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Original Article

Modifiable factors affecting abdominal obesity in relation to physical activity in the population of the eastern region of Kazakhstan

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Abstract:
The rising prevalence of obesity and overweight individuals globally necessitates further research into measures to combat and prevent this pathology, especially as it relates to abdominal obesity, known to cause severe complications and premature death. The objective of this study is to assess predictors of abdominal obesity in the adult population of the Republic of Kazakhstan at varying levels of physical activity per week. Materials and Methods. The present study was executed on medical institutions in Semey city, Republic of Kazakhstan, spanning from 1st March to 31st May 2023. The research project consisted of 272 participants, with a mean age of 35.4 (±11.1) years. In the group of observed respondents, a majority of 69.5% were females. The body length and weight were measured using standardized protocols, and the body mass index (BMI) was computed from these measurements. Patients with a waist circumference of 120.0 cm and above in men and 88.0 cm and above in women were classified as abdominally obese. Abbreviations for technical terms were explained upon first use. All participants were divided into groups based on meeting or exceeding the global physical activity recommendations of 150 minutes per week or having less than 150 minutes of moderate physical activity per week. The respondents also answered questions about their dietary habits and sedentary lifestyle. Research Findings. The research found gender disparities in the prevalence of general and abdominal obesity among the respondents surveyed. Men have a higher incidence of abdominal obesity compared to women. A substantial proportion of both men and women reported low weekly physical activity levels and a sedentary lifestyle. The study identified food habits that could potentially contribute to the development of abdominal obesity. Conclusions. The research project data supplements the existing knowledge on obesity in the field. It can aid specialists in physical education and medicine in rectifying eating habits, physical activity and lifestyles of adults.
Key Words: **abdominal obesity, physical activity, physical mobility, dietary habits**

Introduction

Currently, among specialists in the field of physical education, sport and medicine, it is generally accepted that human body weight is not only a marker of the state of metabolic metabolism in the human body, but in general it represents an integral assessment of the physical, somatic, reproductive and mental health of an individual. Therefore, maintaining normal body weight parameters is an important non-medication approach to preserve and promote human health (Junger et al., 2019). The number of people who are overweight or obese is increasing annually in most countries. World Health Organisation experts predict that by 2035, more than 50% of the world's people will be overweight or obese (WHO. Obesity and overweight. Fact sheet, 2018).

In the current epidemic of overweight and obesity, poor diet and low levels of physical activity in humans are mainly responsible (Jordan et al., 2020; Mozolev et al., 2020). Much less frequently, mental trauma and hormonal disorders of the body may play a role.

As diet and physical activity are modifiable factors, mitigating this risk requires an understanding of their contribution to obesity. A meta-analysis of the National Health and Nutrition Examination Survey (NHANES) indicated that there was an inverse correlation between leisure-time physical activity and the incidence of obesity (Füzéki et al., 2017). In a 15-year follow-up study of over 4,000 young men and women in several US cities, Gordon-Larsen et al. (2009) discovered that physical activity reduced the impact of weight gain and lowered the risk of coronary events for the participants. A beneficial aspect of physical activity in humans is

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the decrease in inflammation within the hypothalamus, leading to a more vigorous reduction of visceral fat (Lucio Della Guardia, & Roberto Codella, 2023).

Several studies have highlighted a robust association between a sedentary way of life and amplified occurrence of obesity in humans, which isn't offset by physical activity during leisure time (Stuart et al., 2017; Romeo et al., 2017; Jason Fanning et al., 2022). Researchers have found that decreasing the time spent in a sedentary position, regardless of physical activity, can lead to enhancements in cardiometabolic markers in the body, including maximal oxygen uptake, blood pressure, resting heart rate, and a reduction in the severity of obesity. Interventional and population studies have demonstrated that a sedentary lifestyle or low levels of fitness are linked to the accumulation of abdominal fat (Belavý et al., 2014; Ullrich et al., 2018; Mihiret Shawel Getahun et al., 2022). Prolonged sedentary behaviour is strongly linked to cardiometabolic risk factors and elevated mortality rates in those individuals, irrespective of their physical activity (Aboma Motuma et al., 2022). Additionally, the connection between inactive behaviour and obesity fluctuates amid genders. The male population experiences the greatest hazard of untimely demise (Nicholas et al., 2015; Soleh Solahuddin et al., 2021). A comprehensive population-based study of working Canadian adults supports findings from previous research indicating a correlation between sedentary work and body mass index as well as waist circumference in men, independent of their leisure-time physical activity (Ruckwongpatr Kamolthip et al., 2023).

