Nutritional Habits According to Human Chronotype and Nutritional Status of Morningness and Eveningness

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Abstract

Sixty one female and eighty one male volunteers participated in the study that aims to assess the nutrition habits according to human chronotype and nutritional status of morningness and eveningness. Chronotype was assessed by Turkish version of the Morningness-Eveningness Questionnaire and the other questionnaire prepared to assess of nutritional habits of participants were used. Furthermore a three-day food record for assessment of nutritional status was completed by twelve male who were definite morning/moderate morning types and eleven male who were definite evening/moderate evening types. According to a three-day food record intake of daily total energy (kkal), fat (g) and carbohydrates (g) were higher and intake of protein (% energy) was lower in the evening types ($p < 0.05$). In conclusion, evening chronotype was associated with inadequate dietary habits and status such as high daily energy (kkal), fat (g) and carbohydrates (g) intakes and low protein intake (% energy) and skipped meal.

Keywords: chronotype, nutrition habits, nutritional status

1. Introduction

Circadian rhythm (meaning 'about day') with a Latin root of circa dies is an basic biological process organizing the organism against predictable changes existing in almost all living organisms and occurring during the 24-hour process in the environment (Summa & Turek, 2014). Chronotype is the expression of circadian rhythmicity in an individual, and chronotype is categorized under three categories. These are morning types, evening types and intermediate types (Vitale & Weydahl, 2017). Morningness-Eveningness reflects personal differences in the circadian rhythms of various biological and psychological processes (Prieto et al., 2012). Morningness-Eveningness is the characteristic that indicates which time of the day the person prefers for rest and activity (Haraszti et al., 2014). Although circadian preference has a strong genetic and biological basis, it varies according to some sociodemographic characteristics, as sex and age (Tonetti et al., 2015). While morning types go to bed early, wake up early and show the best performance during the early hours of the day, evening types prefer to go to bed late and wake up late when compared to morning types. They mentally and physically show the best performance in the afternoon and during the evening hours (Tonetti et al., 2015). In general, there are intermediate types in the population. Definite morning or definite evening types are rare (Haraszti et al., 2014).

In the studies, chronotype is generally evaluated with valid and reliable scales such as the Morningness-Eveningness Questionnaire (Kanerva et al., 2012). According to the studies, disorders in the sleep-wake cycle and circadian adjustment may cause metabolic dysfunctions. Moreover, chronotype may affect mood, substance use (cigarette, alcohol, drugs), psychological problems, personality and academic performance, and eating behaviours. Hormonal changes and psychological characteristics may cause an increase in hunger and fatigue and increase the risk of obesity. There are studies indicating relationships between short sleep duration and unhealthy nutritional habits (Kanerva et al., 2012).

It is indicated in the studies that evening types have unhealthier nutritional habits when compared to morning types, they consume more macronutrients with higher energy after 8 pm, their meal times change, and they have unhealthy life style habits. It is also indicated in the studies that there is a positive relationship between abnormal circadian rhythm and diseases such as obesity, metabolic syndrome, cancer, cardiovascular diseases, asthma, type 2 diabetes (Maukonen et al., 2016; Maukonen et al., 2017; Mota et al., 2016; Sato-Mito et al., 2011a). However, the relationship among circadian rhythm, nutrition and obesity is unclear (Maukonen et al., 2016).

The aim of this study is to identify nutritional habits according to the chronotypes of the students studying at Akdeniz University and to evaluate the nutritional status of morning type and evening type male students whose food consumption reports have been recorded.

2. Methods

2.1 Participants

The study was conducted between January 2017 and May 2017. 61 females and 81 males, in total 142 individuals studying at Akdeniz University participated in the study. Individuals with any health problems such as psychiatric diseases, respiratory diseases, etc. that can affect sleep duration and quality, who use drugs, consume foods and drinks with the high amount of caffeine such as tea, coffee, energy drinks, etc. were not included in the study. Chronotype was assessed by the Turkish version of the Morningness-Eveningness Questionnaire (MEQ). Individuals were also categorized as being evening type (score:16–41), intermediate type (42–58) or morning type (score: 59–86) (Mota et al., 2016). The nutritional habits of the individuals were determined by using the questionnaire form prepared by the researcher. Furthermore, three-day food consumption was obtained from 12 morning-type and 11 evening-type male individuals to identify their nutritional status.

