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Original

EFECTOS DE LA INTERVENCIÓN MATUTINA AERÓBICA SOBRE LOS CAMBIOS DE COMPOSICIÓN CORPORAL EN MUJERES JÓVENES DE MAÑANA Y SIN CRONOTIPOS

EFFECTS OF AEROBIC MORNING INTERVENTION ON BODY COMPOSITION CHANGES IN YOUNG WOMEN OF MORNING AND NEITHER CHRONOTYPES

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RESUMEN

Este estudio tuvo como objetivo comparar el efecto de una intervención física matutina sobre la composición corporal de mujeres jóvenes (n = 8, edad media ± D.T. = 23,1 ± 1,0 años, altura media ± D.T. = 168,9 ± 5,8 cm, peso medio ± D.T. = 66,2 ± 6,8 kg) del cronotipo matinal (tipos M) vs. mujeres jóvenes (n = 25, edad media ± D.T. = 21,4 ± 1,5 años, altura media ± D.T. = 167,1 ± 5,4 cm, peso medio ± D.T. = 65,6 ± 7,8 kg) de ninguno de los dos cronotipos (tipos I). Utilizamos análisis de bioimpedancia para detectar cambios en los siguientes indicadores: peso, índice de masa corporal, masa grasa (FM%), masa libre de grasa (FFM), masa muscular (MM), agua corporal total (TBW), agua corporal total y extracelular (ECW/TBW), proporción de masa celular extracelular y corporal (ECM/BCM) y ángulo de fase (PA). Los efectos de la intervención en los grupos se compararon y evaluaron mediante la d de Cohen dentro del procedimiento estadístico de prueba t de muestras apareadas, que no mostró diferencias significativas en todos los indicadores, excepto AF, entre el pretest y el postest (p> 0,05). Se denotó y examinó una mejora estadística en la PA de los tipos N. La diferencia más significativa se encontró en el indicador ECM/BCM, que se estimuló de forma más eficaz en los tipos M después de la intervención de la mañana en comparación con los tipos N. Los participantes de tipo M mejoraron en ECM/BCM (d = 0,62) y AF (d = 0,70) con un efecto medio, pero puntuaron peor en FM% (d = 0,47) con un efecto pequeño, FFM (d = 0,00). 43), MM (d = 0,42) y TBW (d = 0,40), mientras que no se encontró ningún efecto en ECW/TBW (d = 0,15). Los participantes de tipo N mejoraron en AF (d = 0,60) con un efecto medio, FFM (d = 0,29), MM (d = 0,28) y ECW/TBW (d = 0,28) con un efecto pequeño; no se observó ningún efecto en ECM/BCM (d = 0,01), FM% (d = 0,03) y TBW (d = 0,04). Los resultados mostraron que los parámetros ECM/BCM y PA fueron más sensibles que los otros parámetros. Nuestros hallazgos indican la importancia de una mayor exploración y examen del problema del examen del efecto del tiempo en cronotipos particulares.

Palabras clave: Aerobic; Cronotipo matutino; Ejercicio mañanero; Aptitud física;

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ABSTRACT

This experimental study aimed to compare the effect of an aerobic intervention on the body composition (BC) of young women (n = 8, mean age ± SD = 23.1 ± 1.0 years, mean height ± SD = 168.9 ± 5.8 cm, mean weight ± SD = 66.2 ± 6.8 kg) of the morning chronotype (M-types) vs. young women (n = 25, mean age ± SD = 21.4 ± 1.5 years, mean height ± SD = 167.1 ± 5.4 cm, mean weight ± SD = 65.6 ± 7.8 kg) of the intermediate chronotype (I-types). We used bioimpedance analysis (BIA) to detect changes in the following indicators: body weight (BM), body mass index (BMI), fat mass (FM%), fat free mass (FFM), muscle mass (MM), total body water (TBW), extracellular and total body water ratio (ECW/TBW), extracellular and body cell mass ratio (ECM/BCM), and phase angle (PA). Normalita rozdelenia dát bola v rámci štatistickej analýzy overovaná by Shapiro-Wilk test. Intervention effects in groups were compared and evaluated by Cohen’s d within the statistical procedure of paired samples t-test, which did not show any significant differences in all indicators, except PA, between the pre-test and post-test (p>0.05). Statistical improvement was denoted and examined in the PA of the I-types. The most significant difference was found in the ECM/BCM indicator, which was stimulated more effectively in M-types after the aerobic intervention compared with the I-types. M-type participants improved in ECM/BCM (d = 0.62) and PA (d = 0.70) with a medium effect, but scored worse in FM% (d = 0.47) with a small effect, FFM (d = .43), MM (d = 0.42), and TBW (d = 0.40), whereas no effect was found in ECW/TBW (d = 0.15). I-type participants improved in PA (d = .60) with a medium effect, FFM (d = 0.29), MM (d = 0.28), and ECW/TBW (d = 0.28) with a small effect; no effect was observed in ECM/BCM (d = 0.01), FM% (d = 0.03), and TBW (d = 0.04). The results showed that the ECM/BCM and PA parameters were more sensitive than the other parameters. Our findings indicate the importance of further exploration and examination of the problem of time effect examination on particular chronotypes.

