



Weight Class and Menstrual Symptoms in Female Judo Athletes

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Abstract

Background: Menstrual cycle and menstrual symptoms can affect the physical, mental and exercise performance of female athletes.

Objectives: This study aimed to determine the associated symptoms of premenstrual, menstrual, and postmenstrual periods in female judo athletes by weight class.

Methods: The participants were 169 female judo athletes aged between 18 and 21 years (age 19.5 ± 1.1 years, height 1.6 ± 0.1 m, body mass 64.8 ± 12.1 kg). Weight class and physical characteristics were measured using a questionnaire. Associated menstrual symptoms were measured using the Menstrual Distress Questionnaire (MDQ). For the purposes of this study, athletes of < 48 kg, < 52 kg, and < 57 kg weight were defined as “lightweight,” athletes of < 63 kg and < 70 kg as “medium weight,” and athletes of < 78 kg and > 78 kg as “heavyweight.”

Results: In the postmenstrual MDQ score, the scores for “lack of autonomic nervous system coordination” ($P = 0.037$), “poor concentration” ($P = 0.046$) and “water conservation” ($P = 0.030$) were higher in the lightweight ranks than in the medium and heavyweight ranks ($P < 0.05$). Scores for negative postmenstrual effects tended to be higher in the lightweight ranks than in the medium and heavy weight ranks ($P = 0.053$). For other items, there were no significant differences between the medium and heavy weight ranks and the lightweight ranks before, during, or after menstruation.

Conclusions: This study shows that the degree of postmenstrual symptoms in female judo athletes varies with weight class. These results will contribute to support the condition of female judo athletes based on their menstrual cycle by weight class.

Keywords: Judo, Menstrual Distress Questionnaire, Menstrual Symptoms, Weight Class

1. Background

Understanding the changes in mental and physical conditions caused by menstruation is important for female athletes, and an increasing number of studies have examined the impact of the menstrual cycle on athletic performance (1). A recent review reported a decrease in performance during the early follicular phase (2). Davies et al. reported that muscle strength, an objective measure of performance, is lower in the menstrual phase than in the follicular or luteal phases (3). On the contrary, it has also been reported that aerobic capacity and muscle strength are not related to the menstrual cycle, and no unified view has been obtained (3).

Menstruation causes not only bleeding but also mental and physical symptoms (4). The effects of menstruation on the mind include irritability before menstruation and

other emotional symptoms, as well as effects on appetite and concentration (5). Physical symptoms include menstrual cramps, breast pain, lethargy, and water retention (5). Therefore, it is important for female athletes to understand the mental and physical effects of menstruation on their condition to achieve optimal performance.

Previous studies have shown that female athletes who play weight-restricted sports, such as long-distance track and field athletes, gymnasts, or lightweight athletes in weight-class competitions, have higher rates of menstrual irregularities (6). Excessive weight loss and physical activity are known to affect menstruation through lack of available energy, mental and physical stress, loss of weight and body fat, and hormonal changes (6). Although frequent weight loss and high levels of anxiety have been reported in female judo athletes, particularly senior athletes (7), little is known on the psychological symptoms associated

with menstruation in judo athletes who lose weight. Since judo, like aesthetic sports, often involves weight restriction in the preparation for competition, the circumstances of menstruation-related symptoms need to be clarified.

2. Objectives

This study aimed to clarify the differences of menstruation-associated symptoms in female judo athletes by weight class.

