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DOES BEVERAGE CONSUMPTION AFFECT SLEEP QUALITY?

Özge ESGİN[1]*, Ayşe Özfer ÖZÇELİK[1]

[1]*Department of Nutrition and Dietetics, Faculty of Health Sciences, Ankara University, 06290, Ankara, Turkey*

Abstract: Sleep quality is important due to affects many physiological functions in the body. Recently, it has been considered that an increase in beverage consumption may lead to some negative effects on sleep quality. The aim of this study was to evaluate the effect of beverage consumption on sleep quality. 254 individuals, consisting of 181 females and 73 males, included in the study. The questionnaire including demographic characteristics, anthropometrical measurements, questions about physical activity, beverage consumption form, Pittsburgh Sleep Quality Index conducted by face-to-face method. The mean Pittsburgh Sleep Quality score was 5.81±3.36. It was determined that 55.5% of the participants (n=141) n had good sleep quality. Even though the amount of caffeine intake from beverages, consumption number of the caffeinated and stimulant beverages have a negative impact on sleep quality, the level of this impact is low (P<0.05) (r=0.15, 0.15, 0.14). The consumption of coffee without cream deteriorates sleep quality 4.8 times, while ayran (drinkable yogurt, buttermilk) deteriorates sleep quality 2.6 times. It is considered that the lessening in the consumption of ayran, coffee without cream, caffeinated beverages and stimulant beverages could improve quality.

Keywords: Artificially sweetened beverages, Buttermilk, Coffee, Energy drinks, Sleep

***Corresponding author:** Department of Nutrition and Dietetics, Faculty of Health Sciences, Ankara University, 06290, Ankara, Turkey
E mail: ozge.esgin@ankara.edu.tr (Ö. ESGİN)
Özge ESGİN https://orcid.org/0000-0002-0353-3975
Ayşe Özfer ÖZÇELİK https://orcid.org/0000-0002-9087-2042

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1. Introduction

Beverages are important dietary component impacting human health with different biological reactions (Wolf et al., 2008). The National Health and Nutrition Examination (NHANES) in 2008 revealed that adult males consume more sugar-sweetened beverages than adult females in the United States. It was determined that 40% of women and 55% of men above the age of 20 consume sugar-sweetened beverages daily (Ogden et al., 2011). The American Heart Association (AHA) recommends that the weekly consumption of sugar-sweetened beverages not exceed 450 kilocalorie (kcal) (Lloyd-Jones et al., 2010). It has been reported that sugar-sweetened and caffeinated beverages are associated with sleep quality and duration (Sampasa-Kanyinga et al., 2018; Young et al., 2020; Halldorsson et al., 2021). It has been argued that energy drinks can also affect quality and patterns (Faris et al., 2017). Furthermore, caffeinated energy drinks have been associated with sleep disorders (Chaudhary et al., 2021).

Sleep, which has vital functions for many aspects including growth, development, energy balance, regulation of immune reactions, cognitive performance, and psychological situation, occurs in every organism to a certain extent (Zielinski et al., 2016). While the need for sleep differs from person to person, 7-9 hours (h) of sleep is recommended for adults (Hirshkowitz et al., 2015). Studies have revealed that long and short term sleep durations are related to health problems including obesity (Vioque et al., 2000; Shigeta et al., 2001; Singh et al., 2005; Chaput et al., 2008) type 2 diabetes (Chaput et al., 2009) and hypertension (Knutson et al., 2009). Factors impacting sleep quality can impact sleep duration as well; thus, potential results of insufficient sleep duration should be considered for sleep quality as well. Previous studies have so far focused on the dietary quality, which affects determining sleep quality. Since beverages also belong to the dietary composition, the impact of beverage consumption on sleep quality is a topic worth discussing.

A limited number (n) of studies mentioned above on beverages mostly focused on sugar-sweetened beverages and caffeine consumption (Del Brutto et al., 2016; Clark and Landolt, 2017; Chaput et al., 2018; Li et al., 2018). The fact that coffee affects sleep quality, while other caffeinated beverages do not, has revealed the necessity of investigating different types of beverages that may affect quality (Suna and Ayaz, 2018). The hypothesis of this study; the effect of different beverage groups (sugar-sweetened beverage, alcohol, caffeinated beverage, milk and milk-based beverages, stimulant beverages) on sleep quality is different. It is thought that the results obtained from this study, which examines the effect of beverage consumption on sleep quality, will guide future studies.

