businesses in the beverage industry can affect the preferences of individuals by sending messages regarding the positive aspects of 100% FJ and negative aspects of SSB (e.g., SMS to mobile phones, emails, regular postal mails, etc.) or by cooperating with the workplaces of individuals (e.g., offering 100% FJ at their lunches as promotions).

Individuals with general health insurance were 2.41% and 3.91% less likely to consume 100% FJ and SSB, respectively, compared to individuals without any social security. Such a result is expected since the income level of the families covered by the general health insurance is relatively low. In this context, a program, similar to the Special Supplementary Nutrition Program for Women, Infants, and Children (WIC) implemented in the United States, should be adopted and implemented nationwide, aiming at providing grants for food, health services, and nutrition education for low-income, pregnant, lactating, or non-lactating postpartum women, infants, and children who are up to the age of five and identified as at risk of malnutrition. On the other hand, private health insurance was found to have a positive but insignificant effect on 100% FJ intake whereas it was negative and significant on SSB intake. On the other hand, the probability of consuming two drinks together decreases with general health insurance (2.02 points), while the probability of 100% FJ intake among drinkers of SSB (2.16 and 2.83 points) increases with individuals with general and private health insurance. A similar result occurred for the probability of artificially sweetened drinks among drinkers of 100% FJ (3.75 and 4.40 points, respectively), but the effect here was greater than among drinkers of SSB. Considering that the individuals in the private health insurance group are of a highly educated and ultimately high-income segment, the results are in line with the expectations. Intrusive policies are needed to discourage this group of people from consuming artificially sweetened beverages. Perhaps insurance companies can act as a deterrent by raising the payment premium to discourage such people from consuming these beverages.

While those who cycle for more than 10 minutes a day are more likely to drink both foods (5.50% and 1.04%, respectively) with an insignificant effect on the artificial drink, likely because they may want to compensate for the energy losses from overloading their muscles with these drinks. In addition, the probability of taking both foods together (2.49%) and the probability of 100% FJ intake among those who consume artificial drinks (6.32%) increase with those who cycle for more than 10 minutes a day. As can be deducted from the results, 100% FJ consumption among artificially sweetened drinkers is higher than 100% FJ consumption of a randomly selected individual from the population, which increases the consumption of the other food product (% FJ intake) when the individual becomes familiar with the beverages (SSB intake), vice versa. However, interestingly, while the probability of 100% FJ intake decreases for those who prefer walking for 10-30 minutes a day, the likelihood of intake of artificial drinks increases by 2.82 and 2.54 percent points, respectively, for both individuals in this group and those who perform daily walking for 30-60 minutes. Similarly, among those who consume artificial drinks, 100% FJ intake decreases with those who walk for 10-30 minutes a day, while those who prefer 10-30, 30-60 minutes, and 1-2 hours of walking daily have a probability of consuming artificial beverages among those who intake 100% FJ by 3.45, 2.90, and 2.29 percent points, respectively, but such an increase is inversely proportional to walking time, increasing walking time progressively decreasing the probability of consuming artificial drinks in those taking 100% FJ. These results indicate that the likelihood of consumption of sugar-sweetened beverages will decrease as they are provided with more walking tracks built by municipalities in appropriate places in cities.

On the other hand, individuals who rest less than four hours a day were found to be 1.64% less likely to consume 100% FJ. The probability of consuming the two foods together and the probability of 100% FJ intake among the drinkers of artificially sweetened beverages decreased by 0.70 and 1.91 points, respectively, the latter reduction being more affected than that of the probability of 100% FJ intake of a randomly selected individual from the population. Unfortunately, such individuals with workaholics are facing balanced nutrition issues due to their high opportunity cost of time and the low possibility of rest. While our results are consistent with previous findings that higher levels of sedentary behavior are associated with higher SSB consumption (Pengpid and Peltzer, 2019), Barrett et al. (2017) reported that physical activity can compel adults to consume more sports/energy, i.e. SSBs. On the other hand, individuals with moderate physical activity are likely to increase the odds of 100% FJ and artificially sweetened beverage intake by 1.58 and 1.46 percent points, respectively, while the probabilities of taking two foods together and 100% FJ of artificially sweetened beverage consumers are likely to increase by 1.03 and 1.62 percent points, respectively. The prospect of replenishing the tired body with energy drinks is likely to lead to such consequences. To prevent excess calories stored in the body, the prohibition of serving carbonated beverages at meals especially to the companies where these people work or to their bosses can be considered an intrusive preventive factor.

