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Contents

Barbara Bergier, Krystyna Gawlik, Joanna Baj-Korpak, Ewa Stępień, Agata Poczarska-Głos, Mirosława Sidor, Adam Szepeluk SUBJECTIVE AND OBJECTIVE ASSESSMENTS OF PHYSICAL ACTIVITY IN EMPLOYED WOMEN AGED 50 TO 64 YEARS	5
Ludmila Chervencova PANEURHYTHMY EXERCISES FOR DEVELOPING PARTNERSHIP AND SOCIAL SKILLS	17
Kinga Kostrakiewicz-Gieralt A SUMMARY OF THE USE OF MAIZE IN NUTRITIONAL PRODUCTS FOR SPORTSPEOPLE	33
Nicole J. Hernandez, Bradley J. Myers, Yuri Feito, Jennifer A. Bunn FUNCTIONAL STRENGTH EXERCISE AND BLOOD-FLOW RESTRICTION PROTOCOLS: A SYSTEMATIC REVIEW	47
Joanna Ratajczak, Katarzyna Rucińska, Marek Kolbowicz, Tomasz Zalewski SELECTED NUTRITIONAL BEHAVIORS AND THE LEVEL OF PHYSICAL ACTIVITY OF HIGH SCHOOL STUDENTS	59
Brent D. Bradford, Adam Howorko, Erinn Jacula, Jason Daniels, Shaelyn Hunt, Nicole Correia TRACKING DAILY STEPS: AN INVESTIGATION ON A SMALL POST-SECONDARY CAMPUS	75
Bartosz Bolach, Wojciech Seidel, Mirosław Mrozkowiak RATING TRAINING LOAD OF DISABLED SWIMMERS IN GENERAL PREPARATION SUB-PERIOD	87
Maria Gacek, Grażyna Kosiba, Agnieszka Wojtowicz SENSE OF GENERALISED SELF-EFFICACY AND PRO-HEALTH BEHAVIOURS OF POLISH AND SPANISH PHYSICAL EDUCATION STUDENTS	95
Joanna Trubiłko, Piotr Kolano, Elżbieta Sierńko-Awierianów, Monika Chudecka MORPHOLOGICAL CHARACTERISTICS, ASSESSMENT OF HYPERMOBILITY AND PAIN THRESHOLD OF RUGBY PLAYERS	107
Teresa Drozdek-Małołepsza, Eligiusz Małołepczy SPORTS IN SCHOOLS IN THE PROVINCE OF VOLHYNIA IN THE YEARS 1921–1939	115
Michalina Kuska, Marcin Pasek, Mirosława Szark-Eckardt SELF-ESTEEM OF PHYSICAL EDUCATION STUDENTS WITHIN DIDACTIC AND EDUCATIONAL SKILLS DEPENDING ON THE MODE OF STUDY AGAINST EVALUATION BY PLACEMENT SUPERVISORS	125

SUBJECTIVE AND OBJECTIVE ASSESSMENTS OF PHYSICAL ACTIVITY IN EMPLOYED WOMEN AGED 50 TO 64 YEARS

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Abstract Background: The aim of the study was to present data on subjective and objective assessments of physical activity in employed women and differences in their activity levels depending on age, education level, place of residence, financial status, and BMI. Another aim was to evaluate correlations of physical activity assessed subjectively and objectively with the aforementioned variables. **Methods:** Ninety employed women aged 50 to 64 years were divided into 3 groups. The International Physical Activity Questionnaire (IPAQ-S) was used for the subjective assessment, and the ActiGraph GT3X activity monitor was used for objective assessment. **Results:** The subjective assessment of total physical activity levels in the women was significantly higher than their objective assessment. The statistically significantly highest physical activity levels assessed by means of the questionnaire were found for women with the poorest financial status, or primary or secondary education levels and, for the assessments using accelerometers, the women with a BMI indicating overweight. A weak positive correlation ($R = 0.25$) was found between the total physical activity levels assessed subjectively and objectively. **Conclusions:** It seems that the use of only one tool for evaluation of physical activity level is not very conclusive. The use of both subjective and objective tools is needed to obtain reliable information about physical activity level.