2. Material and Methods

2.1. Study Design and Sample

This was a cross-sectional study. The sampling distribution was set as 254 and calculated with 4.5±2.2 (Del Brutto et al., 2016) prevalence, which was obtained

from the Pittsburgh Sleep Quality Index score from the previous similar studies, with 95% confidence level and 5% deviation, using the G-Power program (version 3.1). 254 individuals are included in this study.

2.2. Data Collection and Variables

Research data were collected with survey forms in face-to-face methods. The survey form includes demographic features, anthropometrical measurements, and questions on physical activity, beverage consumption form and the Pittsburgh Sleep Quality Index. Participants also submitted informed consent forms. Biological factors were questioned in determining the sex of individuals. The chronical disease status of individuals was questioned with open-ended questions. Type 1 Diabetes Mellitus, Type 2 Diabetes Mellitus, hypothyroidism, hyperthyroidism, insulin resistance are classified as endocrine diseases. Venous insufficiency, hypertension, lymphedema, heart failure are classified as cardiovascular diseases. Fibromyalgia and migraine are classified as neurological diseases. Polycystic ovary syndrome, asthma, and Behçet's disease are classified as other chronical diseases.

2.3. Anthropometric Measurements

In the study, wt, body fat percentages, lean body mass and water percentages of the participants were measured using the lightest clothes as possible on and shoes off (using Tanita BC601, Tartı Medikal, Beşiktaş/İstanbul/Turkey). It was ensured that participants had not eaten for 12 h and had not consumed any beverages 3–4 h before the measurement. Participants had not also been involved in any physical activity one day before the measurement. The heights of participants were asked and noted based on their declarations. Body Mass Index of the participants was calculated using wt and height measurements. The World Health Organization defines BMI categories as follows: "underweight" for individuals under 18.5 kilogram/meter^2 (kg/m^2) BMI, "normal weight" between 18.5–24.9 kg/m^2 BMI, "overweight" between 25.0–29.9 kg/m^2 BMI and "obese" above 30.0 kg/m^2 BMI (WHO, 2020).

2.4. Physical Activity Level

Physical activity levels of the participants were measured using a three-question survey form used (Marshall et al., 2005). In this survey form, participants were asked whether they exercise regularly and those answering negative were defined as "non-actives." Participants who exercise regularly were asked how often per week they do intense and moderate physical exercises. If the total points of the answers are 4 and above, the participant was defined as "adequately active," otherwise as "inadequately active."

2.5. Beverage Groups

To calculate the beverage consumption amounts, a beverage consumption form prepared by the researchers prepared. This form interrogates the consumption frequency and amount of each following beverage: blackened/green tea, herbal tea, Turkish coffee, Nescafe, decaffeinated Nescafe, filter coffee, other coffee types with cream and without cream, carbonated beverage, light-carbonated beverage, zero carbonated beverage, ice tea, ice tea without sugar, packaged juice and fresh squeezed juice, homemade sugar-sweetened beverages, mineral water, fruity mineral water, kefir, ayran, milk, flavored milk, energy drinks, sports drinks, beer, raki, wine and others. The amount of water consumption was also questioned. Caffeine, sugar and alcohol content of the beverages were calculated based on the USDA food composition database (USDA, 2019).

2.6. Pittsburgh Sleep Quality Index

The Pittsburgh Sleep Quality Index (PSQI) was developed (Buysse et al., 1989) and validated in Turkish (Agargun, 1996). PSQI consists of 24 questions and 7 subcomponents. These components include subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleeping medication and daytime dysfunction. Each component is assessed on a scale of 0-3 points, and the total sum gives the PSQI point. It indicates good sleep quality when the total PSQI point is ≤5, and it indicates poor sleep quality when it is more than 5.