Keywords: aerobics; composite scale of morningness; morning chronotype; intermediate chronotype; university students.

INTRODUCCIÓN

People face constant requirements to increase the effectiveness of processes in many spheres, such as work, education, training, and physical programs. The modern lifestyle is characterised by a focus on business, a rushed schedule, and a lack of physical activity. People eat unhealthy products and foods with high calorie content. One consequence of such a lifestyle is obesity, which is a problem not only in adulthood but also in childhood. Body composition (BC) analysis is a high-quality method for assessing the state of the components of the body in detail. Bunc et al. (2015) reported that BC is the main predictor of physical fitness and also play an important role in physical performance (Mala et al., 2015). Current scientific and clinical tasks are aimed at finding optimal forms, methods, and programs with targeted interventions. The importance of the positive impact of aerobic exercise on human health is highlighted by many studies (Mersy, 1991; Guiney & Machado, 2013; Swift et al., 2014; etc.). In previous years, the COVID-19 pandemic caused a major problem. The COVID-19 pandemic situation was characterised by limitations and restrictions with respect to physical activities, as people are compelled to work at home. Reduced physical activity during the COVID-19 pandemic has been confirmed by research (Castañeda-Babarro et al., 2020; Luciano et al., 2021;Violant-Holz et al., 2020).

Chronobiology offers many options in which aerobic physical interventions can be effective. Knowledge of the optimal time for physical interventions for each person can present the potential for more effective intervention. The division of the biological day (the diurnal period of the 24-hour circadian day) into a morning and an afternoon part prompted the emergence of the perception of personality in a chronobiological context into two chronotypes: i) morning chronotype is the type of person who is more active, or more inclined to the morning part of the diurnal period, i) the evening chronotype is the type of person who is more active predominantly in the afternoon to evening part of the diurnal period. In chronobiology, we can also distinguish a neutral (intermediate) chronotype, which does not dominantly prefer a particular phase of the day. The basic difference between chronotypes is also the different circadian and diurnal oscillations and phases of physiological markers. The most commonly studied marker in relation to chronotype is body core temperature. Baehr et al. (2000) in a sample of young people (n = 172) found that the minimum body temperature during the circadian period was recorded first for morning chronotypes (3.50 $^{a.m.}$), followed by neutral (5.02 $^{a.m.}$) and evening (6.01 $^{a.m.}$) chronotypes, indicating the best readiness in the morning hours for morning chronotypes. Thus, individuals must exercise according to their particular chronotype, which is one of the optimisation elements. Studies (e.g. Henst et al., 2015; Vitale & Weydahl, 2017) have confirmed lent support to the theory on the relation of chronotype and time precondition of the best performance. A significant benefit of physical programs whose effectiveness is connected with chronotypes is that optimisation respects biorhythms, which are important from the point of view of health. Many studies that have focused on chronotype and diurnal performance problems have suggested the creation of time stereotypes and chronotype preference (e.g. Rae et al., 2015; Montaruli et al., 2017). The time of work or intensive activities impacts the creation of chronotype preferences. Lastella et al. (2016) and Roveda et al. (2020) examined the relation between the identified chronotype and diurnal performance. They detected a relation between chronotype and the best performance at the time of the training process. Kentiba et al. (2020) found that chronotype and training time are not related in the majority of students of the intermediate and morning chronotypes at an African university (Ethiopia). However, they recommended that the time of training and chronotype should be in harmony. Mulè et al. (2019) examined the better dispositions for physical activities among morning chronotype university students in the morning hours, whereas evening chronotype students tend to feel better in the evening hours. Other studies (e.g. Sedliak et al., 2009; Blonc et al., 2010) have compared the effects of morning and evening exercises on the stimulation of strength components. They did not find any significant differences in the five- and ten-week interventions between the morning and evening exercises on the selected strength components. Pivovarniček et al. (2021) did not find any significant differences ($p>0.05$) between the impact of morning and evening physical interventions on BC indicators in young women of the intermediate chronotype. Several studies (Küüsmaa et al., 2015; Korman et al. 2019;

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Sedliak et al., 2019; Smit et al., 2020, etc.) show that morning time is specific for the implementation of sports and physical activities and problematic without prior temporal adaptation. Morning chronotypes are best adapted at this time. Based on these indications, we hypothesized that better effects of aerobic intervention in terms of body composition indicators may occur in young women of the early morning chronotype compared to young women of the neutral chronotype.

MATERIAL Y MÉTODOS

Study setting

The study was conducted in the Slovak Republic in 2017.

Sample selection

We recruited a sample of young women (n = 41) from a population of young women (university studentds) who did not engage in regular and planned physical activities, which meant that they did not do any physical activity more than 2 times a week. Six participants did not observe the rule of minimum attendance in the intervention program (22 of 31 training units, 70% attendance); accordingly, they were not included in the analysis. Two participants were classified as of the evening chronotype and were not included in the research.