Key words physical activity, women aged 50 to 64 years, IPAQ-S, accelerometer

Introduction

Physical activity has been claimed to play an important role in health protection (Blair, Dunn, Marcus, Carpenter, Jaret, 2001; Haskell et al., 2007; Sallis et al., 2009; Riekert, Ockene, Pbert, 2013; Chaix et al. 2014; World Health Organization, 2014; Neufer et al., 2015) and is one of the most important lifestyle factors. At the end of the last century, C. Bouchard and R.J. Shephard (1994) demonstrated a direct effect of physical activity on human health. Many scientific centres have been involved in research on physical activity, however, few studies

have used both subjective and objective assessment tools, particularly to examine active professional women aged 50 to 64 years. This period of life, which is often defined as a precursor to old age, has often been neglected in analyses of the health statuses and functioning of women, although people in this age range tend to experience symptoms of “wear” of the human body that may develop into many adverse health and mental problems. Dynamic hormonal changes are observed in women after 50 years of age, connected with the cessation of ovarian function. Frequent stress, resulting from social determinants (growing children, ageing parents, professional duties), may lead to various health problems, such as mental disorders. M. Chia and R.C. Abrams (2002) found that with the coexistence of these factors, women in their fifties and sixties show clinical symptoms of depression much more often than in other age groups. Various ailments related to menopause and the higher health risks observed after the age of 50, the quality of life of women deteriorates. Due to all the changes and problems experienced by women aged 50+ years, actions should be taken to prevent diseases and dysfunctions that may become frequent in the subsequent decades of life (Ostrowska, 2015). Female health promotion should primarily focus on three factors (diet, physical activity and stress), which are hugely important for the prevention, treatment and rehabilitation of the most serious diseases, and for building health resources (Słońska, 2015). The present study concerns one of the above factors, i.e. physical activity.

Physical activity in people aged 15 to 69 years has been assessed using the IPAQ questionnaire (Craig et al., 2003; Tomioka, Iwamoto, Saeki, Okamoto, 2011). This tool is inexpensive, thus allowing for assessment of physical activity levels in large populations. Since this tool is subjective, it is not perfect and can lead to overestimation or underestimation of physical activity levels (Ferrari, Friedenreich, Matthews, 2007; Neilson, Robson, Friedenreich, Csizmadia, 2008). Therefore, assessment of physical activity is often based on the use of a questionnaire in combination with accelerometer measurements (Kowalski, Rhodes, Naylor, Tuokko, MacDonald, 2012; Prince et al., 2008; Hagstromer, Ainsworth, Oja, Sjostrom, 2010; Harris et al., 2009).

The aim of the study was to present both subjective and objective data concerning assessment of the physical activity of active professional women aged 50 to 64 years, and differences in their activity levels depending on age, education level, place of residence, financial status and BMI. Another aim was to evaluate correlations of physical activity assessed subjectively and objectively with the above variables.

Material and methods

Participants

The examinations were conducted in a group of 90 women aged 50 to 64 years employed full time at a university. The women performed both intellectual and physical work as scientists, teachers, and administration employees. In order to determine the correlation between physical activity and age, the participants were divided into three age groups (50–54; 55–59; 60–64). The inclusion criteria were as follows: an age of 50 to 64 years and provision of consent for the examinations. The exclusion criterion was diseases that limited everyday physical activity purposive sampling was used: all the women who provided the consent and met the inclusion criteria were examined (i.e. 98% of women in this age category). The questionnaire data were used to obtain information concerning age, place of residence (village, city) education (higher, secondary and primary), financial status (below average, average, above average). Characterization of the women studied is presented in Table 1.

Table 1. Characterization of the study participants

		n	%
Education level	primary or secondary	39	43.3
	tertiary	51	56.7
Age	50–54 years	36	40.0
	55–59 years	32	35.6
	60–64 years	22	24.4
Place of residence	rural area	20	22.2
	city	70	77.8
Financial status	below average	10	11.1
	average	62	68.9
	above average	18	20.0
BMI	normal BMI	37	41.1
	overweight	26	28.9
	obese	27	30.0
Age	mean	56.4	
	SD	4.3	
BMI	mean	27.5	
	SD	5.4	

Assessment of physical activity using the questionnaire

Subjective assessment of physical activity (PA) levels was performed by means of a short version of the IPAQ-S questionnaire, which can be used for estimation of the physical activity levels and monitoring of health risks. It allows for collecting information about physical activity (PA) in everyday life over the last 7 days on which participants performed various physical exercises in their professional work, at home, in the garden, to move (e.g. walking, cycling), and during leisure time as recreation, physical exercise and sport (Craig et al., 2003).