2.7. Statistical Analysis

The IBM SPSS Statistic 21 program was used for analysis. The suitability of the variables to the normal distribution was analyzed with analytical methods (Kolmogorov-Smirnov/Shapiro-Wilk tests). Descriptive analyses were taken for normally distributed variables with mean (m) and standard deviation (SD). When normal distribution was impossible in the comparison of the variables for independent groups Mann–Whitney U Test, otherwise, T-test was used. In the comparison of the groups between discrete variables, Pearson Chi-square Test was used as the parametric test, when the normality distribution assumption was not met Fisher's Exact Chi-square test was used (Önder, 2018). Pearson correlation analysis was used to find the correlation between variables, when the normality distribution assumption was not met Spearman's rho Correlation test was used and $P<0.05$ was accepted as statistically significant.

3. Results

3.1. Study Sample Demographics and Behavioral Characteristics

The sample of this study consisted of 254 individuals - 181 women (71.3%) and 73 men (28.7%). The average age of the participants is 34.86±9.95 and the majority (59.4%) are between 20 and 35 age old. 50.4% of the participants have postgraduate education. 24.8% of the participants stated to have a chronical disease. majority of the participants with a chronical disease (44.4%) have endocrine diseases, while cardiovascular diseases (20.6%) and neurological diseases (12.7%) take the second and third places. majority of the participants (81.1%) do not regularly take medicine, while 76.0% do not take vitamin-mineral supplements. 24.8% of the participants smoked, 14.6% have quit smoking and

60.6% never smoked. The average cigarette number (n) per day is 11.41±7.55. The majority of the participants (63.8%) are not physically active. 22.0% of the participants are adequately active, whereas 14.2% are inadequately active (Table 1). There was no significant difference in terms of physical activity between the genders (P>0.05).

Table 1. Demographical characteristics of the participants

Demographic characteristics	n (%)
Sex	
Women	181(71.3)
Men	73 (28.7)
Age	
20-35 years	151 (59.4)
36-55 years	93 (36.7)
56-64	10 (3.9)
Education	
High school	53 (20.9)
Graduated	73 (28.7)
Postgraduated	128 (50.4)
Chronical Diseases	
Yes	63 (24.8)
No	191 (75.2)
Type of Chronic Disease	
Endocrine	28 (44.4)
Cardiovascular	13 (20.6)
Neurological	8 (12.7)
Other	14 (22.3)
Drug Use	
Yes	48 (18.9)
No	206 (81.1)
Supplements Use	
Yes	61 (24.0)
No	193 (76.0)
Smoking	
Never Smoked	154 (60.6)
Smoking	63 (24.8)
Quit Smoking	37 (14.6)
Physical Activity	
Adequately Active	56 (22.0)
Inadequately Active	36 (14.2)
Sedentary	162 (63.8)
	Mean ± SD
Age (years)	34.86 ± 9.95
Amount of Cigarettes (per day)	11.41 ± 7.55

3.2. Beverage Consumption

Analyses of the beverage consumption of the individuals reveal that women significantly consume more sugar-free herbal tea and sugar-free Turkish coffee but less a more blackened tea with sugar, carbonated beverage, packaged juice and sports drinks compared to men (P<0.05). Men consume significantly more vodka and whiskey than women do (P<0.05). analyzes in which the assumption of normality distribution is not met gives the result that median water consumption is 2.0 liter (L) (min-max 0.20–4.00) in women, while this figure amounts to 1.5 L (min-max 0.20–3.50) in men (P<0.05). 1.1% of the women and 4.4% of the men stated that they consume herbal tea with sugar (P<0.05).

Consumption amounts of blackened/green tea with sugar, herbal tea with sugar, coffee with or without cream with sugar/syrup, carbonated beverage, ice tea, packaged juice, homemade sugar-sweetened beverages, fruity mineral water, flavored milk and energy drinks were summed to calculate the total sugar-sweetened beverage consumption of the participants. Total sugar-sweetened beverage consumption in men was significantly higher than that in women (P<0.05). Consumption amounts of beer, raki, wine, vodka, whiskey, and tequila summed to obtain the total alcohol consumption. The total alcohol consumption amount in men was higher than in women (P<0.05). Consumption amounts of blackened/green tea with or without sugar, Turkish coffee with or without sugar, filter coffee, Nescafe, other coffee types with or without cream, carbonated beverage, light and zero carbonated beverage, ice tea and energy drinks were summed to acquire total caffeinated beverage consumption of the participants. This result also revealed that men consume more caffeinated beverages in total more than women, and the difference is statistically significant (P<0.01). Consumption amounts of kefir, ayran, milk, flavored milk and salep summed to obtain the total consumption of milk and milk-based beverages. Women significantly consumed higher amounts of milk and milk-based beverages than men (P<0.01). Total stimulant beverage consumption number of the participants were found by summing up consumption number of energy drinks, alcoholic and caffeinated beverages. The result is that stimulant beverage consumption in men was significantly higher than in women (P<0.001).