Participants

The sample was divided into the morning (M-type: n = 8, mean age ± SD = 23.1 ± 1.0 years, mean height ± SD = 168.9 ± 5.8 cm, mean weight ± SD = 66.2 ± 6.8 kg) or intermediate chronotype (I-type: n = 25, mean age ± SD = 21.4 ± 1.5 years, mean height ± SD = 167.1 ± 5.4 cm, mean weight ± SD = 65.6 ± 7.8 kg). Ethical approval was obtained from the ethical committee at the Charles University under project number UNCE/HUM/032. The participants agreed to have their data used for scientific purposes and a future publication and signed an informed consent form. Measurements were carried out in accordance with the ethical standards of the Declaration of Helsinki, the ethical standards in sport and exercise science research (Harriss & Atkinson, 2015).

Study design

The aerobics program as intervention (Table 1) was performed for 77 days (11 weeks) in a sports hall, three times a week (Mondays, Wednesdays, Thursdays) in the morning hours from 7:15h to 8:15h. The minimal and optimal number of attended training intervention load was 31 from the 77 available. Each training unit lasted 60 minutes (minimal 31 days = 1860 minutes of the total intervention volume).

The training unit followed the pattern in Skopova & Berankova (2008), which lasted for 60 minutes with approximate intensity of 65% max of heart rate (HR,): Warm up, 5 min; Preparatory part: Pre-stretching (induction cardio training), 5 min; Main part: 1. Workout, 20 min; 2. Choreography, 20 min; final part: static stretching, 10 min. All partcipants were equipped an HR monitor device Polar M400 (Polar Electro Oy, Kempele, Finland).

TABLE 1. Indicators of chosen volume and content indicators of the physical intervention

Indicators	Number
Weeks	11
Calendar days of intervention program (study period)	77
Number of loading days	31
Number of training units	31
Week volume load, in minutes	180
Total volume load, in minutes	1860
Total warm-up volume in the introduction part, in minutes	155
Total volume of pre-stretching part, in minutes	155
Total volume load of workout parts, in minutes	620
Total volume load of choreographies, in minutes	620
Total volume of static stretching in the final part, in minutes	310

Chronotype identification

We employed the questionnaire for chronotype identification, which is known as the CSM (Composite Scale of Morningness) (Smith et al., 1989). Each response (A, B, C, D, and, in some cases, E) had a definite and fixed point for all 13 questions. Finally, a particular chronotype was assigned to each participant according to the total score in the questionnaire.

Dotazník spätnej väzby

Po skončení aeróbnej intervencie bol mladým ženám distribuovaný dotazník spätnej väzby, zameraný na zisťovanie prípadných zmien stravovacích návykov počas intervencie, ktoré sú významným faktorom v súvislosti so zmenami BC.

Feedback questionnaire

A feedback questionnaire was distributed to the participants after the aerobic intervention, aimed at identifying any changes in dietary habits during the intervention that should be a significant factor in relation to changes in BC.

Anthropometric and body composition assessment

Body height (BM) was measured using a stadiometer (Medihum, Slovakia). BC and multi-frequency bioimpedance segmental analysis were performed using the following devices: Tanita MC-780MA (Tanita, Japan) in cooperation with Nutriguard-MS (Data Input, Germany). A study by Verney et al. (2015) confirmed the high reliability of the Tanita MC-780MA analyzer with the reference method dual-energy X-ray absorptiometry (DXA) on a sample of university male and female students (n = 71, age = 19 to 30 years). Currently, it is a sufficiently valid and reliable method of detecting body composition quality in clinical research (Brener et al., 2021; Mala et al., 2023). The participants were barefoot and wearing only their underwear during measurement. We conducted the diagnostics in the morning (7:00h–10:00h). The participants did not engage in any physically demanding activities and did not eat or take any drugs or other narcotics (alcohol or caffeine) that could impact BC results (Mala et al., 2020).

The following indicators of BC were measured in selected groups: Body weight (BM), body mass index (BMI), fat mass (FM%), fat free mass (FFM), muscle mass (MM), total body water (TBW), extracellular and total body water ratio (ECW/TBW), extracellular and body cell mass ratio (ECM/BCM), and phase angle (PA). The conditions used for bioimpedance measurement were kept constant (Kyle et al., 2004).

Statistical analysis

The mean (M) was used in the exploratory analysis, and the standard deviation (SD) was used within the level of variation or dispersion. In addition to absolute values and their differences, we used percentage ratio as a relative indicator of the amount of change in the effects of the intervention program on the monitored groups. Changes in the chosen parameters were detected by paired samples t-test (pre-test vs. post-test). Differences in parameters before the intervention between groups were confirmed by an independent samples t-test. Normalita rozdelenia dát bol overená Shapiro-Wilk testom vo všetkých skúmaných indikátoroch telesného zloženia v pre-testoch aj posttestoch v súbore M-types aj I-types. P-hodnoty v rámci procedúry overenia normality boli v súbore M-types v intervale p = 0.07 až p = 0.96 a v súbore I-types p = 0.28 až p = 0.97. The error size of I type (α) was considered at the α level, where α = 0.05 in all statistical analyses. The effect size of the applied intervention was considered by Cohen’s d with the following criteria for effect size: d = 0.20, small effect; d = 0.50, medium effect; d = 0.80, large effect (Cohen, 1988). Effect size was also computed by Cohen “d” coefficient due to lower sample size of M-types participants. Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 25.0 (Armonk, NY: IBM Corp.).

