Health, Sports & Rehabilitation Medicine
Vol. 24, no. 3, July-September 2023, 114–118

ORIGINAL STUDIES

The interplay of weight, menstruation and sleep in a group of amateur sportswomen

Paula Mihaela Onița[1], Gabriela Florentina Sacarea[1], Oana Anamaria Moldovan[1], Alexandru Maftei[2], Roxana Maria Martin-Hadmaș[1]

[1] Community Nutrition and Food Safety Department, "George Emil Palade" University of Medicine, Pharmacy, Science, and Technology of Targu Mures, Romania

[2] Nutritik Performance, Romanian Swimming Federation and Modern Pentathlon

Abstract

Background. Various sources indicate that eating habits are influenced by sleep. Increased food intake, a poor diet, and excess body fat are all associated with short sleep duration, poor sleep quality, and later bedtimes.

Aims. The aim of this study was to examine the relationship between weight, menstruation, and sleep among a group of recreational athletes.

Methods. An observational study was conducted from November 2022 to February 2023 on a sample of 60 female participants in Târgu Mureș, Romania. The collected data included dietary habits analyzed through food journals, detailed anthropometry, characterization of physical activity, menstrual cycle, and sleep patterns.

Results. The dietary habits of the study sample were imbalanced, deficient in proteins and fibers. BMI was significantly associated with nighttime sleep duration and heart rate measured during physical exertion but was not associated with specific menstrual cycle data.

Conclusions. In the analyzed study sample, BMI did not represent a factor influencing menstrual cycle variability.

Keywords: nutrition, menstrual cycle, sleep, physical activity.

Introduction

Various sources support the fact that eating habits are influenced by sleep. Increased food intake, a poor diet, and extra fat mass are all linked to short sleep duration, poor sleep quality, and later bedtimes. When exposed to the present obesogenic milieu of easily accessible food, insufficient sleep can influence the ingestion of high energy foods, which could lead to overeating and overconsumption of calories, increasing the daily energy intake. Lack of sleep has been linked to an increase in snacking, daily meal consumption, and a preference for foods high in energy (Chaput, 2013; Kim et al., 2021).

Numerous epidemiologic al studies have demonstrated a link between short sleep duration and high body mass index (BMI). Lack of sleep may contribute to weight gain and obesity through several mechanisms, including an increase in food consumption, a decrease in energy use, and changes in the levels of hormones that control hunger, such as leptin and ghrelin (Bayon et al., 2014).

In addition to major weight loss, rigorous exercise, large changes in eating or sleeping patterns, and severe stressors, menstrual irregularities can also be brought on by disturbances of the central gonadotropin-releasing hormone pulse generator (Loef & Walach, 2012). Along with chronic problems like poorly managed diabetes mellitus, genetic and congenital disorders like Turner syndrome, and other types of gonadal dysgenesis, menstrual disruptions can also be a symptom of these conditions (Diaz et al., 2006; Gast et al., 2010).

Material and method

Research protocol

a) Period and place of the research

An observational study was performed between 10th of November 2022 and 10th of February 2023. The study was carried out at a private gym, in Targu Mures, Romania.

b) Subjects and groups

The study comprises a diverse group of 60 women who participate in fitness classes three times per week.

Received: 2023, June 20; *Accepted for publication:* 2023, June 30
Address for correspondence: "George Emil Palade" University of Medicine, Pharmacy, Science, and Technology of Targu Mures, Gheorghe Marinescu Street. no. 38, 540139, Romania
E-mail: roxanahadmas@yahoo.com
Corresponding author: Roxana Maria Martin-Hadmaș; roxanahadmas@yahoo.com
https://doi.org/10.26659/pm3.2023.24.3.114

The participants in this study range in age from 21 to 55 years old. They do not adhere to a specific nutritional regimen. The inclusion criteria did not consider age, but required subjects to have experienced menarche, maintain accurate journals, and have precise measurements taken three times. Menopausal individuals, those with incomplete food journals, and individuals with inaccurate measurements were excluded from the study. Each participant gave their consent to participate in the study and have their data analyzed.

c) Applied tests

The analysis utilized data obtained from a questionnaire created by the authors. The study commenced on the first day of the menstrual cycle, and the questionnaire encompassed a 3-day food journal as well as a sleep journal. In addition to the provided questionnaire, the authors conducted anthropometric measurements and measured the heart rate of the study participants before and during their fitness sessions. The exercise regimen involved low-intensity exercises using either light weights or solely the participants' body weight.