3.3. Effects of Beverage Consumption on Sleep Quality

The average Pittsburgh Sleep Quality Index point of the participants is 5.81±3.36 (5.87±3.45 in women, 5.65±3.17 in men). 55.5% of the participants (n=141) have good sleep quality. 3.5% of the participants with good sleep quality consume coffee without cream, while this rate is 12.4% for the participants with poor sleep quality (P<0.01). 30.5% of the participants with good sleep quality stated to consume carbonated beverage, while this rate is 43.4% for the participants with poor sleep quality (P<0.05). 80.9% of the participants with good sleep quality stated to consume ayran, while 93.8% of the participants with poor sleep quality consume ayran (P<0.05). The impact of beverage consumption amount on sleep quality was compared. It has revealed that an increase in the consumption amount of Nescafe with milk, carbonated beverage, ayran, milk and milk-based beverages was associated with poorer sleep quality (P<0.05). It has also been determined that 86.5% of the participants with good sleep quality and 76.1% of

the participants with poor sleep quality take less than 50 g sugar from beverages per day (P<0.05). Furthermore, 72.3% of the participants with good sleep quality and 60.2% of the participants with poor sleep quality took less than 25 g sugar from beverages per day (P<0.05). A correlation analysis was executed caffeine and sugar amount from beverages and total consumption number of sugar-sweetened beverages, alcohol, caffeinated beverages and milk and milk-based beverages based on Pittsburgh Sleep Quality Index points. Correlation analysis has revealed the negative impact of the increase in caffeine and caffeinated beverage consumption on the sleep quality; however, this impact is low (P<0.05) (r=0.15). Whether daily caffeine consumption amount from beverages is above or below 400 milligrams (mg) does not create any difference in sleep quality. However, it has been found that an increase in the consumption of stimulant beverages results in poorer sleep quality. Stimulant beverages have a low impact on the sleep quality (r=0.14; P<0.05) (Fig.1).

Factors found to impact sleep quality in univariate analyses were standardized based on age and gender and included in the Logistic Regression Model. Regression analysis has revealed that coffee without cream consumption deteriorates sleep quality 4.8 times, ayran deteriorates sleep quality by 2.6 times. In the formed regression model, chronical diseases, carbonated beverage, that the sugar intake from beverages is below or above 25 gr or 50 gr, Nescafe with milk consumption, milk and milk-based products, caffeinated beverages and caffeine amount taken from the beverages and stimulant beverages do not show any significant impact on sleep quality (P>0.05) (Table 2).