3. Methods

3.1. Participants

This study was approved by the Institutional Ethics Committee on Human Research in Tokai University (approval number: 20017) and was conducted according to the Declaration of Helsinki. All participants gave written informed consent before participating in the study. A total of 169 female athletes aged 18 - 21 years who participated in a training camp organized by the Ajinomoto National Training Center from March 5 to March 7, 2019, were included in the study. The inclusion criteria for this study were (1) female, (2) judo athletes who could participate in the training camp organized by Ajinomoto National Training Center, and (3) those who gave their consent to participate in the study. The exclusion criteria were (1) male, (2) not attending the camp, and (3) unable to give consent to participate in the study. The subjects were provided with self-administered questionnaires during the camp and completed the questionnaires at their own time. The physical characteristics of the participants were as follows: age 19.5 ± 1.1 years, height 1.6 ± 0.1 m, body mass 64.8 ± 12.1 kg, body mass index 25.2 ± 3.8 kg/m², and training history 13.2 ± 2.6 years (mean \pm standard deviations). The number of female judo athletes in each weight class was 22 in < 48 kg class, 32 in < 52 kg class, 31 in < 57 kg class, 34 in < 63 kg class, 28 in < 70 kg class, 16 in < 78 kg class, and 6 in > 78 kg class. In this study, the < 48kg, < 52 kg, and < 57 kg classes were defined as lightweight classes, the < 63 kg and < 70 kg classes as medium weight classes, and the < 78 kg and > 78 kg classes as heavyweight classes. Baseline physical characteristics of the participants are shown in [Table 1](#).

3.2. Study Protocol

The subjects responded to a self-administered questionnaire consisting of their profile, judo practices, lifestyle, and a questionnaire survey on menstrual-associated symptoms. The profile included age, height, weight, body mass index (BMI), and age at menarche. The items under judo practice status were as follows: Judo

history, rank, weight dropped when losing weight, frequency of judo practice, and duration of practice session. Lifestyle habits were investigated in terms of sleeping hours and the frequency of eating breakfast on weekdays and holidays. For the Menstrual Distress Questionnaire (MDQ), we used the 46-item questionnaire of the modified MDQ, which was developed by Moos (8) and translated into Japanese by Akiyama et al. in 1979 (9).

3.3. Statistical Analyses

Data were subjected to statistical analysis by calculating the mean and the standard deviation. One-way analysis of variance (ANOVA) was conducted for the participants' profiles, judo practice, lifestyle, and total MDQ scores by class. The subscales of the MDQ were subjected to one-way ANOVA for each of the three weight classes. Where significant effects were found, the values were subsequently analyzed with post hoc analysis for multiple comparisons using the Bonferroni method. In addition, comparisons between the lightweight and medium/heavyweight classes and between the light/mediumweight class and the heavyweight class were examined using an unpaired t-test. The effect size for the ANOVA was calculated as η^2 and the effect size for the t-test was calculated as 95% CI. Significance levels were set at 5% and less. All statistical analyses were performed using the SPSS Statistics version 25 statistical analysis software (IBM Corporation, Armonk NY, USA), and the statistical significance was set at $P < 0.05$.

4. Results

4.1. Characteristics of Subjects

The profile, judo practice status, lifestyle habits, and total MDQ scores of the athletes by class are shown in [Table 1](#). There were significant differences in weight ($P < 0.001$), age of menarche ($P = 0.035$), and weight loss between the classes ($P < 0.021$). Age of menarche was earlier in the heavyweight class compared with the light weight class ($P < 0.05$, 95% CI 0.088 - 2.255). Weight loss was tended to greater in the lightweight class than in the heavyweight class ($P < 0.05$, 95% CI -0.033 - 1.543). There were no significant differences in other profile, judo practice status, lifestyle habits, and total score of MDQ among the light, medium, and heavyweight classes ([Table 1](#)).

4.2. Comparison of MDQ Scores Between the Three Weight Classes

MDQ sub scores per menstrual cycle were compared among light, medium, and heavyweight classes. One-way ANOVA revealed that there was no significant difference in control, arousal, behavioral change, autonomic reactions, concentration, water retention, pain, negative affect, other among the groups ($P > 0.05$) ([Table 2](#)).