The participants were required to provide information about their dietary and fluid intake, their sleep patterns, and the quality of their sleep. The study group underwent anthropometric evaluations, which included measuring their height, weight, and body fat percentage. Various measurement tools were used, such as the ADE thaliometer and scale for weight and height, the GMA plicometer for assessing skinfold thickness, and the IMDK pulse oximeter for measuring heart rate.

To calculate the Basal Metabolic Rate (BMR), the Mifflin-St. Jeor formula was employed. The participants in the study also had to provide specific details about their menstrual cycle, including its duration, the intensity of pain experienced, the presence of blood clots, the use of pain medication, and the overall impact of the menstrual cycle on their daily lives.

Excel, utilizing the United States Department of Agriculture Data Base, was utilized to determine the participants' daily food and liquid intake, accurately measuring the quantities of macronutrients, micronutrients, and calories consumed.

d) Statistical processing

The data were statistically analyzed using GraphPad Prism 5.0 software. Descriptive statistical measures such as minimum and maximum values, means or medians, and standard deviations were employed. A standard 95% confidence interval (CI) was established for all the tests conducted.

Results

The study consisted of a cohort of 60 women who engaged in low-intensity fitness activities three times a week. These women expressed their interest in maintaining or achieving a healthy weight through regular exercise.

Upon analyzing the data, it was observed that there was a positive and statistically significant correlation between the participants' BMI and various factors, including the menstrual cycle, resting heart rate, heart rate before and after activity, medium/activity heart rate, and the duration of sleep (Table I).

Table I
Association between BMI and other parameters.

Parameter	Spearman r	95% CI	P value
Menstrual cycle	-0.4425	-0.6307 to -0.2050	0.0004
Resting heart rate	0.1748	-0.09052 to 0.4169	0.1817
Heart rate before activity	0.1831	-0.08195 to 0.4240	0.1614
Heart rate after activity	0.5344	0.3176 to 0.6981	< 0.0001
Medium/activity Heart rate	0.3961	0.1505 to 0.5956	0.0017
Sleeping	0.273	0.01274 to 0.4986	0.0348

The minimum BMI observed in the study was 18.37 while the maximum was 33.51. 70% of the total subjects fit in the normal weight criteria, while 25% were overweight or obese (Table II).

There is a significant positive association between weight and variables such as the menstrual cycle, resting heart rate, heart rate before and after activity, medium/activity heart rate, and sleep (Table III). The data reveal a strong and statistically significant relationship ($p>0.0001$) in the majority of cases.

Table III
Association between weight and other parameters.

Parameter	Spearman r	95% CI	P value
Menstrual cycle	-0.332	-0.5458 to -0.07752	0.0096
Rest heart rate	0.3682	0.1184 to 0.5741	0.0038
heart rate before activity	0.3404	0.08695 to 0.5524	0.0078
Heart rate after activity	0.5036	0.2791 to 0.6759	< 0.0001
Medium/activity heart rate	0.494	0.2673 to 0.6688	< 0.0001
Sleeping	0.2953	0.03696 to 0.5166	0.022

Weight was found to have no significant impact on bleeding time, as measured by the study. The average duration of menstruation was observed to be 4.5 days, while the average length of the menstrual cycle reported by the participants was 26.5 days (Table IV).

Table IV
Menstruation and menstrual cycle length (days)

Parameter	Menstruation	Menstrual cycle
Minimum	2.0	24.0
Medium	4.5	26.5
Maximum	6.0	28.0

Table II
Weight distribution.

Parameter	Normal weight	Underweight	Overweight	Obesity	Weight problems - total
Nr	42	3	9	6	18
%	70	5	15	10	30

The data analysis reveals a significant positive correlation (r=0.2953; 95% CI: 0.03696 to 0.5166) and a statistically significant connection (p=0.022) between age and magnesium intake.

Another crucial aspect examined in the study was the participants' sleep duration. The median reported value for sleep duration was 7.5 hours. Notably, no participant reported sleeping longer than 8 hours or less than 6.5 hours.

A substantial portion of the study's results focuses on comparing macronutrient intake with the group's requirements. Only 10% of the participants consume more than their daily intake needs, while 80% of the group falls short in their dietary intake.

The median calorie intake covers approximately 84% of the daily needs, indicating that the study group is consistently in a caloric deficit. The median protein intake covers only 45% of the daily needs, which is less than the recommended threshold of 0.5 grams per kilogram per day. On the other hand, the median fat intake covers 86% of the needs, and the median carbohydrate intake exceeds the daily requirements by 118% (Table V).