The short version of the questionnaire contains 7 questions concerning time spent on intensive, moderate and low-intensity exercise and time spent sitting over a week. Questions 1 and 2 concerned intensive exercise which make breathing hard. Questions 3 and 4 concerned moderate-intensity exercise which make breathing slightly hard. Questions 5 and 6 concerned low-intensity exercise (walking to work and at home) (Craig et al., 2003). Analyses neglected information about time spent sitting (Question 7). The participants were asked to provide data on age, education level, financial standing and place of residence. The questionnaire was filled in the presence of an examination supervisor, after 7 days wearing an accelerometer in order to compare the objective and subjective measurement of physical activity performed over the same period of time that the IPAQ concerns.

Physical activity levels assessed using accelerometers

The objective assessment of physical exercise (PA) levels was conducted using an ActiGraph (wGT3X-BT) activity monitor, which records 24-hour physical activity information (Trost, Trost, McIver, Pate, 2005). The device is attached to an elastic band, and the women were asked to wear it around their waist for 7 consecutive days, and then to complete the IPAQ questionnaire. The participants were wearing the device all day and took it off only during washing or swimming in a swimming pool. Combined with Actilife software, the ActiGraph wGT3X-BT provides objective information about physical activity and inactivity, measures movement, energy expenditure, body

positions and amount of sleep. Physical activity level was measured with divisions into intensive, moderate and low-intensity exercise.

We also measured body height, body mass and computed BMI, and compared these with WHO norms (World Health Organization, 2014).

The examinations were performed twice (from March to May and from September to October 2017) as recommended for physical activity assessment in Polish climatic conditions (Biernat, Stupnicki, Gajewski, 2007).

Statistical analysis

Statistical analysis was conducted using STATISTICA v.10 software. We calculated arithmetic means and standard deviations for individual physical activity levels evaluated using the IPAQ questionnaire and the ActiGraph accelerometer. The significance of differences between these variables was evaluated using the paired samples Student's t-test. Differences in the physical activity level with consideration for the analyzed variables (age, place of residence, financial status, education, and BMI) were evaluated using the Student's t-test (for variables with two options) and ANOVA analysis of variance (for variables with more than two options). The strength of correlations between the results obtained from the IPAQ questionnaire and those from accelerometers were evaluated using the Spearman's rank correlation coefficient. In all analysed cases, the level of significance was set at $p = 0.05$. We also used k-means clustering analysis adopting two variables that determine the total physical activity levels of the women studied measured using the ActiGraph and the IPAQ questionnaire.

The present study was conducted according to the Declaration of Helsinki guidelines (Act No. 1/2015 of 12 May 2015). The examinations are part of the project "Effect of lifestyles and quality of life on selected aspects of physical status of active professional women aged 50 to 64 years".

Results

Physical activity levels evaluated using the IPAQ questionnaire

Assessment of physical activity (PA) using the IPAQ questionnaire showed that among the analysed variables, significant differences in PA levels occurred for education level (Table 2). Women with tertiary education level and above-average financial situation had lower physical activity levels. Statistically significant differences concerned total PA levels and intensive exercise in the case of education level, and total and low PA levels in the case of financial situation (Table 2).

Weak and average negative correlations of total physical activity levels and low-intensity PA with education level and financial standing was found in the women studied (Table 3).

Table 2. Level of physical activity evaluated by the IPAQ questionnaire (MET-min/wk)