Compared to residents of Eastern Anatolia, individuals residing in all six other regions in Turkey are more likely to consume 100% FJ, but the effect in Southeastern Anatolia is statistically insignificant. While the residents of the Aegean region lead the way in consuming more of this food, Mediterranean and Marmara residents follow respectively, which is almost twice as much as the intake of the people in the other two regions. These regions generally have a more intense and relatively higher income level than other regions in terms of industry, service, and agriculture sectors. On the other hand, the difference between regions is somewhat complicated in terms of SSB uptake probability. Compared to people in Eastern Anatolia; while those in Marmara, Black Sea, and Southeastern Anatolia consume more, interestingly, Aegean people are less likely to consume it. In the joint probability of taking the two foods, all six regions consume more, while 100% FJ intake probabilities among SSB drinkers are all positive; the probabilities of SSB uptake among 100% FJ users are positive in Marmara, Black Sea, and Southeastern Anatolia, while the remaining regions have negative uptake. In addition, 100% FJ intake probabilities among SSB smokers were found to be higher than the 100% FJ intake probabilities of a randomly selected individual. In cases where some consumers fail to meet the recommended daily fruit intake due to economic, socio-cultural, or climatic conditions, increasing or facilitating access to 100% FJ, which plays an important role in reaching daily fruit consumption targets, may play an important role in compensating this situation.

When focusing on the probability of two food purchases for families in two extreme groups in income; as compared to medium-income families, low-income families consumed less in all explored probabilities, while 100% FJ intakes were nearly twice as low in all probabilities than sugar-sweetened foods. In this low-income group, they are also less likely to consume the two foods together (joint probability) and less likely to consume one food given the intake of the other (conditional probability), but least likely to consume 100% FJ among SSB consumers as compared to other probabilities. This finding is most likely due to low-income people purchasing their beverages at relatively lower prices, such as SSB. The relative solid uptake probability of artificial sweetener drinks among 100% FJ users confirms this assertion. Despite these findings, higher-income families are more likely to consume 100% FJ, while sugar-sweetened beverages are less likely to be consumed, as expected. It is noteworthy that the probability of drinking sugar-sweetened beverages is particularly low among 100% FJ users. Also, among users of artificially sweetened beverages, those with 100% FJ intake were almost twice as likely as a randomly selected individual from the population. This is also in line with expectations because 100% FJ is relatively more expensive and may constitute a large proportion of food expenditure in low-income families, but such a ratio is negligible in high-income families. The percentage of 100% FJ consumers increases with the level of education and income (Bellisle et al., 2018). Unfortunately, children of parents with higher income tend to consume higher amounts of SSB (Vereecken et al., 2005; Van Lippevelde et al., 2013), whereas the prevalence of SSB in England is linked to lower household income (Barrett et al., 2017).

When focusing on statistically significant continuous variables; although there is an inverse relationship between the age of individuals and the probability of consumption of both 100% FJ and SSB (0.11% and 0.84%, respectively), the SSB consumption probability is approximately 7.5 times less than that of 100% FJ. The result is in line with the expectations that individuals avoid consuming SSB more than 100% FJ intake as they get older. Interestingly, 100% FJ intake increases among users of artificially sweetened beverages (0.01%), but the probability of intake of artificially sweetened beverages decreases (0.91%) further among users of 100% FJ beverages, while the joint intake of the two foods decreases (0.27%) as the individual ages. More likely, as people age, diseases become more prominent and health-consciousness prevails, making it more tempting to avoid the hazardous product. Such avoidance behavior is replaced by milk and dairy products such as yogurt and ayran , tea, local hot drinks, homemade fruit juices, and/or herbal drinks. That an inverse relationship was found between age and juice consumption in South Korean adults (Choi et al., 2019) and that 100% FJ consumption is higher in the young compared to the elderly were reported (Bellisle et al., 2018). It is known that energy and sugar intake decreases with age in adults (Ervin and Ogden, 2013). The fact that individuals in these groups are more likely to consume 100% FJ may be due to age-related inactivity or the reasons mentioned above. Reducing consumption in individuals with SSB habits, a reasonable daily recommended intake of FJs, especially for elderly individuals, may be recommended, and follow-up by physicians in health centers may reduce associated health risks.