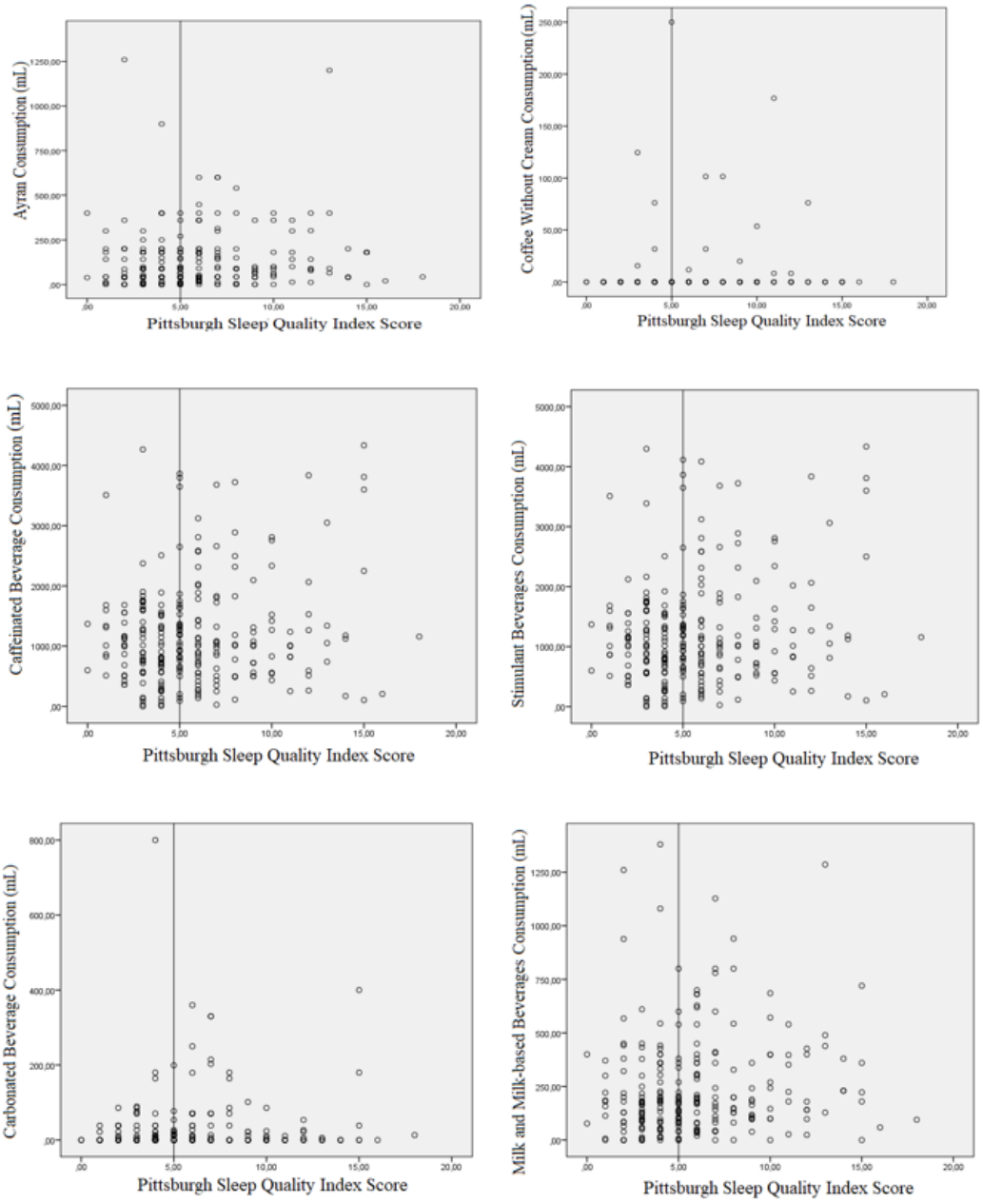

Figure 1. Correlation between ayran, coffee without cream, caffeinated beverage, stimulant beverages, carbonated beverage consumption and Pittsburgh Sleep Quality Index score.

Table 2. Variables related to sleep quality – logistic regression model*

	P	OR	CI
Chronical Disease			
Yes	0.07	1.0	0.94-3.33
No		1.77	
Coffee without Cream Consumption			
Yes	0.02	1.0	1.21-19.38
No		4.8	
Carbonated Beverage Consumption			
Yes	0.12	1.0	0.88-2.85
No		1.5	
Ayran Consumption			
Yes	0.03	1.0	1.06-6.70
No		2.6	
Sugar Amount			
<50 g/day	0.67	1.0	0.31-2.11
≥50 g/day		0.8	
<25 g/day	0.95	1.0	0.45-2.32
≥25 g/day		1.0	
Nescafe with Milk Consumption	0.19	1.0	0.99-1.00
Milk and Milk-based Beverages Consumption	0.11	1.0	1.00-1.00
Caffeinated Beverage Consumption	0.94	1.0	0.99-1.00
Caffeine Amount taken from Beverages	0.33	0.9	0.99-1.00
Stimulant Beverages Consumption	0.70	1.0	0.99-1.00

*Logistic regression model standardized depending on age and gender, OR= odds ratio, CI= 95% confidence interval,

The Pittsburgh Sleep Quality Index consists of 7 subcomponents. The increasing points taken from subcomponents indicate poorer sleep quality. It has also been stated that an increase in the consumption of caffeine amount from beverages and caffeinated beverages has a negative impact on sleep duration and habitual sleep efficiency ($P<0.05$). Besides, an increase in the consumption of milk and milk-based beverages deteriorates habitual sleep efficiency ($P<0.05$). It has also been determined that total stimulant beverage consumption decreases sleep duration and habitual sleep efficiency ($P<0.01$) (Table 3).