		Type of activity							
		total		intensive		moderate		low	
		mean	SD	mean	SD	mean	SD	mean	SD
Education level	primary/secondary ¹	6,874.9²	7,304.0	2,467.7²	4,381.0	1,267.7	2,069.5	3,139.4	3,428.5
	tertiary ²	3,453.1 ¹	4,811.4	895.5¹	1,431.2	735.5	1,455.8	1,822.1	3,077.6
	Student's t-test	t = 2.61; p = 0.0106[*]		t = 2.36; p = 0.0209[*]		t = 1.40; p = 0.1652		t = 1.87; p = 0.0648	
Age	50–54 years ¹	4,429.9	5,388.2	1,429.4	3,488.4	903.5	2,032.5	2,097.0	2,480.6
	55–59 years ²	6,836.5	7,780.9	2,362.2	3,442.2	1,183.4	1,767.3	3,290.9	4,401.5
	60–64 years ³	2,906.0	3,853.9	636.2	1,514.8	740.0	1,208.2	1,529.8	2,079.7
	ANOVA	F = 2.80; p = 0.0666		F = 1.99; p = 0.1436		F = 0.43; p = 0.6535		F = 2.08; p = 0.1315	
Place of residence	rural areas ¹	5,752.1	8,372.5	2,475.1	4,906.6	745.6	726.2	2,531.4	3,978.3
	cities ²	4,690.8	5,505.0	1,315.8	2,425.1	1,026.6	1,951.0	2,348.4	3,087.2
	Student's t-test	t = 0.66; p = 0.5141		t = 1.43; p = 0.1575		t = 0.61; p = 0.5412		t = 0.21; p = 0.8315	
Financial status	below-average ¹	6,498.2³	8,018.6	3,194.7	4,626.2	1,082.7	1,647.9	2,220.9	2,945.5
	average ²	5,653.3	6,439.9	1,549.8	3,190.5	1,118.6	1,981.6	2,984.8³	3,576.9
	above-average ³	1,473.4¹	1,498.9	694.1	1,086.6	360.0	348.5	419.3²	664.2
	ANOVA	F = 3.55; p = 0.0331 [*]		F = 2.04; p = 0.1362		F = 1.27; p = 0.2873		F = 4.37; p = 0.0156[*]	
BMI	normal BMI ¹	3,797.0	4,729.4	1,003.0	2,057.1	722.5	1,077.1	2,071.5	2,763.5
	overweight ²	5,039.8	6,860.2	2,164.8	4,297.8	773.6	1,165.5	2,101.4	3,116.5
	obesity ³	6,334.0	7,189.2	1,767.7	3,053.4	1,473.8	2,684.3	3,092.4	4,015.8
	ANOVA	F = 1.26; p = 0.2895		F = 1.07; p = 0.3484		F = 1.60; p = 0.2086		F = 0.86; p = 0.4289	
Total		4,925.3	6,210.6	1,571.9	3,146.2	964.5	1,755.3	2,388.8	3,279.9

^{*} Significant differences at $p < 0.05$; t – value of Student's t-test for independent samples; F – value of ANOVA analysis of variance.

The different numbers (indicated under 1, 2 and 3) in superscripts mean that differences among items are statistically significant. The same numbers in superscripts mean that differences among items are statistically insignificant.

Table 3. Correlations between physical activity and variables

	Type of activity			
	total	intensive	moderate	low
Education level	–0.30[*]	–0.03	–0.14	–0.36[*]
Age	–0.14	–0.14	0.02	–0.03
Place of residence	0.03	–0.05	–0.09	0.10
Financial status	–0.26[*]	–0.10	–0.08	–0.33[*]
BMI	0.06	0.10	0.13	0.06

^{*} Statistical differences at $p < 0.05$.

Physical activity levels assessed using accelerometers

Physical activity levels assessed using accelerometers showed that among the five factors examined, differences were found only for BMI. Statistically significant differences concerned total PA, moderate PA and low-intensity PA (Table 4).

Table 4. Physical activity levels assessed using accelerometers (MET-min/wk)