RESULTADOS

We found no statistical differences in the pre-test values between both groups (M-type vs. I-type) in the following parameters: BM, BMI, FM%, TBW, ECW/TBW, ECM/BCM, and PA. The pre-test comparison between the monitored groups showed significant differences (p<0.05) in FFM and MM (FFM: M-types: 49.4 ± 3.8 kg vs. I-types: 46.6 ± 3.1 kg; MM: M-types: 46.8 ± 3.6 kg vs. I-types: 44.2 ± 2.9 kg). The effects comparison of the aerobic intervention between M-types and I-types showed the largest difference in ECM/BCM (M-types $_{PRE-POST}$ d = 0.62 vs. I-types $_{PRE-POST}$ d = 0.01) (Tables 2, 3). Differences from the point of view of effects were not significant in other BC indicators; however, changes in indicators showed that the aerobic

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intervention was more effective for M-types than for I-types. Meanwhile, we observed a significant improvement (p<0.05) between the pre-test and post-test the PA that was monitored and examined for I-types. We did not find any significant effect between pre-test and post-test in the BM and BMI in any monitored group.

TABLE 2. Changes in body composition parameters after physical intervention in M-types (n = 8)

Indicator	Measurements		Statistical analysis				
	Pre-test	Post-test	Paired Samples *t*-test		Effect size (ES)		Change (%)
	M (SD)	M (SD)	*t*-value	p-value	ES (d)	ES level	
BM (kg)	66.2 (6.8)	66.2 (6.8)	0.07	p>0.05	0.02	no effect	0%
BMI ($kg.m^{-2}$)	23.3 (2.9)	23.3 (2.8)	0.17	p>0.05	0.06	no effect	0%
FM% (%)	25.2 (4.6)	26.1 (5.3)	1.33	p>0.05	0.47	small	3.6%
FFM (kg)	49.4 (3.8)	48.7 (3.8)	1.21	p>0.05	0.43	small	-1.4%
MM (kg)	46.8 (3.6)	46.3 (3.6)	1.19	p>0.05	0.42	small	-1.1%
TBW (%)	53.9 (3.3)	53.3 (3.8)	1.14	p>0.05	0.40	small	-1.1%
ECW/TBW (%)	41.4 (0.9)	41.5 (1.1)	0.42	p>0.05	0.15	no effect	0.2%
ECM/BCM (ratio)	0.94 (0.14)	0.88 (0.11)	1.74	p>0.05	0.62	medium	-6.4%
PA (°)	5.66 (0.53)	5.81 (0.57)	1.98	p>0.05	0.70	medium	2.7%

BM: body weight; BMI: body mass index; FM%: body fat; FFM: fat free mass; MM: muscle mass; TBW: total body water; ECW/TBW: extracellular and total body water ratio; ECM/BCM: extracellular and body cell mass ratio; PA: phase angle; M: Sample Mean; SD: Sample standard deviation; d: Cohen coefficient effect size

TABLE 3. Changes in body composition parameters after physical intervention in I-types (n = 25)

Indicator	Measurements		Statistical analysis				
	Pre-test	Post-test	Paired Samples *t*-test		Effect size (ES)		Change (%)
	M (SD)	M (SD)	*t*-value	p-value	ES (d)	ES level	
BM (kg)	65.6 (7.8)	66.0 (7.3)	0.95	p>0.05	0.19	no effect	0.6%
BMI ($kg.m^{-2}$)	23.5 (2.9)	23.7 (2.8)	0.90	p>0.05	0.18	no effect	0.9%
FM% (%)	28.0 (6.1)	27.9 (6.0)	0.15	p>0.05	0.03	no effect	-0.4%
FFM (kg)	46.6 (3.1)	46.9 (2.9)	1.44	p>0.05	0.29	small	0.6%
MM (kg)	44.2 (2.9)	44.6 (2.8)	1.42	p>0.05	0.28	small	0.9%
TBW (%)	51.7 (4.2)	51.7 (4.1)	0.22	p>0.05	0.04	no effect	0%
ECW/TBW (%)	42.1 (1.3)	41.9 (1.3)	1.38	p>0.05	0.26	small	-0.5%
ECM/BCM (ratio)	0.89 (0.09)	0.89 (0.10)	0.04	p>0.05	0.01	no effect	0%
PA (°)	5.62 (0.59)	5.80 (0.59)	3.01	p<0.05	0.60	medium	3.2%

BM: body weight; BMI: body mass index; FM%: body fat; FFM: fat free mass; MM: muscle mass; TBW: total body water; ECW/TBW: extracellular and total body water ratio; ECM/BCM: extracellular and body cell mass ratio; PA: phase angle; M: Sample Mean; SD: Sample standard deviation; d: Cohen coefficient effect size