Table V
The intake of daily calories and macronutrients (%).

Parameter	Calories	Fats	Carbohydrates	Proteins
Minimum	28	32	36	18
Medium	84	86	118	45
Maximum	132	197	161	92

An additional significant finding pertains to the daily fiber intake. Across the three consecutive days, the average fiber intake ranged between 14-17 grams per day. The minimum recorded fiber intake varied between 3-6 grams per day, while the maximum value ranged from 34-81 grams per day.

As depicted in Table VI, both the caloric and macronutrient intake deviate significantly from the recommended needs for adult women.

Table VI
Reported food intake and necessary intake values.

Parameter	Calories	Fats (g)	Carbohydrates (g)	Proteins (g)
			Ingestion	
Minimum	419	15	52	20
Medium	1423	47.5	196	56.5
Maximum	2562	138	318	136
			Needs	
Minimum	1447	46.68	141.2	105.9
Medium	1694	54.7	165.6	124
Maximum	2014	70	196.5	147.5

Discussion

A significant correlation exists between weight, sleep, heart rate, and menstruation. Menstrual problems, which are common during reproductive age, include disturbances in monthly rhythms, ovarian dysfunction, and menstrual pain. Previous research has found that between 5% and 30% of adult women experience menstrual abnormalities. Age, endocrine disorders, reproductive factors, and modifiable lifestyle factors such as weight, physical activity, and stress have all been associated with menstrual cycle characteristics (Solomon et al., 2002; Alzueta et al., 2022).

The literature indicates that maintaining optimal physical, mental, and emotional functioning depends on obtaining adequate sleep. The ideal length of sleep is influenced by various individual and contextual factors (Marshall et al., 2008). Among individuals aged 18 to 60, it is generally recommended to get 7-9 hours of sleep per night to promote optimal health (Papatriantafyllou et al., 2022). In our study, we observed that the average sleep duration for the participants was 7.5 hours per night.

Other studies have also shown a correlation between obesity and sleep duration. Multiple studies have indicated that both short sleep duration (less than 6 hours) and long sleep duration (more than 8 or 9 hours) are associated with a higher risk of obesity compared to those who sleep for 7-8 hours (Fatima et al., 2016; Bleich et al., 2008; Chaput et al., 2007). For example, a Dutch study found that individuals who consistently slept for more than eight hours on consecutive nights had a 193% higher relative risk of obesity compared to those who slept for seven to eight hours (van den Berg et al., 2008). Studies have also shown that higher body mass index (BMI) is associated with an increased risk of cardiovascular and cerebrovascular diseases or obstructive sleep apnea (Whitlock et al., 2009; Lee & Cho, 2022).

In one of the initial studies exploring the link between sleep and successful weight reduction, a significant association was observed in a large sample of overweight or obese women participating in a weight loss intervention trial. The study consisted of two groups of women, each comprising an equal number of participants, who underwent separate 24-month weight-loss trials. The only difference between the groups was the duration of sleep, with one group sleeping for 7 hours or more per night. Both groups followed a comprehensive weight-loss plan that included behavioral counseling, an energy-reduced diet, suggestions for increased physical activity, and recommendations for modified sleep patterns. A third control group received general weight-loss counseling from a dietitian. The study found that higher sleep quantity and quality increased the likelihood of successful weight loss by 33% (Thomson et al., 2012).

Lack of sleep increases also the risk of type 2 diabetes, poor lipid-lipoprotein profiles, hypertension, and other cardiovascular diseases, and may even contribute to premature death (Quer et al., 2020; Song et al., 2021).

The results of our study indicate that over 70% of the participants require nutritional intervention. The sample group exhibited inadequate eating and sleeping patterns. There is a correlation between late dinners and snacks and difficulty falling asleep. The timing of meal consumption has been studied as a novel factor in the development, maintenance, and treatment of obesity. Consuming a significant amount of food late in the day or at night has been associated with increased body weight and may impede weight reduction (Lopes et al., 2019; Gallant et al., 2014).

Another study found that women with a BMI higher

than 25 kg/m^2 had higher odds of experiencing irregular and longer menstrual cycles (MacGregor et al., 2021). The study reported an average menstrual cycle length of 26.5 days, with most participants experiencing a 2-3 days irregularity in their monthly menstrual cycle.