Table 2. MDQ Scores Between the Three Weight Classes^a

	Light Class (-48 kg, -52 kg, -57 kg)		Middle Class (-57 kg, -63 kg, -70 kg)		Heavy Class (-78 kg, -78 kg)		P	η^2
	n	Means \pm SD	n	Means \pm SD	n	Means \pm SD		
Premenstrual								
Control	83	1.2 \pm 3.0	61	1.0 \pm 2.4	22	1.2 \pm 1.7	0.915	0.001
Arousal	84	1.1 \pm 2.3	62	0.5 \pm 1.2	22	0.9 \pm 1.6	0.095	0.028
Behavioral change	83	3.8 \pm 3.7	62	3.3 \pm 3.7	22	3.9 \pm 3.6	0.673	0.005
Autonomic reactions	84	1.2 \pm 2.1	62	1.0 \pm 1.8	22	1.3 \pm 1.8	0.772	0.003
Concentration	84	3.4 \pm 4.7	61	2.4 \pm 3.8	22	3.7 \pm 4.7	0.300	0.015
Water retention	84	5.5 \pm 3.2	62	5.5 \pm 3.7	22	6.4 \pm 3.4	0.575	0.007
Pain	84	5.8 \pm 4.7	62	5.5 \pm 5.0	22	6.7 \pm 5.3	0.638	0.005
Negative affect	84	5.0 \pm 5.5	62	3.7 \pm 5.3	22	5.4 \pm 5.3	0.283	0.015
Other	84	0.4 \pm 0.8	62	0.4 \pm 0.9	22	0.6 \pm 1.1	0.571	0.007
During menstruation								
Control	83	1.0 \pm 2.8	61	1.0 \pm 2.4	22	1.3 \pm 2.2	0.898	0.001
Arousal	84	1.3 \pm 2.4	62	1.0 \pm 1.6	22	1.0 \pm 2.1	0.657	0.005
Behavioral change	84	3.8 \pm 3.2	62	3.8 \pm 3.3	22	4.6 \pm 2.7	0.550	0.007
Autonomic reactions	84	2.3 \pm 2.4	61	2.2 \pm 2.9	22	2.1 \pm 2.4	0.937	0.001
Concentration	84	3.9 \pm 4.3	62	3.2 \pm 3.7	22	4.9 \pm 4.6	0.247	0.017
Water retention	84	4.0 \pm 2.7	62	4.1 \pm 3.0	22	4.0 \pm 2.7	0.987	<0.001
Pain	84	7.9 \pm 4.1	62	8.1 \pm 5.0	22	9.5 \pm 4.4	0.326	0.014
Negative affect	84	5.6 \pm 5.2	62	4.6 \pm 5.9	22	5.8 \pm 5.8	0.518	0.008
Other	84	0.2 \pm 0.6	62	0.1 \pm 0.5	22	0.5 \pm 0.9	0.071	0.031
Postmenstrual								
Control	83	0.4 \pm 1.6	60	0.3 \pm 1.3	22	0.4 \pm 1.3	0.767	0.003
Arousal	84	1.1 \pm 2.3	62	0.7 \pm 1.8	22	1.3 \pm 1.9	0.394	0.011
Behavioral change	83	1.4 \pm 2.3	61	0.9 \pm 1.4	22	1.4 \pm 1.7	0.203	0.019
Autonomic reactions	84	0.5 \pm 1.3	62	0.1 \pm 0.6	22	0.3 \pm 0.9	0.083	0.030
Concentration	84	1.2 \pm 2.7	62	0.5 \pm 1.5	22	0.7 \pm 1.9	0.124	0.025
Water retention	84	1.0 \pm 1.5	62	0.6 \pm 1.0	22	0.5 \pm 1.0	0.089	0.029
Pain	84	1.6 \pm 2.8	62	1.2 \pm 2.2	22	1.3 \pm 1.9	0.576	0.007
Negative affect	84	1.3 \pm 2.8	62	0.5 \pm 1.4	22	0.8 \pm 2.3	0.133	0.024
Other	84	0.1 \pm 0.4	62	0.0 \pm 0.1	22	0.1 \pm 0.3	0.316	0.014

^aMeans were compared using one-factor ANOVA for the main effect of trial followed by a Bonferroni test.