DISCUSIÓN

ECM/BCM was the main BC indicator in which we found a significant improvement in M-types. This parameter is significant not only in sports players (Bandyopadhyay et al., 2020; Mala et al., 2020) but also in the general population (Bunc, 2018a), children (Bunc, 2018b, etc.), and even among patients (Małecka-Massalska et al., 2014; Ruperto et al., 2020). We did not find any significant difference in the BC indicator (d = 0.01, 0%) in I-types but confirmed a significant difference in ECM/BCM in M-types with medium effect size (d = 0.62, 6.4%). Important changes were examined in the level of PA, in which we detected improvement with medium effect in both groups (M-types: d = 0.70, 2.7%; I-types: d = 0.60, 3.2%). The aim of our study was to determine the changes brought about by the applied intervention program. We also sought to determine how aerobic loading changed the BC indicators in particular chronotypes. We did not find any significant differences in the majority of the monitored indicators between the pre-test and post-test. For this reason, we were not able to monitor and observe the effects of the physical intervention on particular chronotypes. Significant and statistical differences (<1%) were not found in basic anthropometric indicators (BM and BMI), but they could be expressed and displayed in small changes in BC indicators. The fat mass indicator is one of the most significant factors connected to a healthy lifestyle and proper proportionality in BC. Our 11-week aerobic intervention did not stimulate and encourage noticeable changes in the BC of the sample for us to examine and monitor any significant effect or improvement, particularly weight loss. One potential important reason for these results may be fact, that after the intervention, young women reported in the feedback questionnaire higher caloric intake increased over intervention period, especially they started to eat more in the evening. This is a possible reason which could affected body weight and other BC variables

However, it is necessary to state that many factors could have affected the results of our study, such as unmonitored food intake, a university lifestyle that may not be healthy (lack of sleep, students' night life, stressful situations connected with exams, and irregular schedules and timetables). Kim & Park (2006) implemented a 12-week intervention in a group of female university students whose total fat mass was >30%. They did not find any significant difference between the experimental (n = 20, intervention) and control samples (n = 24, without intervention) from the point of view of total fat mass decrease and muscle mass increase. The intervention program included five training units (each lasting 60 minutes). Meanwhile, Yamazaki et al. (2013) found significant differences in BC indicators after eight weeks of physical intervention with low intensity in a group of female university students. Total body fat decreased from 26.8 ± 0.5% to 24.9 ± 0.5% ($p<0.01$) and muscle mass increased from 69.1 ± 0.5% to 70.8 ± 0.4% ($p<0.01$). In their study, the time spent exercising by the students increased from 6.6 ± 0.7 hours before intervention to 9 ± 0.2 hours a week during the intervention ($p<0.0001$), equivalent to more than six training units a week (each training unit had 60 minutes).

Our results showed changes in certain BC indicators (ECM/BCM in M-types; PA in I-types). Significant to the detection is the fact that some BC indicators are more sensitive to changes during regular aerobic physical activity compared with other monitored parameters. The increasing value of ECM/BCM attributed to intervention programs is interesting because the value of BCM has been reported as one of the best predictors of muscular efficiency, which may predict performance in athletes (Andreoli et al., 2003). When comparing BCM with ECM (with a metabolically inactive part of the human body), the proportion of BCM in healthy individuals should be higher, and a drop in ECM/BCM in most cases indicates an improved BC level (Mala et al., 2010). In our study, both groups reached higher BCM values compared with ECM. The 6.4% decrease in ECM/BCM in M-types after the intervention revealed a positive effect of the applied intervention for this group.

Despite our efforts to fulfil the aim of the research, our study has some limitations, which should be taken into consideration in future similar research. We recommend involving two more parameters that are significant from the point of view of accuracy. The intervention's effects could be more accurately explained with the addition of the following parameters: higher sample of "morning chronotype" participants, respect of individual zones of participant, checking of total volume and intensity of activities engaged in outside of the intervention program, and evidence of food intake (eating habits). Moreover, future research will need to involve more M-type participants; the number of M-type women was low in our randomised sample. The intermediate chronotype is the most dominant among the population of young women (in young adults in general); this fact should be taken into consideration in future research as well (Hagenauer et al., 2011; Biss & Hasher, 2012). The main reason for the predominance of the intermediate chronotype is the variability in the time schedule of young people, especially university students. However, despite these limitations, our study yielded interesting results on the improvement in the ECM/BCM indicator in M-type individuals. We also examined the significant improvement in the PA indicator with a medium effect size in I-types. The present evidence can be used in further examination of the effectiveness of intervention programs from the point of view of time of day and in the monitoring of BC changes in more sensitive indicators.

CONCLUSIONES

This study aimed to determine the effects of an aerobic intervention on the morning and intermediate chronotypes from the point of view of changes in BC indicators. The results showed that the largest effect difference was in ECM/BCM in the M-type group, in which we confirmed an improvement with a medium effect size. Meanwhile, we did not observe any change in the I-type group in this indicator. We also did not find any significant difference in the other BC indicators between M-types and I-types, which may be because of the possible slight and minor effects between the pre- and post-tests. Nonetheless, the PA indicator showed significant improvement ($p<0.05$) in the I-type group. The results also indicated that some BC indicators (ECM/BCM and PA) may be more sensitive to regular aerobic intervention programs compared with other parameters. These results can contribute to further research on the effects of aerobic interventions in various parts of the day on particular chronotypes. Our findings are primarily related to young women aged 18 to 30 years. Our data are not able to generalize, due to limitation related to the low number of M-types participants. Validation of the effectiveness of intervention programmes will require additional methods and tools in future research, such as: assessment of physiological and biochemical parameters and also controlling the calories intake. Our study showed a low effectiveness of the program (3 x week) at light moderate intensity on changes in body fat in young women regardless chronotype. The results of our study can serve as data for meta-analyses and systematic reviews.