Abdominal obesity has been shown to have a particularly detrimental effect on human health due to the concentration of fat mass in this region. Waist circumference of ≥102 cm in men and ≥88 cm in women is indicative of abdominal obesity, regardless of BMI. Abdominal obesity can lead to severe somatic diseases and is often responsible for premature death from various diseases (Hu et al., 2017). Several studies have shown that it is abdominal fat instead of total body fat contributing to systemic inflammation, leading to chronic disease development (Wedell-Neergaard et al., 2018).

In recent times, the emergence of new viral ailments, especially Covid-19, has led to prolonged isolation and changed food habits (Hermassi et al., 2021). This often leads to hypodynamia (Kolokoltsev et al., 2021) and results in overweight and obesity (Jordan et al., 2020; Ruckwongpatr Kamolthip et al., 2023), including among athletes (Junaidi et al., 2021).

Despite the available scientific studies on the genesis of overweight or obesity in humans, it is still relevant to study issues related to the identification and assessment of different predictors of abdominal obesity in populations with different levels of physical activity. Detailed decoding of these characteristics will make it possible to prevent the development of normal body mass disorders and to preserve human health.

Research aim. To evaluate the predictors of abdominal obesity in the adult population of the Republic of Kazakhstan with different levels of weekly physical activity.

Material & methods

The study was conducted on the basis of primary care medical institutions of Semey city (East Kazakhstan region, Republic of Kazakhstan) from 1 March to 31 May 2023. Exclusion criteria were: children aged 0-19 years, adults aged 65 years and older, pregnant women, underweight adults (BMI <18.5 kg/m2). There were 272 participants in the research project and the mean age of the participants was 35.4 ± 11.1 years. In the observed group, 69.5% were female. In terms of national composition, 94.1% were Kazakhs and 73.9% had higher education.

At the beginning of the study, written informed consent for participation in the observation was obtained from all respondents. The study did not violate the ethical principles of the 2008 Helsinki Declaration on the Rights of Biomedical Experiments.

Height and weight were measured using standardised protocols. Body mass index (BMI) was calculated from these measurements. This was calculated by dividing body mass in kilograms by body length in metres squared. Respondents with BMI = 24.0-27.9 kg/m2 and obese respondents with BMI ≥ 28.0 kg/m2 were classified as overweight (WHO. Obesity and overweight. Fact sheet. Reviewed February 2018). Respondents were identified as having abdominal obesity by measuring waist circumference along the upper lateral border of the iliac crest using a tape measure. Patients were classified as abdominally obese if their waist circumference was ≥120.0 cm for men and ≥88.0 cm for women.

Weekly physical activity was assessed by interviewing respondents using WHO recommendations (Global recommendations on physical activity for health, 2010). All respondents were categorised into those whose weekly physical activity met or exceeded the global recommendation of 150 minutes of physical activity (5 days per week x 30 minutes per day). The second group consisted of respondents whose weekly physical activity was less than 150 minutes of moderate physical activity.

Total time spent sitting was assessed by asking participants. They were asked to report the total number of minutes per day they spent sitting at home, at work, including time spent sitting at a desk, travelling by car or bus, reading, watching TV or working on a computer. Answers ranged from 0 to 1,200 minutes per day. Three categories of daily sedentary time (0 to 359 minutes, 360 to 539 minutes, and 540 minutes or more) were created based on the categories used in the study (Yang Du et al., 2019). Project participants answered questions about

their eating habits, including whether they added sugar to tea or coffee, whether they ate sweets after meals, whether they ate in response to stress, and how often they consumed sugary drinks and fried foods.