Table 3. MDQ Scores for Each of the Two Weight Classes ^a

	Premenstrual		During Menstruation		Postmenstrual	
	Light Class vs Middle and Heavy Class, P (95% CI)	Light and Middle Class vs Heavy Class, P (95% CI)	Light Class vs Middle and Heavy Class, P (95% CI)	Light and Middle Class vs Heavy Class, P (95% CI)	Light Class vs Middle and Heavy Class, P (95% CI)	Light and Middle Class vs Heavy Class, P (95% CI)
Control	0.768 (-0.686 - 0.927)	0.788 (-0.999 - 0.760)	0.835 (-0.882 - 0.714)	0.433 (-1.214-0.522)	0.498 (-0.291-0.598)	0.682 (-0.585-0.384)
Arousal	0.054 (-0.009 - 1.128)	0.300 (-0.297 - 0.955)	0.359 (-0.341 - 0.937)	0.394 (-0.396-1.002)	0.401 (-0.368-0.915)	0.731 (-0.825-0.580)
Behavioral change	0.562 (-0.793 - 1.455)	0.958 (-1.262 - 1.195)	0.717 (-1.149 - 0.792)	0.524 (-1.404-0.717)	0.159 (-0.172-1.040)	0.421 (-0.392-0.933)
Autonomic reactions	0.691 (-0.471 - 0.709)	0.934 (-0.619 - 0.673)	0.728 (-0.656 - 0.938)	0.631 (-1.082-0.658)	0.037 (0.021-0.669)	0.534 (-0.247-0.470)
Concentration	0.311 (-0.653 - 2.040)	0.784 (-1.269 - 1.679)	0.699 (-1.023 - 1.523)	0.524 (-1.841-0.941)	0.046 (0.012-1.369)	0.272 (-0.330-1.164)
Water retention	0.654 (-1.287 - 0.810)	0.889 (-1.229 - 1.066)	0.912 (-0.899 - 0.804)	0.405 (-0.536-1.321)	0.030 (0.044-0.837)	0.015 (0.089-0.832)
Pain	0.987 (-1.475 - 1.499)	0.917 (-1.713 - 1.540)	0.376 (-1.994 - 0.757)	0.515 (-0.200-1.008)	0.302 (-0.357-1.142)	0.301 (-0.387-1.250)
Negative affect	0.320 (-0.817 - 2.483)	0.969 (-1.845 - 1.775)	0.455 (-1.051 - 2.337)	0.892 (-1.984-1.728)	0.053 (-0.010-1.415)	0.488 (-0.509-1.063)
Other	0.431 (-0.375 - 0.161)	0.721 (-0.347 - 0.240)	0.717 (-0.159 - 0.230)	0.676 (-0.258-0.168)	0.278 (-0.389-0.134)	0.989 (-0.095-0.094)

^aValues are P value and 95% CI. Means were compared using *t*-test.

4.3. Comparison of MDQ Scores Between Light Weight vs. Medium and Heavyweight Classes

In the postmenstrual period, MDQ scores for autonomic nervous system incoordination ($P = 0.037$, 95% CI 0.021 - 0.669), poor concentration ($P = 0.046$, 95% CI 0.012 - 1.369), and water retention ($P = 0.030$, 95% CI 0.044 - 0.837) were higher in the lightweight class compared with the medium and heavyweight classes. In addition, the scores of negative affects tended to be higher in the lightweight class than in the medium and heavyweight classes after menstruation ($P = 0.053$, 95% CI -0.103 - 1.415). There was no significant difference in the other parameters between the medium and heavyweight ranks and the lightweight classes either in premenstrual, menstrual, or post menstrual periods (Table 3).

5. Discussion

The purpose of this study was to clarify the differences in menstruation-associated symptoms by weight class among female judo athletes. The results showed that postmenstrual autonomic nervous system dysfunction, decreased concentration, and water retention were higher in the lightweight class compared with the medium and heavyweight classes. The concentration of female ovarian hormones (estrogen, progesterone) changes continuously throughout the menstrual cycle, and it has been shown that the ratio of estrogen to progesterone has a variety of effects on the body (10). Although many studies have shown that the condition of female athletes is

worse before and during menstruation (11, 12), the present study is the first to demonstrate that postmenstrual recovery of menstruation-related symptoms is suppressed in lightweight female athletes in classified sports. These results will contribute to supporting the condition of female judo athletes in accordance with the menstrual cycle.