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REFERENCIAS BIBLIOGRÁFICAS

1. Baehr, E.K.; Revelle, W.; Eastman, C.I. (2000). Individual differences in the phase and amplitude of the human circadian temperature rhythm: with an emphasis on morningness-eveningness. *Journal of sleep research*. 9(2): 117-127. https://onlinelibrary.wiley.com/doi/10.1046/j.1365-2869.2000.00196.x

2. Bandyopadhyay, A.; Datta, G.; Dey, S.K. (2020). Relationship of Body Composition Variables with Selected Physiological Parameterso of Young Sports Person of Different Games. *International Journal of Sports Science & Medicine*. 4(1): 1-9. https://www.sciresliterature.org/SportsMedicine/IJSSM-ID48.pdf

3. Andreoli, A.; Melchiorri, G.; Brozzi, M.; Di Marco, A.; Volpe, S.L.; Garofano, P.; Di Daniele, N.; De Lorenzo, A. (2003). Effect of different sports on body cell mass in highly trained athletes. *Acta diabetologica*. 40(Suppl 1): 122-125. https://link.springer.com/article/10.1007/s00592-003-0043-9

4. Biss, R.K.; Hasher, L. (2012). Happy as a lark: morning-type younger and older adults are higher in positive affect. *Emotion*. 12(3): 437-441. https://psycnet.apa.org/doiLanding?doi=10.1037%2Fa0027071

5. Blonc, S.; Perrot, S.; Racinais, S.; Aussepe, S.; Hue, O. (2010). Effects of 5 weeks of training at

the same time of day on the diurnal variations of maximal muscle power performance. *Journal of strength and conditioning research / National Strength & Conditioning Association*. 24(1): 23-29. https://journals.lww.com/nsca-jscr/Fulltext/2010/01000/Effects_of_5_Weeks_of_Training_at_the_Same_Time_of.4.aspx

6. Brener, A.; Peleg, I.; Rosenfeld, T.; Kern, S.; Uretzky, A.; Elkon-Tamir, E.; Rosen, G.; Levinson, H.; Israeli, G.; Interator, H.; Lebenthal, Y. (2021). Beyond Body Mass Index - Body Composition Assessment by Bioimpedance in Routine Endocrine Practice. *Endocrine practice : official journal of the American College of Endocrinology and the American Association of Clinical Endocrinologists*. 27(5): 419-425. https://www.endocrinepractice.org/article/S1530-891X(20)48392-2/fulltext

7. Bunc, V. (2018a). Effect of physical exercise on adiposity and aerobic fitness in middle age men differing in body mass. In: Conference: 2nd World Obesity CongressAt: Tokyo, Japan.

8. Bunc, V. (2018b). Active lifestyle is a crucial means of body mass reduction in overweight or obese girls. Conference: 20th Global Obesity Meeting.

9. Bunc, V. (2019). Title: Motor skills like a tool of overweight and obesity reduction in children and adolescents. Conference: 3rd International Conference on Obesity and Metabolic Diseases 2019At: Bangkok, Thailand.

10. Bunc, V.; Hráský, P.; Skalská, M. (2015). Changes in Body Composition, During the Season, in Highly Trained Soccer Players. *The Open Sports Sciences Journal*. 8(1): 18-24. https://opensportssciencesjournal.com/contents/volumes/V8/TOSSJ-8-18/TOSSJ-8-18.pdf

11. Castañeda-Babarro, A.; Arbillaga-Etxarri, A.; Gutiérrez-Santamaría, B.; Coca, A. (2020). Physical Activity Change during COVID-19 Confinement. *International journal of environmental research and public health*. 17(18): 6878. https://www.mdpi.com/1660-4601/17/18/6878

12. Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). New York (US): Psychology Press.

13. Guiney, H.; Machado, L. (2013). Benefits of regular aerobic exercise for executive functioning in healthy populations. *Psychonomic bulletin & review*. 20(1): 73-86. https://link.springer.com/article/10.3758/s13423-012-0345-4

14. Hagenauer, M.H.; Ku, J.H.; Lee, T.M. (2011). Chronotype changes during puberty depend on gonadal hormones in the slow-developing rodent, Octodon degus. *Hormones and behavior*. 60(1): 37-45. https://www.sciencedirect.com/science/article/abs/pii/S0018506X11000328?via%3Dihub

15. Harriss, D.J.; Atkinson, G. (2015). Ethical Standards in Sport and Exercise Science Research: 2016 Update. *International journal of sports medicine*. 36(14): 1121-1124. https://www.thieme-connect.de/products/ejournals/abstract/10.1055/s-0035-1565186