Descriptive statistics were used to analyse the data. The choice of statistical criteria depended on the type of variables used. Pearson's chi-square test was used to analyse qualitative data. Multiple logistic regression analysis was used to determine the risk factors for the development of abdominal obesity in the study population. Variables whose significance was determined using Pearson's chi-square were included in the model. Unadjusted and adjusted coefficient values and their 95% confidence interval (CI) are presented. A value of $p < 0.05$ was considered a statistically significant difference.

Results

Table 1 presents information on demographics, weekly physical activity levels, body mass index and dietary habits of the respondents.

Table 1. Demographics, BMI, physical activity and dietary habits of observed male and female participants

Characteristic	Total	Men	Women	p
Respondents, n (%)	272 (100)	83 (30.5)	189 (69.5)	
Age, years ± m	35.4 ±11.0	35.0 ±11.6	36.3 ±10.7	0.101
Nationality, n (%)				0.621
Kazakhs	256 (94.1)	79 (30.9)	177 (69.1)	
Other nationalities	16 (5.9)	4 (25.0)	12 (77.0)	
Education, n (%)				0.683
Higher	201 (73.9)	61 (73.5)	140 (74.1)	
Secondary specialised	44 (16.2)	12 (14.5)	32 (16.9)	
Secondary	27 (9.9)	10 (12.0)	17 (9.0)	
BMI, n (%)				0.155
Normal	156 (57.4)	49 (59.0)	107 (56.6)	
Overweight	66 (24.3)	24 (28.9)	42 (22.2)	
Obesity	50 (18.3)	10 (12.0)	40 (21.2)	
Abdominal obesity, n (%)				0.000
No	231 (84.9%)	56 (67.5%)	175 (92.6%)	
Yes	41 (51.1%)	27 (32.5%)	14 (7.4%)	
Physical activity, n (%)				0.500
Less than 150 minutes per week	146 (53.7)	42 (50.6)	104 (55.0)	
More than 150 minutes per week	126 (46.3)	41 (49.4)	85 (45.0)	
Total sitting time, min/day, n (%)				0.127
0-359	156 (57.4)	50 (60.2)	106 (56.1)	
360-539	57 (21.0)	21 (25.3)	36 (19.0)	
≥540	59 (21.7)	12 (19.0)	47 (24.9)	
Add sugar to tea, coffee, n (%)				0.363
Always	86 (31.6)	31 (37.3)	55 (29.1)	
Sometimes	113 (41.5)	33 (39.8)	80 (42.3)	
Never	73 (26.8)	19 (22.9)	54 (28.6)	
Have a sweet after a meal, n (%)				0.163
Always	98 (36.0)	23 (27.7)	75 (39.7)	
Sometimes	152 (55.9)	52 (62.7)	100 (52.9)	
Never	22 (8.1)	8 (9.6)	14 (7.4)	
Eating in response to stress, n (%)				0.000
Always	66 (24.3)	10 (12.0)	56 (29.6)	
Sometimes	109 (40.1)	25 (30.1)	84 (44.4)	
Never	97 (35.7)	48 (57.8)	49 (25.9)	
Drink sugary drinks, n (%)				0.002
Often	69 (25.4)	32 (38.6)	37 (19.6)	
Sometimes	178 (65.4)	42 (50.6)	136 (72.0)	
Never	25 (9.2)	9 (10.8)	16 (8.5)	
Eat fried food, n (%)				0.001
Often	124 (45.6)	51 (61.4)	73 (38.6)	
Sometimes	134 (49.3)	27 (32.5)	107 (56.6)	
Never	14 (5.1)	5 (6.0)	9 (4.8)	

As shown in Table 1, more than half of the participants in the research project (57.4%) had a normal BMI. In the male population, the number of overweight respondents was 23.2% higher than in the female population (28.9% and 22.2%, respectively). Obesity was reported 76.7% more often in women (21.2%) than in men (12.0%). Abdominal obesity was 4.39 times more common in men (32.5%) than in women (7.4%).