Carmichael et al. reported that sports performance was affected by the menstrual cycle and was lower in the early follicular phase and late luteal phase (13). In fact, as a result of examining the menstrual cycle and performance of 241 female athletes, there were many athletes whose condition deteriorated just before menstruation (14). Furthermore, it is reported that the incidence of menstrual dysfunction is as high as 58.3% in female judoka athletes (15). A distinctive finding of the study was that postmenstrual MDQ scores were worse in lightweight female judo athletes. Although few studies have examined physiological symptoms and the frequency of weight loss in female judo athletes by weight class, the present study revealed that lightweight female judo athletes had an earlier age at menarche and greater weight loss than female judo athletes in other weight classes. Excessive weight loss leads to various menstruation-related symptoms (16). The results of this study, which showed that MDQ scores did not recover after menstruation in the lightweight class, suggest that menstrual symptoms may be more serious in the lightweight class with greater weight loss. Previous research has pointed to the need to vary the training of female judo athletes according to their menstrual cycle (17), and the present study may contribute to the condition of

female judo athletes by indicating that menstrual symptoms vary according to weight class.

The results of the present study show that the autonomic nervous system, water retention, and concentration were not recovered in the lightweight class during the postmenstrual period. Previous studies have reported that weight loss can affect autonomic nervous system (18) and mental abilities such as lack of concentration (19). Water deprivation is often used as a method of weight loss in combat sports athletes (20). The endocrine hormones aldosterone and antidiuretic hormone regulate osmolarity through the retention of electrolytes and body fluids (21). The loss of body water by rapid weight loss might reduce the ability of hormones to maintain homeostasis.

There are several strengths of the present study. First, this study examined premenstrual, menstrual, and postmenstrual MDQ scores in female judo athletes by weight class. Although judo athletes of all ranks trained for the same amount of time and the same amount of weight, postmenstrual symptoms were more severe in lightweight than in medium and heavyweight female judo athletes, which represent an essential finding in the condition of female athletes. Second, we examined the physical symptoms of menstruation in female judo athletes who have a relatively high BMI. Although menstrual irregularities have been reported to occur in underweight athletes such as gymnasts and long-distance track and field athletes (22), our study showed that menstrual symptoms also occur in women with a BMI of 25 or more, such as female judo athletes. However, the study also has some limitations. The first is the small number of participants, especially in the heavyweight class. The small number of participants in the heavyweight class compared with the medium and lightweight classes may have affected the statistical results. Second, the study examined the MDQ scores of premenstrual, menstrual, and postmenstrual by weight class; however, physical parameters such as body fat and skeletal muscle mass were not measured. Thus, the influence of physical parameters cannot be discussed as a reason for the differences in MDQ scores among weight classes. Future studies are needed to examine menstrual symptoms and physical parameters in female judo athletes at the same time to determine the reasons for the association between weight class and menstrual symptoms. Third, the accuracy of the MDQ has been widely discussed, especially the validity of the translated version across different cultures and types of symptoms by ethnicity (23). Therefore, future research should include not only the MDQ but also a wide range of surveys on menstrual symptoms. Finally, future studies should also evaluate menstrual-associated symptoms in female judo athletes from the perspective of energy availability. Since low available energy due to excessive dietary restriction has been associated with amenor-

rhea and osteoporosis, future studies should also examine the energy availability as a cause of menstrual-associated symptoms (24).

5.1. Conclusions

This study showed that lightweight female judo athletes reported worse autonomic dysreflexia, concentration difficulties, and water retention after menstruation compared with medium and heavyweight female judo athletes. Therefore, the approach to menstrual symptoms is necessary for different ranks in martial arts sports such as judo, as well as for aesthetic and lighter weight female athletes, which have been studied in the previous studies.