It is recommended that all individuals aged 18 and above engage in aerobic physical activity for a minimum of 150 minutes per week at a moderate intensity or for a minimum of 75 minutes per week at a vigorous level. These activities should be spread out over at least three different days. Muscle-strengthening exercises should be performed at least twice a week (Malm et al., 2019). In our study, the sample group engaged in physical activity three times a week at a very low intensity. The study showed that they burned approximately 230 calories during each session, with the maximum and minimum values observed being 294 and 148 calories burned, respectively. However, only 10% of the group reached the maximum values.

The total intake of proteins, fats, carbohydrates, and calories reported by the women in our study significantly differed from the recommended dietary intake (Table VI). The necessary intake was also calculated statistically and compared to the literature (Wohlgemuth et al., 2021). The average values for calorie consumption by the group covered only 84% of their daily needs, fat intake covered 86%, and protein intake covered 45%. The average carbohydrate intake indicated that the study group consumed 118% of their daily needs.

Numerous studies have shown that consuming dietary fiber has several positive health effects. However, both adults and children consume less than half of the recommended daily intake of fiber. High dietary fiber intake has been found to significantly reduce the risk of coronary heart disease, stroke, hypertension, diabetes, obesity, and various gastrointestinal illnesses. Increasing fiber consumption also decreases serum cholesterol levels and blood pressure. Additionally, increasing soluble fiber intake improves glycemia and insulin sensitivity in both diabetics and non-diabetics (Anderson et al., 2009). Our results indicate that 90% of the sample group consumed less than 50% of the recommended daily intake of fiber.

Limitations: the research group was small and the duration of monitoring was very short, however, we intend to extend this observational study by increasing the number of participants and observing the data of the group for a longer period.

Conclusions

1. No apparent correlation can be observed between the BMI of the subjects and their menstrual cycles.

2. Participants with higher BMI values displayed higher heart rates at the conclusion of the exercise session and reported longer sleep durations.

3. The findings indicate a prevalent calorie deficit among amateur sportswomen, along with a significant deficiency in protein intake.

Conflict of interests

The authors state that they have no conflicts of interest.

Acknowledgment

The second author's bachelor's thesis includes some of this study preliminary findings.

References

Alzueta E, de Zambotti M, Javitz H, et al. Tracking Sleep, Temperature, Heart Rate, and Daily Symptoms Across the Menstrual Cycle with the Oura Ring in Healthy Women. Int J Womens Health. 2022;14:491-503. doi:10.2147/IJWH.S341917.

Anderson JW, Baird P, Davis RH Jr et al. Health benefits of dietary fiber. Nutr Rev. 2009;67(4):188-205.doi:10.1111/j.1753-4887.2009.00189.x.

Bayon V, Leger D, Gomez-Merino D, Vecchierini MF, Chennaoui M. Sleep debt and obesity. Ann Med. 2014; 46(5):264-272. doi:10.3109/07853890.2014.931103.

Bleich SN, Cutler D, Murray C, Adams A. Why is the developed world obese? Ann Rev Publ Health. 2008; 29:273-295. doi:10.1146/annurev.publhealth.29.020907.090954.

Chaput JP, Després JP, Bouchard C, Tremblay A. Short Sleep Duration is Associated with Reduced Leptin Levels and Increased Adiposity: Results from the Québec Family Study. Obesity. 2007; 15(1): 253-261. doi: 10.1038/oby.2007.512.

Chaput JP. Sleep patterns, diet quality and energy balance. Physiol Behav. 2014; 134:86-91. doi:10.1016/j.physbeh.2013.09.006.

Diaz A, Laufer MR, Breech LL, American Academy of Pediatrics Committee on Adolescence, American College of Obstetricians and Gynecologists Committee on Adolescent Health Care. Menstruation in girls and adolescents: using the menstrual cycle as a vital sign. Pediatrics. 2006;118(5):2245-2250. doi: 10.1542/peds.2006-2481.

Fatima Y, Doi SA, Mamun AA. Sleep quality and obesity in young subjects: a meta-analysis. Obes Rev. 2016; 17(11):1154-1166. doi:10.1111/obr.12444.

Gallant A, Lundgren J, Drapeau V. Nutritional Aspects of Late Eating and Night Eating. Curr Obes Rep. 2014; 3(1):101-107. doi:10.1007/s13679-013-0081-8.

Gast G-CM, Grobbee DE, Smit HA, Bueno-de-Mesquita HB, Samsioe GN, van der Schouw YT. Menstrual cycle characteristics and risk of coronary heart disease and type 2 diabetes. Fertil Steril. 2010; 94(6):2379-2381. doi: 10.1016/j.fertnstert.2010.03.044.