2.2 Measurement Instruments

2.2.1 Chronotype

Chronotype was evaluated using MEQ developed by Horne and Ostberg and adapted into Turkish by Pündük et al. (2005). Morningness–eveningness is expressed by a score that ranges from 16 to 86, low scores indicating eveningness and high scores, morningness. Individuals were also categorized as being evening type (score:16–41), intermediate type (42–58) or morning type (score: 59–86) in study (Mota et al., 2016) .

2.2.2 Nutritional Habits

A questionnaire form prepared by the researcher and consisting of 12 questions was applied to the individuals to determine descriptive information such as age, gender, anthropometric measurement information, nutritional habits, consumption frequency of fast-food, and water consumption amount.

2.2.3 Nutritional Status

Food records were filled in for three non-consecutive days (two weekdays and one weekend day) and dietary recall forms were processed by a specialized dietitian. A nutrition software program ("Ebispro for Windows, Stuttgart, Germany; Turkish version BeBiS; Data Bases: Bundeslebens-mittelschlüssell, 11.3 and other sources") that contains information on 20,000 foods and beverages was used to calculate the mean daily intakes of energy and nutrients (protein, fat, carbohydrate).

2.2.4 Statistical Analysis

Descriptive statistical methods were used for the evaluation process of the data and one-way ANOVA or Kruskal-Wallis test was conducted to find out body mass index and water consumption according to chronotypes. And also according to three-day food record, unpaired t test or Mann Whitney U test was used to compare the results of macro nutrient intakes of individuals.

3. Results

Sixty one female (age: 22,06±2,61 years, height: 165,18±6,51 cm, body mass: 57,44±9,59 kg) and eighty one male volunteers (age: 21,66±2,18 years, height: 178,56±7,12 cm, body mass: 75,46±11,54 kg) participated in the study that aims to assess the nutrition habits according to human chronotype and nutritional status of morningness and eveningness (table 1).

Table 1. Subjects Characteristics

	Female (n=61) (Mean) SD	Male (n=81) (Mean) SD	Total (n=142) (Mean) SD
Age (yıl)	22,06±2,61	21,66±2,18	21,83±2,37
Height (cm)	165,18±6,51	178,56±7,12	67,72±13,96
Weight (kg)	57,44±9,59	75,46±11,54	68,89±8,96

In this study, 2,8 % of the participants were definite morning types, 9,9 % were moderate morning types, 62,7 % were intermediate types, 22,5 % were moderate evening types, 2,1 % were definite evening types. Individuals were classified as morning, evening and intermediate types (table 2).

Table 2. The Distribution of Morning and Evening Types in Human Circadian Rhythm in Terms of Gender

	Morningness-eveningness type (n=104)		Female (n=61) f	%	Male (n=81) f	%	Total (n=142) f	%
Morningne	Definite morning types		0	0,0	4	4,9	4	2,8
	Moderate morning types		6	9,8	8	9,9	14	9,9
Eveningness	Intermediate types		42	68,9	47	58,0	89	62,7
	Moderate evening types		13	21,3	19	23,5	32	22,5
	Definite evening types		0	0,0	3	3,7	3	2,1

While 11.1% of morning-type individuals do not skip a meal, 14.6% of intermediate-type individuals do. Moreover, all of the evening-type individuals skip a meal. The most frequently skipped meal is breakfast in all three groups (33.33% of the morning type, 60.00% of the evening type, 44.9% of the intermediate type). Most of the morning-type (56.3%) and evening-type (40.0%) individuals skip a meal because they forget/cannot find an opportunity and a large part of the intermediate-type individuals skip a meal because they do not feel like it. Most of the morning types (69.2%), evening types (50.0%) and intermediate types (77.3%) have breakfast at home. While 53.3% of the morning types and 65.2% of the intermediate types have lunch at the school cafeteria, 54.2% of the evening types prefer fast-food companies. Most of the morning-type (93.8%), evening-type (71.0%) and intermediate-type (84.3%) individuals have dinner at home. 5.6% of the morning-type, 14.3% of the evening-type and 9.0% of the intermediate-type individuals stated that they consume fast-food and beverages every day (Table 3).