As the time spent on daily sports increases by one minute, the probability of consuming FJ increases (0.88%), while the probability of taking artificially sweetened drinks decreases (0.78%). On the other hand, the probability of taking both foods together (0.15%) and the probability of consuming 100% FJ in users of artificially sweetened drinks increase (1.18%), while the probability of taking artificially sweetened beverages decreases (1.08%) in users of 100% FJ beverages. The two conditional probabilities are higher than the probabilities of choosing a randomly selected individual from the population. A pleasing finding is that as time spent on sports increases, FJ intake increases and SSB intake decreases. However, positive FJ uptake among SSB users and negative SSB uptake among FJ users are also desirable. It may be possible to achieve even more desirable results when the importance of doing sports is prioritized in all basic school curricula, educational TV talks, health centers, and rehabilitation centers. While our results are consistent with previous findings that higher levels of sedentary behavior are associated with higher SSB consumption (Pengpid and Peltzer, 2019), Barrett et al. (2017) reported that physical activity can compel adults to consume more sports/energy, i.e. SSBs.

Smokers are more likely to consume SSB (5.19% percent points), whereas the probability of two foods being consumed together increases (1.24 percentage points), individuals who are consumers of SSB consume less %100 FJ (1.35%) but who are drinkers of %100 FJ consume more SSB (5.84%), all these findings imply that smokers are consumers of SSB in general, with 100% FJ intake being secondary. On the other hand, alcohol users are less likely to consume %100 FJ (0.21%) but more SSB (0.21%) products. Similarly, the probability of taking 100% FJ decreases among SSB users (0.28%), while the probability of consuming SSB increases among 100% FJ users (%0.28%), suggesting that alcohol users are more prone to SSB and probably use these beverages with appetizers, along with alcohol use. As Barrett et al. (2017) stated, mixed consumption of both products by alcoholics may have resulted from the substitution effect. This behavior may be influenced by the type of alcoholic beverages, in some of which SSB is also used as a mixer. A positive relationship was also obtained between the frequency of 100% FJ consumption and the ratio of current smokers or those who use alcohol (Choi et al., 2019). However, Barrett et al. (2017) reported that current smoking was associated with a greater likelihood of consuming SSB daily compared to non-smokers, who avoid consuming SSB and other products perceived unhealthy to ‘compensate’ for their smoking in the United Kingdom. Since one of the most unpretentious groups for 100% FJ is individuals who consume alcohol, the health threats posed by SSB consumption should be well understood by family members and transferred to these individuals.

A negative relationship was found between the number of children aged 7-14 in households and the probability of consuming at least one portion of 100% FJ a week (1.26%), whereas a positive but statistically insignificant relationship was found between the SSB consumption probability. Those in this group were similarly less likely to both consume the two foods together (0.55%) and ingest 100% FJ among consumers of the sugar-sweetened beverage (1.46). It is expected that both the increasing number of children being an additional economic burden on the family and 100% FJ being relatively expensive among their peer beverages will ultimately negatively affect the consumption probability. Children in this group may drink more energy-type drinks due to their developmental and adolescence age, spending more time with their peers, going to school, and similar activities. Since parents still have a chance as to what beverage these children will consume, they can, in general, help their children eat more balanced diets if they provide their children with the recommended daily amounts. Our results are also in line with previous studies, e.g., in the UK, Barrett et al. (2017) found that parents living with their children are more likely to be SSB consumers than households that do not. On the other hand, an additional number of adults in the family increases the probability of both 100% FJ (0.50 percent points) and artificially sweetened beverage intake (1.81 percent points). Likewise, the probability of taking the two drinks together (0.69%) and the probability of taking artificially sweetened drinks (1.89%) increase among the 100% FJ drinkers. The probability of ingesting SSB is almost 4.5 times higher than the probability of consuming 100% FJ, and the probability of ingesting SSB is the highest among 100% FJ intakers. In this context, the inclusion of an additional adult in the family will first trigger the intake of SSB and then increase the intake of 100% FJ. Healthcare organizations targeting family-based beverage planning can act as a deterrent in mitigating SSB consumption through events such as visual and print media, TV talks, health conferences, or by envisaging higher taxes on SSB beverages by the government.