The caffeine amount taken from beverages was categorized as described above and below 400 mg/day, while sugar amount was categorized as described above and below 25–50 g/day, and sleep durations were compared in hours. It was determined that when the caffeine amount is above 400 mg/day, the sleep duration decreases ($P<0.001$) (Table 4).

4. Discussion

Previous studies have so far analyzed the relationship between beverage consumption and sleep quality with caffeine, energy drinks, alcohol, stimulant beverage, and sugar-sweetened beverages. A systematic review has pointed out that caffeine typically increases the sleep latency, decreases total sleep duration and sleep efficiency and deteriorates subjective sleep quality (Clark and Landolt, 2017). It has been determined that higher caffeine intake is associated with lower sleep duration (Halldorsson et al., 2021). A study has revealed that sleep duration is 15 min shorter in people who consume caffeinated beverages than in people who do not (Calamaro et al., 2012). It has been argued that 80 mg caffeine is sufficient to induce alertness and affect slow-wave sleep (Reichert et al., 2021). Researchers have specified a positive correlation between energy drinks/caffeinated beverages and poor sleep quality (Lohsoonthorn et al., 2013). Our study has also determined that an increase in caffeine amount and caffeinated beverage consumption deteriorates sleep quality. Besides, an increase in caffeine amount and caffeinated beverage consumption negatively affects sleep duration and routine sleep activity. When the amount of caffeine consumption was above 400 mg, sleep duration decreased ($P<0.05$). Studies conducted on the consumption of sugar-sweetened beverages and sleep activity have also revealed that there is no significant relationship between those (Chaput et al., 2018). However, another study has revealed a relationship between consumption of sugar-sweetened beverages and sleep duration (Li et al., 2018). Researchers have found in a study that people who sleep 5 h or less in a day consume higher amounts of sugar-sweetened beverages (Prather et al., 2016). It is pointed out that the consumption of sugar-sweetened beverages could affect sleep duration (Sampasa-Kanyinga et al., 2018). In our study, it has been revealed that individuals with less than 50 g/day sugar intake have better sleep quality, while as sugar amount taken from beverages increases, so does the daytime dysfunction.

Table 3. The Correlation of beverage consumption amounts with pittsburgh sleep quality ındex subcomponents

	Subjective Sleep Quality		Sleep Latency		Sleep Duration		Habitual Sleep Efficiency		Sleep Disturbance		Use of Sleeping Medication		Daytime Dysfunction		PSQI (Total Points)	
BT	r	P*	r	P*	r	P*	r	P*	r	P*	r	P*	r	P*	r	P*
TSSBC	-0.04	0.51	0.00	0.91	0.06	0.31	-0.01	0.83	0.00	0.92	-0.06	0.30	0.08	0.17	0.02	0.66
TMMBBC	0.10	0.10	-0.00	0.89	0.08	0.16	0.13	0.02	0.07	0.26	0.02	0.70	0.04	0.45	0.10	0.09
TCBC	0.06	0.30	0.04	0.43	0.18	0.00	0.17	0.00	0.03	0.60	0.07	0.23	0.08	0.19	0.15	0.01
TABC	-0.01	0.77	-0.08	0.17	0.11	0.07	0.03	0.06	0.03	0.62	-0.02	0.71	-0.01	0.77	0.00	0.94
TSBC	0.05	0.35	0.03	0.62	0.20	0.00	0.17	0.00	0.03	0.53	0.06	0.28	0.07	0.23	0.14	0.01
TSC	-0.06	0.29	-0.00	0.96	0.01	0.80	-0.03	0.63	0.02	0.70	-0.04	0.52	0.15	0.01	0.03	0.63
TCC	0.08	0.16	0.02	0.64	0.18	0.00	0.15	0.01	0.09	0.15	0.03	0.58	0.09	0.14	0.15	0.01