		Type of activity							
		total		intensive		moderate		low	
		mean	SD	mean	SD	mean	SD	mean	SD
Education level	primary/secondary ¹	2,881.0	2,541.1	1.6	7.2	5,09.9	790.7	2,369.5	1,811.8
	tertiary ²	2,609.5	2,812.6	5.3	20.5	5,15.6	1,004.9	2,088.6	1,867.0
	Student's t-test	t = 0.03; p = 0.9774		t = 1.14; p = 0.2578		t = 0.50; p = 0.6153		t = 0.22; p = 0.8274	
Age	50–54 years ¹	2,255.8	1,952.9	3.1	8.5	369.4	541.4	1,883.4	1,429.2
	55–59 years ²	3,321.2	3,171.9	6.3	25.3	701.0	1,179.3	2,613.9	2,057.0
	60–64 years ³	2,609.8	2,892.0	0.9	4.0	468.5	941.9	2,140.3	2,049.6
	ANOVA	F = 1.15; p = 0.3219		F = 0.65; p = 0.5224		F = 1.12; p = 0.3322		F = 1.08; p = 0.3453	
Place of residence	rural areas ¹	5,752.1	8,372.5	2,475.1	4,906.6	745.6	726.2	2,531.4	3,978.3
	city ²	4,690.8	5,505.0	1,315.8	2,425.1	1,026.6	1,951.0	2,348.4	3,087.2
	Student's t-test	t = 0.66; p = 0.5141		t = 1.43; p = 0.1575		t = 0.61; p = 0.5412		t = 0.21; p = 0.8315	
Financial status	below-average ¹	3,622.8	2,612.9	13.6	43.1	684.5	842.5	2,924.6	1,802.2
	average ²	2,854.2	2,897.3	2.0	7.3	552.3	1,008.8	2,299.9	1,962.6
	above-average ³	1,755.1	1,588.8	3.8	9.5	276.5	514.0	1,474.7	1,110.8
	ANOVA	F = 1.44; p = 0.2423		F = 2.61; p = 0.0792		F = 0.45; p = 0.6388		F = 2.02; p = 0.1389	
BMI	normal BMI ¹	2,210.7³	1,917.5	6.8	24.3	380.7	629.4	1,823.2³	1,356.6
	overweight ²	2,115.2³	1,742.8	3.1	8.1	296.4³	443.3	1,815.7³	1,324.3
	obesity ³	4,008.0^{1, 2}	3,765.5	0.1	0.3	899.8²	1,372.9	3,108.0 ^{1, 2}	2,469.0
	ANOVA	F = 4.62; p = 0.0122[*]		F = 1.54; p = 0.2197		F = 3.77; p = 0.0265[*]		F = 4.82; p = 0.0102[*]	
Total		2,726.3	2,687.1	3.7	16.2	513.1	913.8	2,209.4	1,838.0

^{*} Significant differences at p < 0.05; t – value of Student's t-test for independent samples; F – value of ANOVA analysis of variance.

The different numbers (indicated under 1, 2 and 3) in superscripts mean that differences among items are statistically significant. The same numbers in superscripts mean that differences among items are statistically insignificant.

We found weak negative correlations of total, moderate and low-intensity physical activity with the financial standing of the women examined and a weak positive correlation between low-intensity PA and BMI (Table 5).

Table 5. Correlations between physical activity and variables

	Type of activity			
	total	intensive	moderate	low
Education level	–0.12	0.09	–0.08	–0.12
Age	–0.01	–0.06	–0.05	0.01
Place of residence	0.09	–0.01	0.08	0.09
Financial status	–0.27[*]	0.13	–0.27[*]	–0.27[*]
BMI	0.21	–0.10	0.13	0.23[*]

^{*} Statistical differences at p < 0.05.

Comparison of physical activity levels using the questionnaire and accelerometers

The results of examinations of physical activity obtained during measurements using the questionnaire and accelerometers showed statistically significant differences for total, intensive and moderate activity, with substantially higher values obtained using the questionnaire (Table 6).

Table 6. Physical activity levels assessed using accelerometers and the IPAQ questionnaire (MET-min/wk)

		Mean	SD
Type of activity	total Accelerometer ¹	2,730.9²	2,670.3
	total IPAQ ²	3,687.5 ¹	5,116.9
	total Student's t-test	t = 2.89; p = 0.0049*	
	intensive Accelerometer ¹	3.3²	15.0
	intensive IPAQ ²	1,251.3¹	2,684.5
	intensive Student's t-test	4.60; p < 0.0001*	
	moderate Accelerometer ¹	529.9²	918.4
	moderate IPAQ ²	829.5¹	1,489.3
	moderate Student's t-test	t = 2.06; p = 0.0420*	
low	low Accelerometer ¹	2,197.6	1,815.6
	low IPAQ ²	1,606.7	2,681.3
	low Student's t-test	t = 0.1113; p = 0.9116	

* Significant differences at p < 0.05; t – value of the Student's t-test for dependent samples.