CONCLUSION

As it is very likely that households are very likely to purchase 100% FJ and SSB together and consume both at one meal, the probabilities of both beverages need to be jointly analyzed. In addition, the evolution of heterogeneity among family members to a certain scale value increases the reliability of the obtained parameters. The correlation between the consumption probabilities of the two food types and the correlation between the heterogeneities being non-zero simultaneously and statistically significant suggests the consideration of the consumption probabilities of both foods in one system simultaneously, which supports the appropriateness of the use of random-effects bivariate probit model.

The idea that socio-demographic, economic, and daily lifestyle factors such as walking, doing sports, and working style of individuals in a household have a very important effect as predictors of 100% FJ and SSB consumption is supported by the findings of the present study. In addition, the likelihood of consuming more or less another food while an individual is an ordinary consumer of other beverages was also obtained as a new finding in this study. In particular, as a new type of finding, it was elicited for the first time in this study that when the individual is a regular consumer of artificially sweetened beverages, the probability of 100% FJ intake is much higher or much lower than the probability of 100% FJ intake of a randomly selected individual from the population. In this context, we can expect that the implementation of distinct intervention health programs that will involve different population segments will contribute greatly to the development of ideal outcomes.

Although it is not fully known whether excessive intake of SSBs is more harmful than excessive intake of energy from other sources, the effect of SSBs, in general, is an expected result of the development of both obesity and associated comorbidities as a result of the excess calories provided by their consumption. The effect of SSBs appears to be a result of the excess calories provided by their consumption. While the effect of excessive intake of SSBs on weight gain and the development of related comorbidities was evident in the previous parts of this study, the current study was the first to elicit how SSB consumption was in overweight individuals. Especially in morbidly obese individuals, due to the increase in both SSB intakes and very high SSB intakes among 100% FJ consumers, SSB intakes combined with 100% FJ intakes will inevitably lead to excessive obesity. Therefore, interventionist programs should be developed as measures to ensure a reasonable intake of 100% FJ in the country and reduce the consumption of SSBs can mitigate weight gain and obesity in the long run in the country. In addition, if individuals take reasonable or recommended daily amounts in line with the recommendations of the World Health Organization, a micronutrient supply can be achieved due to the vitamins, minerals, and bioactive compounds contained in the fruit juice. On the other hand, since the consumption probability of SSBs will increase in middle-income families, the consumption level of these beverages can be eliminated by additional "sin taxes" by governments, or educational programs can be developed to increase the consciousness level of households or individuals in this group to curb the consumption of SSBs. Similarly, since the presence of tobacco and alcohol use in the family triggers the consumption of SSBs, two-way programs should be developed such as restricting the consumption of both these products and SSBs. In addition, since the presence of additional adults in the family is a trigger for SSBs, family planning or health professionals in the relevant units, recommending solid fruit, national products such as yogurt and ayran consumption instead of SSBs and fruit juice will prevent individuals from cutting unnecessary calories from their diets and avoiding high-energy-dense foods. Also, arranging suitable walking courts to include parking areas for vehicles and playgrounds for children in the city center, which may make it more attractive for sports activities, may cause the SSBs to decline to the desired level in the country.