Table.3. Nutritional Habits According to Circadian Rhythm Types

	Morningness (n=18) f	%	Eveningness (n=35) f	%	Intermediate (n=89) f	%
Skipping Meals						
Not skipped	2	11,1	0	0,0	13	14,6
Morning	6	33,3	21	60,0	40	44,9
Lunch	2	11,1	6	17,1	15	16,9
Morning-Lunch	1	5,6	4	11,4	5	5,6
Dinner	2	11,1	2	5,7	5	5,6
Break	5	27,8	2	5,7	11	12,4
The reasons of skipping meal						
Weight loss	1	6,3	1	2,9	2	2,6
Feel disinclined	2	12,5	12	34,3	32	42,1
Forgetting/lack of time	9	56,3	14	40,0	29	38,2
Not in the habit	4	25,0	8	22,9	13	17,1
Usually breakfast place						
Home	9	69,2	5	50,0	34	77,3
School	2	15,4	3	30,0	7	15,9
Fast food restaurant	0	0,0	2	20,0	1	2,3
Dormitory	2	15,4	0	0,0	2	4,5
Usually lunch place						
Home	1	6,7	2	8,3	7	10,1
School dining hall	8	53,3	7	29,2	45	65,2
Home made	0	0,0	2	8,3	5	7,2
Fast food restaurant	4	26,7	13	54,2	10	14,5
Restaurant	2	13,3	0	0,0	1	1,4
Dormitory	0	0,0	0	0,0	1	1,4
Usually dinner place						
Home	15	93,8	22	71,0	70	84,3
School dining hall	0	0,0	0	0,0	2	2,4
Home made	0	0,0	0	0,0	3	3,6
Fast food restaurant	0	0,0	5	16,1	5	6,0
Restaurant	0	0,0	2	6,5	0	0,0
Dormitory	1	6,3	2	6,5	3	3,6
Fast food frequency						
Everyday	1	5,6	5	14,3	8	9,0
1-2 times a week	5	27,8	10	28,6	32	36,0
3-4 times a week	7	38,9	15	48,6	19	21,3
Once every 15 days	2	11,1	1	2,9	12	13,5
Once a month	3	16,7	2	5,7	16	18,0
Never	0	0,0	0	0,0	2	2,2

As indicated in Table 4, there is no significant difference among morning-type, evening-type and intermediate-type individuals in terms of the body mass index and water consumption amount (p>0.05).

Table 4. Body Mass Index and Water Consumption Amount According to Circadian Rhythm Types

	Morningness (n=18) (Mean) SD	Eveningness (n=35) (Mean) SD	Intermediate (n=89) (Mean) SD	
Body mass index (kg/m^2)	22,69±2,83	22,76±3,22	22,30±2,90	F=0,36 p=0,70
Water Consumption	2067,65±955,07	1461,18±795,54	1813,07±995,08	χ^2=4,93 sd=2 p=0,08

According to the data of the three-day food consumption form obtained from 12 morning type and 11 evening type male individuals, while the energy amount (kcal), fat content (g) and carbohydrate amount (g) that evening-type individuals obtain from food are higher when compared to morning-type individuals, the percentage rate of daily consumed energy obtained from protein is lower in evening-type individuals (p<0.05). There is no difference among the daily consumed protein, the percentage rate of energy obtained from carbohydrate and fat, fiber (g), cholesterol (mg), vitamin A (μg), vitamin E, B_1, B_2, B_6, C (mg), sodium (mg), potassium (mg), calcium (mg), magnesium (mg), phosphor (mg), iron (mg) and zinc (mg) intakes of morning-type and evening-type male individuals (p>0,05). (table 5).

Moreover, there is no difference between the BMIs of morning-type (BMI: 22.60±2.41 kg/m^2) and evening-type (BMI: 22.09±l.83 kg/m^2) male individuals (p>0.05).

Table 5. Nutritional Status Determined with Three-Day Food Consumption in Morning and Evening-Type Male Individuals