Insufficient weekly physical activity of less than 150 minutes was almost 10% more common in women than in men, 55.0% and 50.6% respectively. Therefore, individuals whose weekly physical activity met the WHO global recommendation for physical activity were more often recorded in men than in women. There were also 31.0% more women (24.9%) than men (19.0%) who were sedentary for more than 540 minutes per day.

Men were found to be 28.2% more likely to always add sugar to tea or coffee (37.3%) compared to women (29.1%). They are more likely to consume sweet foods after meals (39.7%) and eat in response to stress (29.6%), men are more likely to drink sweet drinks (38.6%) and consume fried foods (61.4%). Table 2 shows the results of the multivariate analysis of the factors influencing the development of abdominal obesity among adult residents of Semey.

Table 2. Results of multivariate analysis of modifiable factors influencing the development of abdominal obesity in men and women

Variable factors	Unadjusted odds ratio	95% CI	Adjusted odds ratio	95% CI	p
Gender					0.000
Men	0.08	2.96-12.3	11.4	4.33-30.0	
Women	1.00	Reference	1.00	Reference	
Nationality, n (%)					0.719
Kazakhs	0.23	0.21-2.78	0.73	0.14-3.97	
Other nationalities	1.00	Reference	1.00	Reference	
Education, n (%)					0.003
Higher	1.00	Reference	1.00	Reference	
Secondary specialised	2.71	1.20-6.12	4.47	1.63-12.2	
Secondary	3.43	1.34-8.75	4.53	1.43-14.3	
Physical activity, n (%)					0.080
Less than 150 minutes per week	0.14	0.81-3.18	2.20	0.91-5.31	
More than 150 minutes per week	1.00	Reference	1.00	Reference	
Total sitting time, min/day, n (%)					
0-359	1.00	Reference			
360-539	2.23	1.98-6.93			
≥540	5.72	2.16-9.23			
Add sugar to tea, coffee, n (%)					0.176
Always	2.30	0.94-5.63	1.97	0.65-5.97	
Sometimes	1.15	0.46-2.89	0.82	0.28-2.42	
Never	1.00	Reference	1.00	Reference	
Have a sweet after a meal, n (%)					0.758
Always	0.57	0.18-1.78	1.42	0.15-13.2	
Sometimes	0.58	0.19-1.72	0.18	0.04-0.80	
Never	1.00	Reference	1.00	Reference	
Eating in response to stress, n (%)					0.004
Often	1.19	0.50-2.80	4.65	1.20-17.9	
Sometimes	1.02	0.47-2.22	4.15	1.42-12.1	
Never	1.00	Reference	1.00	Reference	
Drink sugary drinks, n (%)					0.717
Often	2.04	0.54-7.74	1.03	0.17-6.14	
Sometimes	1.09	0.30-3.93	0.74	0.14-4.00	
Never	1.00	Reference	1.00	Reference	
Eat fried food, n (%)					0.446
Often	1.59	0.34-7.56	3.53	0.21-60.2	
Sometimes	0.65	0.13-3.20	2.10	0.13-34.0	
Never	1.00	Reference	1.00	Reference	

Multiple logistic regression analysis considered the following factors: "gender", "ethnicity", "education", "physical activity", "add sugar to tea, coffee", "consume sweets after meals", "consume food in response to stress", "drink sweet drinks", and "consume fried food". The adjusted odds ratio revealed that these variables had an impact on the study population. "Nationality", "physical activity", "adding sugar to tea or coffee", "consuming sweets after meals", "drinking sweetened drinks" and "consuming fried food" were found to have no significant impact on the development of abdominal obesity among men and women.

The regression model of analysis took into account variables such as "gender", "education", and "eating in response to stress". The results revealed that males had 11.4 times (95% CI: 4.33-30.0) greater risk of developing abdominal obesity in comparison to the female population. Respondents with secondary vocational and secondary education had 4.47 (95%CI: 1.63-12.2) and 4.53 (95%CI: 1.43-14.3) times greater risks of developing abdominal obesity, respectively, compared to individuals with higher education. It was observed that

the risk of developing abdominal obesity was 4.65 times greater (95% CI:1.20-17.9) among respondents who always eat in response to stress, compared to those who only occasionally do so. The risk was also found to be 4.15 times greater (95% CI:1.42-12.1) among those who never eat in response to stress. Please note that we exclude subjective evaluations unless they are clearly marked as such.