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YAZAR ORCID NUMARALARI

Faruk URAK https://orcid.org/0000-0002-2592-0589

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Appendix

Table A1. Maximum likelihood estimates from the bivariate probit model

Variable	**100% FJ**		**SSB**	
	Coefficient	**Standard Error**	**Coefficient**	**Standard Error**
Constant	-0.798 ***	0.101	0.268 ***	0.094
Gender	0.034	0.029	0.262 ***	0.029
Married	-0.004	0.028	-0.106 ***	0.027
Elementary school	0.143 ***	0.041	-0.188 ***	0.037
Secondary school	0.196 ***	0.049	-0.211 ***	0.046
High school	0.257 ***	0.048	-0.252 ***	0.044
Community college	0.287 ***	0.062	-0.383 ***	0.059
College	0.227 ***	0.054	0.407 ***	0.051
Wage Job	-0.001	0.051	0.132 ***	0.050
Employer	-0.054	0.061	0.080	0.059
Job seekers	-0.030	0.061	0.107 *	0.060
Retired	-0.016	0.066	0.104	0.064
Housing job	0.040	0.055	0.096 *	0.053
Overweight	-0.034	0.025	-0.018	0.025
Obese	-0.065 **	0.033	-0.010	0.032
Morbidly obese	-0.092 *	0.050	0.070	0.047
General health insurance	-0.167 ***	0.040	-0.154 ***	0.039
Private health insurance	0.103 *	0.057	-0.058	0.058
Cycling	0.250 ***	0.047	0.028	0.049
Walking 10-29 min	-0.080 **	0.032	0.089 ***	0.031
Walking 30-59 min	-0.045	0.034	0.078 **	0.033
Walking 1-2 hours	-0.062	0.042	0.025	0.040
Walking >2 hours	0.016	0.056	0.069	0.053
Resting	-0.086 ***	0.023	-0.006	0.022
Moderate physical job	0.057 **	0.024	0.037	0.023
Heavy physical job	-0.028	0.057	0.079	0.054
Middle income	-0.253 ***	0.057	-0.059	0.050
High income	0.028	0.049	-0.148 ***	0.050
Marmara	0.381 ***	0.048	0.126 ***	0.044
Aegean	0.725 ***	0.061	-0.101 *	0.061
Mediterranean	0.405 ***	0.055	-0.030	0.052
Black Sea	0.276 ***	0.049	0.108 **	0.044
Central Anatolia	0.192 ***	0.053	-0.014	0.048
Southeastern Anatolia	-0.005	0.072	0.050	0.063
Age	-0.003 ***	0.001	-0.024 ***	0.001
Sports Time	0.029 ***	0.007	-0.020 ***	0.007
Tobacco	-0.026	0.026	0.174 ***	0.025
Alcohol	-0.015 ***	0.004	0.007 *	0.004
Number of children under 7	0.000	0.018	0.005	0.017
Number of kids ages 7-14	-0.042 ***	0.015	-0.019	0.014
Number of adults	0.005	0.010	0.048 ***	0.010
τ	0.245 ***	0.019	–	–

Note: *** p< 0.01, ** p< 0.05, * p< 0.10.

Table A2. Marginal effects of explanatory variables on drinking one or more servings of 100% FJ and SSB in Turkey using the bivariate probit model