The different numbers (indicated under 1, 2 and 3) in superscripts mean that differences among items are statistically significant. The same numbers in superscripts mean that differences among items are statistically insignificant.

A weak positive correlation was found between the total physical activity levels assessed using the questionnaire and accelerometers (Table 7).

Table 7. Correlations between physical activity levels assessed using the questionnaire and accelerometers

Type of activity	Spearman's R	t	p
Total	0.25	2.37	0.0199*
Intensive	0.19	1.80	0.0757
Moderate	0.14	1.34	0.1846
Low	0.17	1.65	0.1029

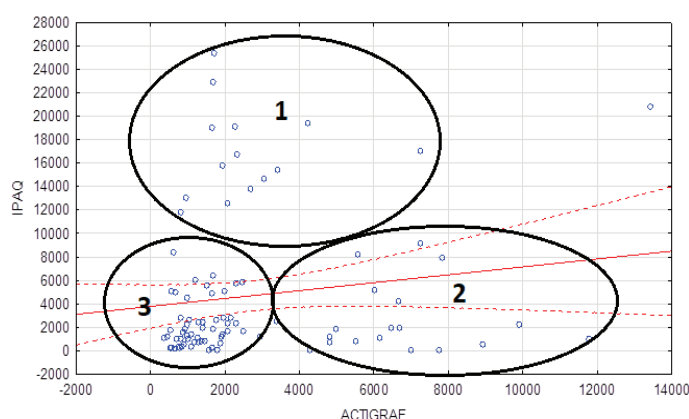
* Significant differences at p < 0.05; t – value of the Student's t-test.

Cluster analysis was also conducted with two variables: total physical activity levels for the assessment using the questionnaire and using accelerometers. Both analysed variables turned out to be statistically significant (Table 8).

Table 8. Analysis of variance for PA assessed using the questionnaire and accelerometers

Variable	Analysis of variance					
	between SS	df	int. SS	df	F	signif. p
Actigraf	4.094081E+08	2	233,994,500	87	76.1097	0.000000
IPAQ	2.791444E+09	2	579,848,800	87	209.4129	0.000000

Three groups were identified. The first group (15 women) included participants with low PA evaluated using accelerometers and high PA assessed using the questionnaire. Despite high results using accelerometers, the second group (17 women) showed a low PA for the questionnaire. The third group (58 women) included women whose results obtained using both measurement tools were the most similar (Figure 1).

**Figure 1.** Dispersion of physical activity levels assessed using the questionnaire and accelerometers

The most numerous group (3), where subjective and objective assessment of PA were most similar, was women with higher education levels (63.6%) at the age of 50–54 (47.3%) living in cities (76.4%) with average (65.5%) or above-average (27.3%) financial situation and normal BMI (47.3%). Significant differences between the groups were found only in the case of financial status ($p = 0.0323$), with percentage of people with above-average financial standing (27.3%) significantly higher in the third group compared to the second (12.5%) and the first (0%).

Discussion

The aim of the study was to compare subjective (IPAQ) and objective (ActiGraph) assessments of physical activity levels in a group of active professional women aged over 50 years. The assessment of physical activity levels pointed to substantial variation with respect to total, intensive and moderate activity, with higher measurements resulting from the subjective assessment. This points to overestimation of the measurements obtained using

the IPAQ questionnaire. Furthermore, some help was needed to fill in the questionnaire to minimize the number of misinterpreted or missing replies. These difficulties have been also emphasized by other researchers (O'Neill et al., 2017).

The above findings encourage a more frequent use of objective tools that can be compared with each other. To meet these conditions, uniform recommendations for physical activity measurements using accelerometers should be developed, including the location of the device during the examinations, the duration of wear and the examination periods. The best solution would be to fill out the IPAQ questionnaire after the accelerometer had been worn for one week (7 consecutive days). When the respondents return the accelerometers, they would complete the IPAQ to provide information about their subjective assessments of their physical activity over the period of wearing the accelerometers. Wearing an accelerometer for one week seems to be sufficient, because this period ensures that the participants can easily recall all forms of physical activity as well as the duration and intensity. A combination of subjective and objective tools for the assessment of physical activity levels allows for a comprehensive analysis of behaviours concerning physical activity (Ainsworth, Cahalin, Buman, Ross, 2015).