Dicussion

The high prevalence of obesity and overweight in various countries across the world, along with the negative forecast for the future (WHO. Obesity and overweight. Fact sheet, 2018; Junger et al., 2019), demands the comprehensive study of this issue with the involvement of specialists in physical education and sport (Denisova, 2019). Numerous scientific studies underline the crucial role of using aerobic physical education and sports methods for body weight correction (Jordan et al., 2020; Mozolev et al., 2020).

Our research project focuses on assessing factors that could affect the occurrence of abdominal obesity in the population of the Republic of Kazakhstan. Abdominal obesity is known to have the most severe impact on human health. It is linked to the emergence of serious negative cardiometabolic processes in the body, which is a contributor to premature population mortality (Ullrich et al., 2018; Mihiret Shawel Getahun et al., 2022).

According to our data, abdominal obesity was detected 4.39 times more often in men (32.5%) than in women (7.4%), which allows us to consider the male population as the risk group for the development of this type of obesity. A similar gender specificity in the dynamics of the distribution of abdominal obesity has been observed in studies by other authors (Soleh Solahuddin et al., 2021). In our opinion, one of the main reasons for the development of abdominal obesity is a person's low physical activity, which is consistent with the opinion of other authors (Belavý et al., 2014; Hu et al., 2017). We found that insufficient weekly physical activity was observed in almost 50% of the examined individuals, both in men and women. At the same time, physical activity of less than 150 minutes per week was 10% more frequent in women than in men (55.0% and 50.6%, respectively), which is confirmed by the more frequent detection of obesity in the observed population of women.

A sedentary lifestyle plays a role in the development of abdominal obesity, as shown by the studies of some authors (Füzéki et al., 2017). At the same time, according to Stuart et al. (2017); Romeo et al. (2017); Jason Fanning et al. (2022), the negative changes in the body due to a sedentary lifestyle are not compensated by further physical activity of the individual. This confirms the key role of excessive sedentary behaviour in the development of abdominal obesity. According to our data, sedentary behaviour is 31.0% more common in women than in men. A total of more than 540 minutes of sedentary time per day was recorded in 24.9% of women compared to 19.0% of men. We believe that sedentary lifestyle was one of the causes of abdominal obesity in the observed population, which is consistent with the findings of Aboma Motuma et al (2022).

Among our respondents, the dependence of the development of abdominal obesity on the level of education was observed. Individuals with a specialised secondary education and those with a general secondary education have a 4.47 and 4.53 times higher risk of developing abdominal obesity, respectively, than those with a tertiary education. Food intake in response to stress plays a role in the development of abdominal obesity. The risk of abdominal obesity was higher among respondents who occasionally ate in response to stress than among those who never ate in response to stress.

Our research highlights the need to further promote regular physical activity, reduce sedentary behaviour and correct eating habits to reduce BMI and abdominal obesity in adults, especially those at risk.

Conclusions

It was found that in the observed population of males in the East Kazakhstan region of the Republic of Kazakhstan at the age of 35.0 years, overweight is registered in almost one third (28.9%) of persons. Obesity is more common among women (21.2%) than men (12.0%). Men have a higher risk of developing abdominal obesity than women. This is indicated by the higher incidence of abdominal obesity in men, which is 4.39 times higher than in women. In men, the risk of developing abdominal obesity was found to be 11.4 times higher than in the female population.

Low levels of weekly physical activity were found to be one of the causes of overweight and abdominal obesity in both men and women. Weekly physical activity of less than 150 minutes and total sedentary time of more than 540 minutes per day were more common in women. At the same time, men were more likely to always add sugar to tea and coffee, to drink sweet drinks more often and to eat fried food, which with hypodynamia leads to the development of abdominal obesity in them. Women were more likely to consume sweets after meals and to eat in response to stress. In the study population, secondary specialised, secondary education increases the risk of developing abdominal obesity compared to those who had higher education. Those who always and sometimes eat in response to stress have an increased risk of developing abdominal obesity compared to those who never have this habit in response to stress.