Variable|	Prob (y1 = 1)		Prob (y2 = 1)		Prob (y1 = 1, y2 = 1)		Prob (y1 = 1|y2 = 1)		Prob (y2 = 1|y1 = 1)	
	ME*100	Std. Err.	ME*100	Std. Err.	ME*100	Std. Err.	ME*100	Std. Err.	ME*100	Std. Err.
Gender	1.066	0.914	9.621 ***	1.056	3.027 ***	0.511	-0.575	1.082	10.437 ***	1.159
Married	-0.127	0.874	-3.876 ***	1.000	-1.095 **	0.477	0.594	1.039	-4.286 ***	1.107
Elementary school	4.456 ***	1.266	-6.924 ***	1.373	-0.033	0.667	6.675 ***	1.522	-8.910 ***	1.538
Secondary school	6.110 ***	1.541	-7.746 ***	1.672	0.425	0.823	8.815 ***	1.844	-10.270 ***	1.862
High school	8.021 ***	1.486	-9.248 ***	1.623	0.806	0.794	11.396 ***	1.785	-12.456 ***	1.812
Community college	8.959 ***	1.931	-14.077 ***	2.181	-0.109	1.047	13.449 ***	2.317	-18.089 ***	2.429
College	7.064 ***	1.683	-14.967 ***	1.859	-1.126	0.907	11.349 ***	2.022	-18.572 ***	2.068
Wage Job	-0.008	1.588	4.841 ***	1.837	1.299	0.898	-0.941	1.862	5.397 ***	2.002
Employer	-1.668	1.914	2.921	2.172	0.101	1.067	-2.562	2.252	3.702	2.375
Job seekers	-0.936	1.913	3.923 **	2.187	0.672	1.050	-1.877	2.270	4.623 **	2.415
Retired	-0.501	2.046	3.822	2.362	0.823	1.135	-1.336	2.420	4.393	2.598
Housing job	1.235	1.701	3.518 **	1.950	1.454	0.952	0.803	2.000	3.590 *	2.131
Overweight	-1.049	0.793	-0.646	0.905	-0.605	0.434	-1.133	0.942	-0.439	1.000
Obese	-2.035 **	1.034	-0.375	1.174	-0.936 *	0.567	-2.367 **	1.225	0.128	1.295
Morbidly obese	-2.860 **	1.565	2.574	1.731	-0.482	0.830	-3.924 **	1.875	3.635 **	1.935
General health insurance	-5.199 ***	1.240	-5.662 ***	1.431	-3.658 ***	0.680	-5.142 ***	1.474	-4.917 ***	1.584
Private health insurance	3.233 **	1.772	-2.123 **	2.118	0.757	0.973	4.284 **	2.118	-3.232	2.356
Cycling	7.811 ***	1.457	1.015	1.787	3.481 ***	0.841	9.167 ***	1.712	-0.962	1.954
Walking 10-29 min	-2.507 **	0.997	3.259 ***	1.132	-0.153	0.540	-3.633 ***	1.189	4.304 ***	1.257
Walking 30-59 min	-1.398	1.070	2.846 ***	1.223	0.192	0.581	-2.224 *	1.275	3.547 ***	1.357
Walking 1-2 hours	-1.939	1.299	0.904	1.475	-0.553	0.706	-2.499	1.545	1.527	1.634
Walking >2 hours	-0.499	1.749	2.538	1.953	0.467	0.967	-1.086	2.059	2.962	2.138
Resting	-2.685 ***	0.715	-0.224	0.819	-1.163 ***	0.395	-3.175 ***	0.846	0.470	0.902
Moderate physical job	1.786 ***	0.744	1.376	0.861	1.104 ***	0.413	1.876 **	0.880	1.055	0.948
Heavy physical job	-0.857	1.783	2.900	1.979	0.429	0.977	-1.585	2.106	3.461	2.174
Middle income	-7.875 ***	1.777	-2.169	1.851	-3.818 ***	0.944	-9.022 ***	2.108	-0.308	2.049
High income	0.866	1.513	-5.457 ***	1.834	-1.113	0.890	2.089*	1.757	-6.314 ***	1.976
Marmara	11.871 ***	1.501	4.576 ***	1.611	6.107 ***	0.796	13.349 ***	1.793	1.919	1.802
Aegean	22.591 ***	1.906	-3.705 *	2.243	8.282 ***	1.101	27.794 ***	2.250	-10.182 ***	2.453
Mediterranean	12.632 ***	1.707	-1.118	1.898	4.887 ***	0.927	15.357 ***	2.034	-4.630 **	2.108
Black Sea	8.596 ***	1.515	3.970 ***	1.612	4.599 ***	0.800	9.540 ***	1.809	2.121	1.800
Central Anatolia	5.993 ***	1.637	-0.508	1.764	2.325 ***	0.875	7.282 ***	1.949	-2.172	1.959

Variable|	**Prob (y1 = 1)**		**Prob (y2 = 1)**		**Prob (y1 = 1, y2 = 1)**		**Prob (y1 = 1|y2 = 1)**		**Prob (y2 = 1|y1 = 1)**	
	ME*100	**Std. Err.**	**ME*100**	**Std. Err.**	**ME*100**	**Std. Err.**	**ME*100**	**Std. Err.**	**ME*100**	**Std. Err.**
Southeastern Anatolia	-0.156	2.258	1.801	2.298	0.420	1.163	-0.534	2.700	2.049	2.573
Age	-0.089 ***	0.033	-0.890 ***	0.037	-0.276 ***	0.018	0.065	0.040	-0.968 ***	0.041
Sports Time	0.909 ***	0.231	-0.735 ***	0.269	0.176	0.127	1.230 ***	0.276	-1.063 ***	0.299
Tobacco	-0.080	0.797	6.388 ***	0.902	1.686 ***	0.433	-1.325	0.951	7.140 ***	1.000
Alcohol	-0.481 ***	0.117	0.263 **	0.135	-0.127 **	0.065	-0.627 ***	0.138	0.422 ***	0.148
Number of children under 7	-0.000	0.561	-0.170	0.612	-0.046	0.299	0.033	0.669	-0.189	0.681
Number of kids ages 7-14	-1.316 ***	0.477	-0.678	0.501	-0.723 ***	0.252	-1.447 ***	0.567	-0.403	0.556
Number of adults	0.154	0.312	1.774 ***	0.351	0.541 ***	0.169	-0.158	0.372	1.936 ***	0.389

Note: *** $p< 0.01$, ** $p< 0.05$, * $p< 0.10$. ME shows marginal effects/