Footnotes

Authors' Contribution: Study concept and design: T. I., M. T. and Y.K.; analysis and interpretation of data: K. F., T. I. and Y. O.; drafting of the manuscript: K. F.; critical revision of the manuscript for important intellectual content: S. M. and Y. O.; statistical analysis: K. F. and T.I.

Conflict of Interests: The authors have no conflicts of interest relevant to this article.

Data Reproducibility: The data presented in this study are openly available in one of the repositories or will be available on request from the corresponding author by this journal representative at any time during submission or after publication. Otherwise, all consequences of possible withdrawal or future retraction will be with the corresponding author

Ethical Approval: This study was approved by the Institutional Ethics Committee on Human Research in Tokai University (approval number: 20017) and was conducted according to the Declaration of Helsinki.

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Informed Consent: All participants gave written informed consent before participating in the study. Since this study was an observational study based on a single survey, we explained the study and obtained consent by responding to the questionnaire. In addition, the submitted questionnaire did not include a name and was anonymous.

References

1. Janse de Jonge XA. Effects of the menstrual cycle on exercise performance. *Sports Med.* 2003;33(11):833–51. [PubMed ID: 12959622]. <https://doi.org/10.2165/00007256-200333110-00004>.
2. McNulty KL, Elliott-Sale KJ, Dolan E, Swinton PA, Ansdell P, Goodall S, et al. The Effects of Menstrual Cycle Phase on Exercise Performance in Eumenorrheic Women: A Systematic Review and Meta-Analysis. *Sports Med.* 2020;50(10):1813–27. [PubMed ID: 32661839]. [PubMed Central ID: PMC7497427]. <https://doi.org/10.1007/s40279-020-01319-3>.