16. Henst, R.H.; Jaspers, R.T.; Roden, L.C.; Rae, D.E. (2015). A chronotype comparison of South African and Dutch marathon runners: The role of scheduled race start times and effects on performance. *Chronobiology international*. 32(6): 858-868. https://www.tandfonline.com/doi/abs/10.3109/07420528.2015.1048870?journalCode=icbi20

17. Kentiba, E.; Legesse, K.; Mandal, S.; Gebrehiwot, A.; Tesfay, A.; Alemayehu, M.; Kebede, R.; George, M. (2020). Relationship between chronotype preference and choice of sport participation and time of day of training: insights gained from the ninth all African university game players. *Chronobiology international*. 37(12): 1748-1753. https://www.tandfonline.com/doi/abs/10.1080/07420528.2020.1803904?journalCode=icbi20

18. Kim, H.D.; Park, J.S. (2006). The effect of an exercise program on body composition and physical fitness in obese female college students. *Journal of Korean Academy of Nursing*. 36(1): 5-

14. https://jkan.or.kr/DOIx.php?id=10.4040/jkan.2006.36.1.5

19. Korman, M.; Levy, I.; Maaravi-Hesseg, R.; Eshed-Mantel, A.; Karni, A. (2019). Subclinical Scores in Self-Report Based Screening Tools for Attention Deficits Correlate With Cognitive Traits in Typical Evening-Type Adults Tested in the Morning. *Frontiers in psychology*. 10: 1397. https://www.frontiersin.org/articles/10.3389/fpsyg.2019.01397/full

20. Küüsmaa, M.; Sedliak, M.; Häkkinen, K. (2015). Effects of time-of-day on neuromuscular function in untrained men: Specific responses of high morning performers and high evening performers. *Chronobiology international*. 32(8): 1115-1124. https://www.tandfonline.com/doi/abs/10.3109/07420528.2015.1065269?journalCode=icbi20

21. Kyle, U.G.; Bosaeus, I.; De Lorenzo, A.D.; Deurenberg, P.; Elia, M.; Gómez, J.M.; Heitmann, B.L.; Kent-Smith, L.; Melchior, J.C.; Pirlich, M.; Scharfetter, H.; Schols, A.M.; Pichard, C. (2004). Bioelectrical impedance analysis--part I: review of principles and methods. *Clinical nutrition : official journal of the European Society of Parenteral and Enteral Nutrition*. 23(5): 1226-1243. https://www.clinicalnutritionjournal.com/article/S0261-5614(04)00093-7/fulltext

22. Lastella, M.; Roach, G.D.; Halson, S.L.; Sargent, C. (2016). The Chronotype of Elite Athletes. *Journal of human kinetics*. 54(1): 219-225. https://sciendo.com/article/10.1515/hukin-2016-0049

23. Luciano, F.; Cenacchi, V.; Vegro, V.; Pavei, G. (2021). COVID-19 lockdown: Physical activity, sedentary behaviour and sleep in Italian medicine students. *European journal of sport science*. 21(10): 1459-1468. https://www.tandfonline.com/doi/full/10.1080/17461391.2020.1842910

24. Mala, L.; Hak, M.; Stastny, P.; Ford, R.; Zmijewsky, P.; Bujnovsky, D.; Petr, M.; Maly, T. (2023). Elite young soccer players have smaller inter-limb asymmetry and better body composition than non-elite players. *Biology of Sport*. 40(1): 265-272. doi:10.5114/biolsport.2023.114840.

25. Mala, L.; Maly, T.; Cabell, L.; Hank, M.; Bujnovsky, D.; Zahalka, F. (2020). Anthropometric, Body Composition, and Morphological Lower Limb Asymmetries in Elite Soccer Players: A Prospective Cohort Study. *International journal of environmental research and public health*. 17(4): 1140. https://www.mdpi.com/1660-4601/17/4/1140

26. Mala, L.; Maly, T.; Zahalka, F.; Bunc, V. (2010). The profile and comparison of body composition of elite female volleyball players. *Kinesiology*. 42(1): 90-97. https://hrcak.srce.hr/file/82649

27. Mala, L.; Maly, T.; Zahalka, F.; Bunc, V.; Kaplan, A.; Jebavy, R.; Tuma, M. (2015). Body composition of elite female players in five different sports games. *Journal of human kinetics*. 45(1): 207-215. https://sciendo.com/article/10.1515/hukin-2015-0021

28. Małecka-Massalska, T.; Smoleń, A.; Morshed, K. (2014). Extracellular-to-body cell mass ratio and subjective global assessment in head-and-neck cancers. *Current oncology*. 21(1): 62-66. https://www.mdpi.com/1718-7729/21/1/1671

29. Mersy, D.J. (1991). Health benefits of aerobic exercise. *Postgraduate medicine*. 90(1): 103-107, 110-112. https://www.tandfonline.com/doi/abs/10.1080/00325481.1991.11700983

30. Mulè, A.; Galasso, L.; Castelli, L.; Condemi, V.; Bisconti, A.V.; Esposito, F.; Roveda, E.; Montaruli, A. (2020). Effect of chronotype on rating of perceived exertion in active young people. *Sport Sciences for Health*. 16: 331-336. https://doi.org/10.1007/s11332-019-00610-9

31. Pivovarnicek, P.; Kondratova, D.; Jancokova, L.; Maly, T.; Hank, M.; Hrasky, P.; Mala, L.; Zahalka, F. (2021). Effect of diurnal aerobic intervention on indicators of body composition of young women. *Biological Rhythm Research*.