Kim JH, Kim O, Jung H, Pang Y, Dan H. Body mass index, menstruation, acne, and hirsutism of polycystic ovary syndrome in women: A cross-sectional study. Health Care Women Int. 2022; 43(1-3):85-97. doi:10.1080/07399332.2021.193934.

Lee JH, Cho J. Sleep and Obesity. Sleep Med Clin. 2022;17(1):111-116. doi:10.1016/j.jsmc.2021.10.009

Loef M, Walach H. The combined effects of healthy lifestyle behaviors on all cause mortality: a systematic review and meta-analysis. Prev Med. 2012; 55(3):163-170. doi:10.1016/j.ypmed.2012.06.017.

Lopes TDVC, Borba ME, Lopes RDVC et al. Eating Late Negatively Affects Sleep Pattern and Apnea Severity in Individuals With Sleep Apnea. J Clin Sleep Med. 2019;15(3):383-392. doi:10.5664/jcsm.7658.

MacGregor KA, Gallagher IJ, Moran CN. Relationship Between Insulin Sensitivity and Menstrual Cycle Is Modified by BMI, Fitness, and Physical Activity in NHANES. J Clin Endocrinol Metab. 2021 Sep 27;106(10):2979-2990. doi: 10.1210/clinem/dgab415.

Malm C, Jakobsson J, Isaksson A. Physical Activity and Sports-Real Health Benefits: A Review with Insight into the Public Health of Sweden. Sports (Basel). 2019;7(5):127. doi:10.3390/sports7050127.

Marshall NS, Glozier N, Grunstein RR. Is sleep duration related to obesity? A critical review of the epidemiological evidence.Sleep Med Rev. 2008; 12:289–298. doi:10.1016/j.smrv.2008.03.001

Papatriantafyllou E, Efthymiou D, Zoumbaneas E, Popescu CA, Vassilopoulou E. Sleep Deprivation: Effects on Weight Loss and Weight Loss Maintenance. Nutrients. 2022;14(8):1549. doi:10.3390/nu14081549.

Quer G, Gouda P, Galarnyk M, Topol EJ, Steinhubl SR. Inter- and intraindividual variability in daily resting heart rate and its associations with age, sex, sleep, BMI, and time of year: Retrospective, longitudinal cohort study of 92,457 adults. PLoS One. 2020;15(2):e0227709. doi:10.1371/journal.pone.0227709.

Solomon CG, Hu FB, Dunaif A, Rich-Edwards JE, Stampfer MJ, Willett WC, Speizer FE, Manson JE. Menstrual cycle irregularity and risk for future cardiovascular disease. J Clin Endocrinol Metab. 2002;87(5):2013-2017. doi: 10.1210/jcem.87.5.8471.

Song Z, Yang R, Wang W et al. Association of healthy lifestyle including a healthy sleep pattern with incident type 2 diabetes mellitus among individuals with hypertension. Cardiovasc Diabetol. 2021;20(1):239. doi: 10.1186/s12933-021-01434-z.

Thomson CA, Morrow KL, Flatt SW, Wertheim BC, Perfect MM, Ravia JJ, Sherwood NE, Karanja N, Rock CL. Relationship between Sleep Quality and Quantity and Weight Loss in Women Participating in a Weight-Loss Intervention Trial. Obesity. 2012;20(7):1419-1425. doi: 10.1038/oby.2012.62.

van den Berg J, Knvistingh Neven A, Tulen JHM et al. Actigraphic sleep duration and fragmentation are related to obesity in the elderly: the Rotterdam Study. Int J Obes. 2008;32(7):1083-1090. doi: 10.1038/ijo.2008.57.

Whitlock G, Lewington S, Sherliker P, Clarke R, Emberson J, Halsey J, Qizilbash N, Collins R, Peto R. Prospective Studies Collaboration. Body-mass index and cause-specific mortality in 900 000 adults: collaborative analyses of 57 prospective studies. Lancet. 2009; 373(9669):1083-1096. doi:10.1016/S0140-6736(09)60318-4.

Wohlgemuth KJ, Arieta LR, Brewer GJ, Hoselton AL, Gould LM, Smith-Ryan AE. Sex differences and considerations for female specific nutritional strategies: a narrative review. J Int Soc Sports Nutr. 2021;18(1):27. doi:10.1186/s12970-021-00422-8.