*Bivariate correlation analysis, BT= beverage type, TSSBC= total sugar-sweetened beverage consumption, TMMBBC= total milk and milk-based beverage consumption, TCBC= total caffeinated beverage consumption, TABC= total alcoholic beverage consumption, TSBC= total stimulant beverage consumption. TSC= total sugar consumption, TCC= total caffein consumption

Table 4. The Comparison of sleep duration with caffeine and sugar amounts from beverages

		n	Median	Min-Max	U	Z	*P**
Sleep Duration	Sugar Amount from Beverages						
	<50 g/day	208	7.00	3.00–12.00	4295.5	-1.09	0.27
	≥50 g/day	46	6.00	4.00–10.00			
	<25 g/day	170	5.00	1.00–18.00	6679.0	-0.84	0.40
	≥25 g/day	84	6.00	0.00–16.00			
Sleep Duration	Caffeine Amount from Beverages						
	<400 mg/day	227	7.00	3.00–12.00	1943.0	-3.14	0.00
	≥400 mg/day	27	6.00	3.00–12.00			

*Mann–Whitney U test.

However, there is no significant relationship found between consumption of sugar-sweetened beverages and sleep quality, habitual sleep efficiency and sleep duration (P>0.05). Some are also studies conducted on the impact of alcohol consumption on sleep. A systematic review and meta-analysis study has revealed that alcohol consumption increases the risk of sleep apnea (Simou et al., 2018). It has been stated that alcohol consumption can increase sleep problems (He et al., 2019). Furthermore, it is argued that alcohol consumption can lead to sleep disorders, and lack of sleep may trigger alcohol consumption (Campbell et al., 2020). Our study has not determined any correlation between alcohol consumption and sleep quality (P>0.05). This result may stem from the misclassification. It would not be correct to make this comparison, since there is a 4-fold difference between the n of participants who did not consume alcohol and those who do. Energy drinks, caffeinated beverages and alcohol are all categorized under stimulant beverages. There are few studies analyzing the correlation between stimulant beverages and sleep quality. A study has determined that any stimulant beverage increases the deterioration risk of the sleep quality (Vélez et al., 2013). Another study has found a relationship between stimulant beverage consumption three times or more in a week and short sleep duration (Sanchez et al., 2013). In our study, a deterioration in sleep quality as well as a decrease in sleep duration and sleep activity have been found with increasing consumption of stimulant beverages.

The limitation of this study is that the heights of the participants were taken based on the declarations of the participants, and due to unevenness of the n of academic and administrative staff, these two groups could not be compared. Another limitation of the study is that caffeine and sugar consumption of the participants covers the intake from the beverages only.

5. Conclusion

Improving sleep quality is of vital importance since sleep quality affects mental and physical health. Previous studies have so far analyzed the relationship between beverage consumption and sleep quality for one or several beverage types. This study, on the other hand, has questioned almost all the beverage types widely consumed in Turkish society. It is considered that decreasing the consumption of carbonated beverage, ayran, coffee without cream, caffeinated beverages, caffeine intake from beverages and stimulant beverages can ease sleep quality.

Author Contributions

All authors have equal contribution and authors reviewed and approved the manuscript.

Conflict of Interest

The authors affirm there are no conflicts of interest and the authors have no financial interest related to the

material of this manuscript. We declare that the content of this article has not been published or sent for publication elsewhere. This research did not receive any specific grant from funding agencies in the public, commercial, ornot-for-profit sectors.

Ethical Approval/Informed Consent

The research was conducted with permission at Ankara University – Faculty of Health Sciences, Faculty of Communication, Faculty of Politics, Faculty of Educational Sciences and Faculty of Law. For this study, 'Ethics Committee Approval' (56786525-050.04.04/9226) was received from the Ethics Committee Directorate of Ankara University Rectorate. This study complied with the provisions of the Declaration of Helsinki and an informed consent form was obtained from the participants. Individuals who do not work as an academic or administrative staff at Ankara University, who are not in the age range of 20–64 and who are illiterate are excluded from the study.

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