52(1): 81-91. https://www.tandfonline.com/doi/full/10.1080/09291016.2019.1586101

32. Rae, D.E.; Stephenson, K.J.; Roden, L.C. (2015). Factors to consider when assessing diurnal variation in sports performance: the influence of chronotype and habitual training time-of-day. *European journal of applied physiology*. 115(6): 1339-1349. https://link.springer.com/article/10.1007/s00421-015-3109-9

33. Roveda, E.; Mulè, A.; Galasso, L.; Castelli. L.; Scurati, R.; Michielon, G.; Esposito, F.; Caumo, A.; Montaruli, A. (2020). Effect of chronotype on motor skills specific to soccer in adolescent players. *Chronobiology international*. 37(4): 552-563. https://www.tandfonline.com/doi/full/10.1080/07420528.2020.1729787

34. Ruperto, M.; Sánchez-Muniz, F.J.; Barril, G. (2020). Extracellular mass to body cell mass ratio as a potential index of wasting and fluid overload in hemodialysis patients. A case-control study. *Clinical nutrition : official journal of the European Society of Parenteral and Enteral Nutrition*. 39(4): 1117-1123. https://www.clinicalnutritionjournal.com/article/S0261-5614(19)30197-9/fulltext

35. Sedliak, M.; Finni, T.; Cheng, S.; Lind, M.; Häkkinen, K. (2009). Effect of time-of-day-specific strength training on muscular hypertrophy in men. *Journal of strength and conditioning research / National Strength & Conditioning Association*. 23(9): 2451-2457. https://journals.lww.com/nsca-jscr/Fulltext/2009/12000/Effect_of_Time_of_Day_Specific_Strength_Training.5.aspx

36. Sedliak, M.; Zeman, M.; Buzgó, G.; Cvecka, J.; Hamar, D.; Laczo, E.; Okuliarova, M.; Vanderka, M.; Kampmiller, T.; Häkkinen, K.; Ahtiainen, J.P.; Hulmi, J.J.; Nilsen, T.S.; Wiig, H.; Raastad, T. (2018). Morphological, molecular and hormonal adaptations to early morning versus afternoon resistance training. *Chronobiology international*. 35(4): 450-464. https://www.tandfonline.com/doi/abs/10.1080/07420528.2017.1411360?journalCode=icbi20

37. Skopova, M.; Berankova, J. (2008). *Aerobik* (1st ed.). Prague (CZ): Grada Publishing.

38. Smit, A.N.; Michalik, M.; Livingstone, A.C.; Mistlberger, R.E.; McDonald, J.J. (2020). Circadian misalignment impairs ability to suppress visual distractions. *Psychophysiology*. 57(2): e13485. https://onlinelibrary.wiley.com/doi/10.1111/psyp.13485

39. Smith, C.; Reilly, C.; Midkiff, K. (1989). Evaluation of three circadian rhythm questionnaires with suggestions for an improved measure of morningness. *The Journal of applied psychology*. 74(5): 728-738. https://psycnet.apa.org/doiLanding?doi=10.1037%2F0021-9010.74.5.728

40. Swift, D.L.; Johannsen, N.M.; Lavie, C.J.; Earnest, C.P.; Church, T.S. (2014). The role of exercise and physical activity in weight loss and maintenance. *Progress in cardiovascular diseases*. 56(4): 441-447. https://www.sciencedirect.com/science/article/abs/pii/S0033062013001655?via%3Dihub

41. Verney, J.; Schwartz, C.; Amiche, S.; Pereira, B.; Thivel, D. (2015). Comparisons of a Multi-Frequency Bioelectrical Impedance Analysis to the Dual-Energy X-Ray Absorptiometry Scan in Healthy Young Adults Depending on their Physical Activity Level. *Journal of human kinetics*. 14;47:73-80. https://sciendo.com/article/10.1515/hukin-2015-0063

42. Violant-Holz, V; Gallego-Jiménez, M.G.; González-González, C.S.; Muñoz-Violant, S.; Rodríguez, M.J.; Sansano-Nadal, O.; Guerra-Balic, M. (2020). Psychological Health and Physical Activity Levels during the COVID-19 Pandemic: A Systematic Review. *International journal of environmental research and public health*. 17(24): 9419. https://www.mdpi.com/1660-4601/17/24/9419

Journal of Sport and Health Research 2024, 16(1):53-66

43. Vitale, J.A.; Weydahl, A. (2017). Chronotype, Physical Activity, and Sport Performance: A Systematic Review. *Sports medicine*. 47(9): 1859-1868. https://link.springer.com/article/10.1007/s40279-017-0741-z

44. Yamazaki, F.; Yamada, H.; Morikawa, S. (2013). Influence of an 8-week exercise intervention on body composition, physical fitness, and mental health in female nursing students. *Journal of UOEH*. 35(1): 51-58. https://www.jstage.jst.go.jp/article/juoeh/35/1/35_51/_article/-char/ja/