Literature presents a lack of information about specific recommendations connected with the assessment of physical activity using accelerometers, although these modern devices are characterized by high validity and reliability (Wanner, Martin, Meier, Probst-Hensch, Kriemler, 2013; Butte, Ekelund, Westerterp, 2012). W. Osinski (2003) argued that respondents were likely to modify their behaviors during the examination period, because they attempted to obtain the best results possible. In this aspect, an interesting proposal was made by D.W. Eslinger, J.L. Copeland, J.D. Barnes and M.S. Tremblay (2005). These researchers suggested that in the case where accelerometer measurements are collected for a duration of 8 days, the first day the device is worn should be neglected, because it may encourage a higher level of activity at the beginning of data collection. With the increasing popularity of the use of accelerometers in examinations of physical activity, many studies have recently explored this area of research. S. Skender et al. (2012) reviewed studies that used accelerometers and physical activity questionnaires. In most studies, the participants wore the devices for 7 days attached mainly near their hips (belt or waist). In the conclusion section, the authors argued that accelerometers were capable of ensuring more reliable and coherent results. They admitted that there were no standards concerning the use of accelerometers, including the location to which they should be attached and the minimal time of wearing. This lack leads to some inconsistencies, which indicate the need for the development of general guidelines for the use of accelerometers to improve the comparability of the measurement results in future studies. In 57 publications analysed by S. Skender et al. (2012), the correlations between the results obtained from the IPAQ and the accelerometer data were intermediate (poor to moderate). The authors found no clear correlations between physical activity assessed using the IPAQ and activity measured by accelerometers with regards to sex, age, BMI and even the time spent wearing the device. Slightly stronger correlations were found in men than in women and in younger than in older people.

In our study, the highest physical activity levels assessed using the questionnaire were obtained by women with secondary and primary education and those with the poorest financial standing. Weak and average negative correlations of the total physical activity levels and low-intensity PA with education level and financial standing was found in the women examined. It was surprising in the case of PA assessment using accelerometers that a significantly higher physical activity levels were observed in overweight women. Furthermore, we found weak negative correlations of total, moderate and low-intensity physical activity with the financial standing of the women examined, and a weak positive correlation between low-intensity PA and BMI.

We found a weak positive correlation between the total physical activity levels evaluated subjectively and objectively. As demonstrated by S. Sabia et al. (2015), who used data from an extensive study conducted in the UK ($n = 3,940$, including 1,016 women) in an adult population aged 60 to 83 years, the correlation of physical activity levels with obesity markers in older adults was stronger if physical activity was evaluated using accelerometers than using the questionnaire. This suggests that physical activity may be more important to obesity than it was believed before. Correlations between total physical activity and all obesity markers were greater in women compared to men.

S. Sabia et al. (2015), who cited previous researchers (Esliger et al., 2005; Skender et al., 2012), demonstrated that the correlations between subjective and objective assessment of physical activity were low or moderate and seemed to be even lower at older age (Prince et al., 2008).

Cluster analysis conducted in our study allowed for identification of a group of women where physical activity assessments using the IPAQ questionnaire was the most similar. These were women with tertiary education aged 50 to 54 years living in cities and with average or above-average financial standing and correct BMI.

Although this group was the biggest, the results of examinations of physical activity levels obtained during measurements using the questionnaire and accelerometers demonstrated statistically significant differences for total, intensive and moderate activity, with substantially higher values obtained using the questionnaire. This shows that the IPAQ is insufficient to be used as the sole tool for assessment of PA in this group.

Conclusion

Physical activity levels in the women analysed using the subjective assessment was significantly higher than for the objective assessment with respect to total, intensive and moderate activity. Therefore, it seems that the IPAQ cannot be the only tool for PA assessment but can be successfully used as an auxiliary tool. The use of both subjective and objective tools is needed to obtain reliable information about physical activity level.

Abbreviations

IPAQ: International Physical Activity Questionnaire; MET min./wk: Metabolic Equivalent of Work minute/week; WHO: World Health Organisation; BMI: Body Mass Index.

Declarations. Ethics approval and consent to participate

The protocol of this study was approved by the Ethics Committee of the Academy of Physical Education (No. 1/2015 from 12 of May, 2015).