We believe that the data obtained during the research project can be used by specialists in the field of physical education and medicine to correct the eating behaviour, physical activity and lifestyle of the adult population, which will improve their health status.

Conflicts of interest. If the authors have any conflicts of interest to declare.

References:

Aboma, Motuma, Tesfaye, Gobena, Kedir, Teji Roba, Yemane, Berhane, Alemayehu, Worku (2022). Long sedentary time is associated with worsened cardiometabolic risk factors among university employees in Eastern Ethiopia. *Sci Rep.*, *12(1),* 22431. DOI: 10.1038/s41598-022-26762-2

Belavý, D.L., Möhlig, M., Pfeiffer, A.F., Felsenberg, D., & Armbrecht, G. (2014). Preferential deposition of visceral adipose tissue occurs due to physical inactivity. *Int J Obes*., *38(11),* 1478–80. DOI:10.1038/ijo.2014.26

Denisova, G. S. (2019). The dependence of the body mass of students of a special department of the Altai State University on the nature of nutrition and the optimal level of motor activity. *Health, Physical Culture and Sports*, *12(1),* 127-152. Retrieved from http://hpcas.ru/article/view/5232

Füzéki, E., Engeroff, T., & Banzer, W. (2017). Health benefits of lightintensity physical activity: a systematic review of accelerometer data of the National Health and Nutrition Examination Survey (NHANES). *Sports Med*., *47(9*), 1769 – 1793. DOI: 10.1007/S40279-017-0724-0

Gordon-Larsen, P., Hou, N., Sidney, S., Sternfeld, B., Lewis, C.E., Jacobs, D.R. Jr, & Popkin, B.M. (2009). Fifteen-year longitudinal trends in walking patterns and their impact on weight change. *Am J Clin Nutr*., *89(1),* 19 – 26. DOI: 10.3945/AJCN.2008.26147

Hermassi, S., Sellami, M., Salman, A., Al-Mohannadi, A. S., Bouhafs, E. G., Hayes, L. D., & Schwesig, R. (2021). Effects of covid-19 lockdown on physical activity, sedentary behavior, and satisfaction with life in Qatar: A preliminary study. *International Journal of Environmental Research and Public Health,* 18(6), 1-14. DOI:10.3390/ijerph18063093

Jan, Junger, Ferdinand, Salonna, Józef, BErgier, Andrea, Junger, Karel, Frömel, Pongrác, Ács, & Barbara, Bergier. (2019). Physical activity and Body-Mass-Index relation in secondary-school students of the Visegrad region. *Journal of Physical Education and Sport*, Vol 19 (Supplement issue 1), Art 35, 235-241. DOI:10.7752/jpes.2019.s1035

Jason, Fanning, Barbara, J. Nicklas, W., & Jack, Rejeski (2022). Intervening on physical activity and sedentary behavior in older adults. *Exp Gerontol*, 157, 111634. DOI: 10.1016/j.exger.2021.111634

Jordan, S., Starker, A., Krug, S., Manz, K., Moosburger, R., Schienkiewitz, A., Varnaccia, G., Zieher, J., Wachtler, B., & Loss, J. (2020). Gesundheitsverhalten und COVID-19: Erste Erkenntnisse zur Pandemie. Health Behavior and COVID-19: First Findings on the Pandemic. *Journal of Health Monitoring*, 5(S8). DOI:10.25646/7054

Junaidi, Tirto, Apriyanto, Inarot, Laily, & Putra, Rizki. (2021). The comparison of offline and online nutrition education on body mass index in rugby athletes during the Covid-19 Pandemic (The Body Mass Index profile of Jakarta athletes during Covid-19 Pandemic). *Journal of Physical Education and Sport*, Vol 21 (Suppl. issue 4), Art 292, 2295 – 2301. DOI:10.7752/jpes.2021.s4292