	Morningness (n=12) (Mean) SD	Eveningness (n=11) (Mean) SD	
Energy (kkal)	1723,54±543,28	2450,42±625,02	t= -2,92 p=0,00*
Protein (g)	64,27±20,89	73,09±26,51	t= -0,87 p=0,39
Protein (%)	15,58±2,84	12,50±3,81	t=2,17 p=0,04*
Carbohydrate (g)	198,14±81,71	301,72±105,38	z=-2,31 p=0,02*
Carbohydrate (%)	46,67±7,32	50,80±8,47	t=-1,23 p=0,23
Fat (g)	69,69±18,95	99,32±26,73	t=-3,03 p=0,00*
Fat (%)	37,67±7,51	36,70±7,02	t=0,30 p=0,76
Fiber (g)	17,09±7,39	20,89±5,82	t= -1,32 p=0,20
Cholesterol(mg)	357,01±163,11	312,00±237,69	t=0,53 p=0,61
Vit A (μg)	1258,29±996,69	1322,33±1993,31	t=-0,09 p=0,92
Vit E (mg)	17,53±7,13	19,72±5,67	t=-0,79 p=0,44
Vit B_1 (mg)	0,72±0,37	0,85±0,21	t=-0,93 p=0,37
Vit B_2 (mg)	1,17±0,34	1,38±0,58	t=-1,07 p=0,30
Vit B_6 (mg)	1,18±0,45	1,46±0,36	t=-1,62 p=0,12
Vit C (mg)	66,55±39,88	57,55±22,64	t=0,63 p=0,53
Sodium (mg)	3294,87±1047,36	4214,90±1553,86	t=-1,65 p=0,11
Potassium (mg)	1911,88±673,05	2309,71±551,95	t=-1,49 p=0,15
Calcium (mg)	532,83±223,39	646,95±210,86	t=-1,22 p=0,23
Magnesium (mg)	214,73±71,40	268,89±70,26	t=-1,79 p=0,09
Phosphor (mg)	987,93±333,53	1166,46±345,62	t=-1,23 p=0,23
Iron (mg)	9,90±2,98	11,72±3,10	t=-1,40 p=0,18
Zinc (mg)	8,86±3,25	10,30±3,79	t=-0,93 p=0,35

p<0.05

4. Discussion

In the study conducted to determine the nutritional habits of the students studying at Akdeniz University according to their chronotype and to evaluate the nutritional status of morning-type and evening-type male students whose food consumption has been recorded, while 11.1% of the morning-type individuals do not skip meal, 14.6% of the intermediate-type individuals do not skip meal. Moreover, all of the evening-type individuals skip a meal. The most frequently skipped meal is breakfast in all three groups (33.33% of the morning type, 60.00% of the evening type, 44.9% of the intermediate type). 5.6% of the morning-type individuals, 14.3% of the evening-type individuals and 9.0% of the intermediate type individuals stated that they consume fast-food and beverages every day.

The studies indicate that evening types have different nutritional habits such as skipping breakfast, consuming food in bigger portions, consuming foods of low quality (Mota et al., 2016). In the study conducted on 800 Japanese female students between the ages of 18-29 years, the MEQ score was found to be positively related to breakfast consumption frequency (Nakade et al., 2009). In another study conducted on 197 females, 138 males, in total 335 students, evening types are inclined to skip breakfast and consume more fast-food (Schubert & Randler, 2008). In a study conducted on 152 female and male students, morning types consumed less fast-food (Fleig & Randler, 2009). In a study conducted on 1854 individuals between the ages of 25-74 years, it is stated that evening types have irregular meal times (Maukonen et al., 2017).

In our study, there is no significant difference among morning-type, evening-type and intermediate-type individuals in terms of the body mass index and water consumption amount. According to the data of the three-day food consumption form obtained from 12 morning-type and 11 evening-type male individuals, while the energy amount (kcal), fat content (g) and carbohydrate amount (g) that evening-type individuals obtain from food are higher when compared to morning-type individuals, the percentage rate of daily consumed energy obtained from protein is lower in evening-type individuals. There is no difference among the daily consumed protein, the percentage rate of energy obtained from carbohydrate and fat, fiber (g), cholesterol (mg), vitamin A (μg), vitamin E, B_1, B_2, B_6, C (mg), sodium (mg), potassium (mg), calcium (mg), magnesium (mg), phosphor (mg), iron (mg) and zinc (mg) intakes of morning-type and evening-type male individuals ($p > 0.05$). Moreover, there is no difference among the BMIs of morning-type and evening-type male individuals.

There are inconsistent results related to the relationship between obesity and chronotype in the studies. In the study conducted by Maukonen et al. (2016), BMI is not different according to the chronotypes. Arora and Taheri (2015) found in the study they conducted on 511 adolescents between the ages of 11-13 years that evening chronotypes have higher BMI when compared to definite morning chronotypes. In the study conducted on 4493 individuals between the ages of 25-74 years, no relationship was found between BMI and energy consumption, and the ME score (Kanerva et al., 2012). In our study, while the energy amount (kcal), fat content (g) and carbohydrate amount (g) that evening-type individuals among male individuals whose food consumption has been recorded obtain from food are higher when compared to morning-type individuals, although the percentage rate of daily consumed energy obtained from protein is lower in evening-type individuals, there is no difference between their BMIs. The BMIs of the evening types are not high. One of the explanations for this situation is that the individuals are at a young age (There may be an increase in gaining weight with age). Another explanation and one of the limitations of the study may be that there are no records of physical activity.