3. Davies BN, Elford JC, Jamieson KF. Variations in performance in simple muscle tests at different phases of the menstrual cycle. *J Sports Med Phys Fitness*. 1991;**31**(4):532-7.
4. Schoene RB, Robertson HT, Pierson DJ, Peterson AP. Respiratory drives and exercise in menstrual cycles of athletic and nonathletic women. *J Appl Physiol Respir Environ Exerc Physiol*. 1981;**50**(6):1300-5. [PubMed ID: 7263392]. <https://doi.org/10.1152/jappl.1981.50.6.1300>.
5. Critchley HOD, Babayev E, Bulun SE, Clark S, Garcia-Grau I, Gregersen PK, et al. Menstruation: science and society. *Am J Obstet Gynecol*. 2020;**223**(5):624-64. [PubMed ID: 32707266]. [PubMed Central ID: PMC7661839]. <https://doi.org/10.1016/j.ajog.2020.06.004>.
6. Dickerson LM, Mazyck PJ, Hunter MH. Premenstrual syndrome. *Am Fam Physician*. 2003;**67**(8):1743-52.
7. Nazem TG, Ackerman KE. The female athlete triad. *Sports Health*. 2012;**4**(4):302-11. [PubMed ID: 23016101]. [PubMed Central ID: PMC3435916]. <https://doi.org/10.1177/1941738112439685>.
8. Escobar-Molina R, Rodriguez-Ruiz S, Gutierrez-Garcia C, Franchini E. Weight loss and psychological-related states in high-level judo athletes. *Int J Sport Nutr Exerc Metab*. 2015;**25**(2):110-8. [PubMed ID: 25029701]. <https://doi.org/10.1123/ijnsnem.2013-0163>.
9. Akiyama A, Kayashima E, Matsui Y, Miyamoto S, editors. *Menstrual Distress Questionnaire (MDQ) Psychological Measurement Fixed Scale Collection VI*. Tokyo: Science; 1979. [Japanese].
10. Sung ES, Kim JH. The difference effect of estrogen on muscle tone of medial and lateral thigh muscle during ovulation. *J Exerc Rehabil*. 2018;**14**(3):419-23. [PubMed ID: 30018928]. [PubMed Central ID: PMC6028216]. <https://doi.org/10.12965/jer.1836110.055>.
11. Findlay RJ, Macrae EHR, Whyte IY, Easton C, Forrest Nee Whyte LJ. How the menstrual cycle and menstruation affect sporting performance: experiences and perceptions of elite female rugby players. *Br J Sports Med*. 2020;**54**(18):1108-13. [PubMed ID: 32349965]. <https://doi.org/10.1136/bjsports-2019-101486>.
12. Carmichael MA, Thomson RL, Moran LJ, Dunstan JR, Nelson MJ, Mathai ML, et al. A Pilot Study on the Impact of Menstrual Cycle Phase on Elite Australian Football Athletes. *Int J Environ Res Public Health*. 2021;**18**(18). [PubMed ID: 34574516]. [PubMed Central ID: PMC8471812]. <https://doi.org/10.3390/ijerph18189591>.
13. Carmichael MA, Thomson RL, Moran LJ, Wycherley TP. The Impact of Menstrual Cycle Phase on Athletes' Performance: A Narrative Review. *Int J Environ Res Public Health*. 2021;**18**(4). [PubMed ID: 33572406]. [PubMed Central ID: PMC7916245]. <https://doi.org/10.3390/ijerph18041667>.
14. Kishali NF, Imamoglu O, Katkat D, Atan T, Akyol P. Effects of menstrual cycle on sports performance. *Int J Neurosci*. 2006;**116**(12):1549-63. [PubMed ID: 17145688]. <https://doi.org/10.1080/00207450600675217>.
15. Rouveix M, Bouget M, Pannafieux C, Champely S, Filaire E. Eating attitudes, body esteem, perfectionism and anxiety of judo athletes and nonathletes. *Int J Sports Med*. 2007;**28**(4):340-5. [PubMed ID: 17024652]. <https://doi.org/10.1055/s-2006-924334>.
16. Falsetti L, Pasinetti E, Mazzani MD, Gastaldi A. Weight loss and menstrual cycle: clinical and endocrinological evaluation. *Gynecol Endocrinol*. 1992;**6**(1):49-56. [PubMed ID: 1580168]. <https://doi.org/10.3109/09513599209081006>.
17. Kakiashvili LO, Iashvili GM, Chkhikvishvili MA, Khvedelidze KR. Muscle strength and mobility of nerve processes among women judoists taking into account their menstrual cycle. *Georgian Med News*. 2006;(137):65-8.
18. Costa J, Moreira A, Moreira P, Delgado L, Silva D. Effects of weight changes in the autonomic nervous system: A systematic review and meta-analysis. *Clin Nutr*. 2019;**38**(1):10-26. [PubMed ID: 29395374]. <https://doi.org/10.1016/j.clnu.2018.01.006>.
19. Franchini E, Brito CJ, Artioli GG. Weight loss in combat sports: physiological, psychological and performance effects. *J Int Soc Sports Nutr*. 2012;**9**(1):52. [PubMed ID: 23237303]. [PubMed Central ID: PMC3607973]. <https://doi.org/10.1186/1550-2783-9-52>.
20. Barley OR, Chapman DW, Abbiss CR. Weight Loss Strategies in Combat Sports and Concerning Habits in Mixed Martial Arts. *Int J Sports Physiol Perform*. 2018;**13**(7):933-9. [PubMed ID: 29283792]. <https://doi.org/10.1123/ijpspp.2017-0715>.
21. Thornton SN. Thirst and hydration: physiology and consequences of dysfunction. *Physiol Behav*. 2010;**100**(1):15-21. [PubMed ID: 20211637]. <https://doi.org/10.1016/j.physbeh.2010.02.026>.
22. Torstveit MK, Sundgot-Borgen J. The female athlete triad: are elite athletes at increased risk? *Med Sci Sports Exerc*. 2005;**37**(2):184-93. [PubMed ID: 15692312]. <https://doi.org/10.1249/01.mss.0000152677.60545.3a>.
23. Lee Y, Sohng K. Translation and Cross-Cultural Validation of Korean Version of the Menstrual Distress Questionnaire. *SAGE Open*. 2020;**10**(3):215824402095155. <https://doi.org/10.1177/2158244020951550>.
24. Nattiv A, Loucks AB, Manore MM, Sanborn CF, Sundgot-Borgen J, Warren MP, et al. American College of Sports Medicine position stand. The female athlete triad. *Med Sci Sports Exerc*. 2007;**39**(10):1867-82. [PubMed ID: 17909417]. <https://doi.org/10.1249/mss.0b013e318149f111>.