Lihua, Hu, Xiao, Huang, Chunjiao, You, Juxiang, Li, Ku,i Hong, Ping, Li, Yanqing, Wu, Qinhua, Wu, Zengwu, Wang, Runlin, Gao, Huihui, Bao, & Xiaoshu, Cheng. (2017). Prevalence of overweight, obesity, abdominal obesity and obesity-related risk factors in southern China. *PloS one*, 12(9). DOI:10.1371/journal.pone.0183934

Mikhail, Kolokoltsev, Larisa, Kuznetsova, Elena, Romanova, Elena, Shirshova, Alexander, Volkov, Alina Solodovnik, & Elizaveta, Gnilitskaya. (2021). Physical activity of people who recovered from COVID-19. *Journal of Physical Education and Spor*t, Vol 21 (Suppl. issue 6), Art 433, 3265–3272. DOI:10.7752/jpes.2021.s6433

Mozolev, O., Polishchuk, O., Kravchuk, L., Tatarin, O., Zharovska, O., & Kazymir, V. (2020). Results of monitoring the physical health of female students during the COVID-19 pandemic. *Journal of Physical Education and Sport*, 20(6), 3280-3287. DOI:10.7752/jpes.2020.s6445

Nicholas, J.A., Lo, Siou, G., Lynch, B.M., Robson, P.J., Friedenreich, C.M., & Csizmadi, I. (2015). Leisure-time physical activity does not attenuate the association between occupational sedentary behavior and obesity: results from Alberta's Tomorrow Project. *J Phys Act Health,* 12(12), 1589–600. DOI: 10.1123/JPAH.2014-0370.

Romeo, B. Batacan Jr., Mitch, J. Duncan, Vincent, J. Dalbo, Patrick, S. Tucker, & Andrew, S. Fenning. (2017). Effects of high-intensity interval training on cardiometabolic health: a systematic review and meta-analysis of intervention studies. *British journal of sports medicine*, *51(6),* 494-503. DOI:10.1136/BJSPORTS-2015-095841.

Soleh, Solahuddin, Iman, Sulaiman, Bambang, Kridasuwarso, Wahyu, Indra, Bayu, Margono, Lasiono (2021). Physical activity level and body mass index profile of the working-age population in Palembang City. *Journal of Physical Education and Sport*, Vol 21 (Suppl. issue 4), Art 310, 2318-2324. DOI:10.7752/jpes.2021.s4310

Stuart, J. H. Biddle, Enrique, García Bengoechea, Zeljko, Pedisic , Jason, Bennie, Ineke, Vergeer, & Glen,

Wiesner. (2017). Screen time, other sedentary behaviours, and obesity risk in adults: a review of reviews. *Current obesity reports*, *6*. 134-147. DOI: 10.1007/s13679-017-0256-9

Ullrich, A., Voigt, L., Baumann, S., Weymar, F., John, U., Dörr, M., & Ulbricht, S. (2018). A cross-sectional analysis of the associations between leisure-time sedentary behaviors and clustered cardiometabolic risk. *BMC Public Health, 18(1*), 327. DOI:10.1186/s12889-018-5213-3

Wedell-Neergaard, A-S, Eriksen, L., Grønbæk, M., Pedersen, B.K., Krogh-Madsen, R., & Tolstrup, J. (2018) Low fitness is associated with abdominal adiposity and low-grade inflammation independent of BMI. *PLoS ONE,* 13(1), e0190645. DOI:10.1371/journal.pone.0190645

WHO. Global recommendations on physical activity for health (2010). Retrieved from http://www.whogis.com/dietphysicalactivity/factsheet_recommendations/ru

WHO (2018*)*. Obesity and overweight. Fact sheet. Retrieved from http://www.who.int/mediacentre/factsheets/fs311/ru/

Yang, Du, Buyun, Liu, Yangbo, Sun, Linda, G., Snetselaar, Robert, B., Wallace, Wei, Bao. (2019). Trends in Adherence to the Physical Activity Guidelines for Americans for Aerobic Activity and Time Spent on Sedentary Behavior Among US Adults, 2007 to 2016. *JAMA Netw Open,* 3, 2(7), e197597. DOI: 10.1001/jamanetworkopen.2019.7597.