Previous studies indicate that evening types consume unhealthy food and nutrients, consume more beverages, alcohol and chocolate, take more fat and saturated fat, consume less carbohydrate, pulp, vegetables, fruit and fish and their diet quality is low (Baron et al., 2011; Haraszti et al., 2014; Kanerva et al., 2012; Maukonen et al., 2016; Sato-Mito et al., 2011b).

A study, in which the relationship between the chronotype, and food groups and nutrient intake in Japan was examined, was conducted on 3304 female dietetic students between the ages of 18-20 years. A negative relationship was found between the late midpoint of sleep (The midpoint of sleep was calculated using self-reported bedtimes and risetimes) and the percentage of the total daily energy obtained from carbohydrate and protein, cholesterol, potassium, calcium, magnesium, iron, zinc, vitamin A and D, thiamin, riboflavin, vitamin B_6, folate, rice, vegetables, eggs, dairy products, legumes, and a positive relationship was determined among the percentage of energy obtained from alcohol and fat, noodle, candy, fat and oil and meat consumption (Sato-Mito et al., 2011b). In another study conducted on 112 young Japanese women, in which the relationship between chronotype and food intake was examined, evening tendency was found to be related to lower protein, calcium, magnesium, zinc, vitamin D, riboflavin, vitamin B6 and vegetable intake and more noodle intake. Energy consumption and BMI are not different according to the MEQ score (Sato-Mito et al., 2011a). In a study in which the relationship between energy and macronutrient intake time, and chronotype was examined, the total energy intake is not different according to the chronotype. However, while evening types take less

energy and nutrient in the morning (before 10 AM) when compared to morning types, they take more energy and macronutrients in the evening (after 8 PM) (meal time was not questioned in our study). In a study conducted on 1854 individuals between the ages of 25-74 years, protein intakes of evening types were found to be lower in terms of macronutrients. Evening types take more sucrose, fat and saturated fat during evening hours (Maukonen et al., 2017). In a study in which the relationship between food intake and chronotype was examined, a negative relationship was found between the chronotype score, and energy, carbohydrate, protein, cholesterol and sweet consumption (Mota et al., 2016).

Maukonen et al. (2016) have stated that although evening types are less inclined to a healthy diet, there is no evidence that chronotype will modify the relationship between obesity and healthy diet. In this study, no difference was found among the chronotypes in terms of energy consumption.

It is stated that Social jet lag may be one of the mechanisms for the evening types to be more inclined to unhealthy diet when compared to other chronotypes. Social jet lag is likely to have an effect on food consumption along with other lifestyle factors. The other mechanism may be different personal characteristics among the chronotypes. Evening types are less conscientious and have less self-control (Maukonen et al., 2016). Evening types also have unhealthy behaviours such as smoking, physical inactivity in addition to an unhealthy diet (Haraszti et al., 2014; Nakade et al., 2009; Urban et al., 2011).

For example, in a study conducted on 4493 individuals between the ages of 25-74 years, most of the evening types are physically inactive (Kanerva et al., 2012). It is indicated that short term sleep deprivation, which evening types are inclined to, decreases physical activity (Schmid et al., 2009). A decrease in physical activity, watching television or using a computer, keeping late hours and irregular schedule affect the food consumption of evening types. Depressive symptoms may affect food consumption (Kanerva et al., 2012).

It is stated in the studies that leptin, cortisol, insulin, thyroid stimulating hormone and other parameters are affected by short sleep duration, short sleep duration causes changes in hormones related to appetite and it especially increases hunger and appetite for foods with high carbohydrate and calories (Kanerva et al., 2012; Nguyen & Wright, 2009; Sato-Mito et al., 2011b; Scheer et al., 2009).

Although there are studies conducted on energy intake timing and obesity, BMI, further studies are required on the role of chronotype in this relationship (Maukonen et al., 2017).

The strengths of this study included a random sample, and chronotype was assessed using a validated method. There are some limitations in the present research. Since the number of samples is low, it did not include a population-based approach. Also, dietary intakes and the assessment of chronotype were based only on self-reported data. In this study, food consumption frequency, sleep duration and physical activities were not recorded. Further studies with larger populations are necessary to better understand the relationship between chronotype and nutrition.

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