Table 1. Baseline Physical Characteristics of the Participants^a

	Lightweight Class (< 48 kg, < 57 kg)			Middleweight Class (< 63 kg, < 70 kg)			Heavyweight Class (< 78 kg, > 78 kg)			One-way ANOVA	
	n	Means ± SD	n	Means ± SD	n	Means ± SD	n	Means ± SD	P	η^2	
Subjective profile											
Age (y)	85	19.6 ± 1.1	62	19.5 ± 1.0	22	19.5 ± 1.1	22	19.5 ± 1.1	0.861	0.002	
Training history (y)	85	13.5 ± 2.6	62	13.0 ± 2.4	22	12.5 ± 3.1	22	12.5 ± 3.1	0.262	0.016	
Height (m)	85	1.6 ± 0.1	62	1.6 ± 0.1	22	1.6 ± 0.1	22	1.6 ± 0.1	0.443	0.010	
Weight (kg)	85	56.4 ± 4.1	62	68.3 ± 3.5	22	87.7 ± 13.8	22	87.7 ± 13.8	< 0.001	0.747	
BMI (kg/m ²)	85	25.1 ± 4.0	62	25.5 ± 3.7	22	25.2 ± 3.2	22	25.2 ± 3.2	0.795	0.003	
Age at menarche (y)	74	12.8 ± 1.9	52	12.6 ± 1.5	18	11.7 ± 1.0	18	11.7 ± 1.0	0.035	0.046	
Judo practices											
Loss of weight (kg)	79	3.9 ± 1.7	44	3.2 ± 1.8	5	2.4 ± 1.9	5	2.4 ± 1.9	0.021	0.060	
Frequency of practice (day/week)	85	6.0 ± 0.3	62	6.0 ± 0.2	21	6.0 ± 0.2	21	6.0 ± 0.2	0.908	0.001	
Training hours (hours/day)	85	3.1 ± 0.8	62	3.3 ± 0.8	22	3.2 ± 0.7	22	3.2 ± 0.7	0.581	0.007	
Lifestyle											
Hours of sleep on weekdays (hours/day)	85	6.6 ± 0.9	62	6.7 ± 0.7	22	6.6 ± 0.7	22	6.6 ± 0.7	0.751	0.003	
Sleeping hours on holidays (hours/day)	84	8.1 ± 1.6	62	8.2 ± 1.1	22	8.4 ± 0.8	22	8.4 ± 0.8	0.754	0.003	
Frequency of breakfast intake (times/week)	85	1.3 ± 0.7	62	1.4 ± 0.7	22	1.2 ± 0.4	22	1.2 ± 0.4	0.469	0.009	
Total score of MDQ											
Premenstrual	84	27.3 ± 24.5	62	23.3 ± 22.6	22	30.0 ± 22.3	22	30.0 ± 22.3	0.424	0.010	
During menstruation	84	30.0 ± 23.0	62	28.0 ± 21.6	22	33.7 ± 22.2	22	33.7 ± 22.2	0.580	0.007	
Postmenstrual	84	8.7 ± 15.5	61	4.8 ± 8.6	22	6.8 ± 10.1	22	6.8 ± 10.1	0.187	0.020	

Abbreviations: SD, standard deviation; ANOVA, analysis of variance; BMI, body mass index; MDQ, Menstrual Distress Questionnaire.
^aMeans were compared using one-way ANOVA for the main effect of trial followed by a Bonferroni test.