The ethical approval was obtained from the Ethics Committee of the Academy of Physical Education because at the time when we started the research, i.e. in 2015, there was no Bioethical Commission in Pope John Paul II State School of Higher Education in Biała Podlaska. Accordingly, we turned to the Jerzy Kukuczka Academy of Physical Education in Katowice, whose employees deal with similar research issues, and we obtained permission for doing the research from the Bioethics Committee for Scientific Research working in the Academy of Physical Education in Katowice. It was issued as a resolution of 12/05/2015 No. 1/2015. On the other hand, the research was conducted in John Paul II State School of Higher Education in Biała Podlaska, ul. Siderska 95/97.

We would also like to confirm that we had written consent from all the women who participated in our research and we ensured that the results had been collected in such a way that the women could not be personally identified in any way.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and/or analyzed during the study are available from the authors upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

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PANEURHYTHMY EXERCISES FOR DEVELOPING PARTNERSHIP AND SOCIAL SKILLS

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Abstract Paneurhythmy is a group psycho-physical practice created in Europe, involving marked social interaction. The purpose of this paper is to provide information about Paneurhythmy, and to discuss its potential as a means of development of partnership and social skills.

This article offers a brief introduction into Paneurhythmy. The basic characteristics of Paneurhythmy practices providing appropriate conditions for the improvement of partnership skills are formulated and explained. By means of analysis, discussion and examples, it is shown how Paneurhythmy for beginners and its further practice can develop skills for successful partnership with children and adults. The existent empirical and theoretical studies on the subject to date have been specified, confirming the cultivation of partnership and social skills through Paneurhythmy.

Paneurhythmy has an extremely big potential for the development of partnership skills and for the improvement of social functioning. In this respect, the most important characteristics of Paneurhythmy are the following: group practice in pairs, an appropriate aim of the practice, the right music, common rhythm and synchronization of movements, specific distances between participants, typical characteristics and expressiveness of participants' movements, Paneurhythmy philosophy, sharing space, suitable lyrics of Paneurhythmy songs, figures for the arrangement of participants, acting social roles and broadening the range of awareness. Paneurhythmy is a widely-accessible new instrument for personal and social development. This is confirmed by the existent scientific studies, revealing that, with children and adults, both initial training and further practising Paneurhythmy leads to the improvement of interpersonal relations and social skills.

Key words outdoor exercise, learning, partnership, social skills

Introduction

Regardless of the fast development of technologies enhancing the exchange of information between contemporary generations, people nowadays suffer from a number of problems related to deficiencies in communication and social contacts. These deficiencies restrict their abilities for social realization and affect their health status, defined as the state of complete physical, mental and social well-being (WHO Constitution). The influence of positive social relations on human health has already been proven theoretically and confirmed in

practice (Cohen, 2004; Umberson, Karas Montez, 2010). Research in social epidemiology uncover that the absence of positive social relationships is a significant risk factor for morbidity and mortality (Cacioppo, Cacioppo, 2014).

Prosocial behavior is voluntary, intentional action that benefits others. It finds expression in actions such as helping, sharing, cooperation and caring (Grusec, Davidov, Lundell, 2002). Prosocial behavior seems to be a key aspect of social competence and it has been positively associated with socioemotional (social competence, empathy-related responding) and sociocognitive outcomes in youth, and negatively associated with delinquency and aggression (Malti, Perren, 2011; Morris, Eisenberg, Houlberg, 2011).

Social skills and social understanding are substantial for individual psychological well-being and peer group adjustment (Smith, Hart, 2002). There are still needs for increasing the number of effective means that help children form and improve friendships (Ladd, Buhs, Troop, 2002). There are different ways to develop successful partnership and social skills, but their cultivation through practical activities is among the most successful. Motor practices, performed in a variety of open geometrical figures by large groups of varying sizes, could be not only a big challenge for partnership and social skills, but also an appropriate environment and important stimulus for their development. This article for the first time presents and analyses the potential of Paneurhythmy as unique contemporary system of psycho-physical exercises for the effective development of social skills with people of all ages.

What is Paneurhythmy

Paneurhythmy is a unique psycho-physical activity consisting of exercises performed to music outdoors, in pairs and in groups (Figures 1 and 2). It has three parts, comprising 30 exercises, performed with small pauses between them and two longer breaks/pauses for rearrangement. The duration of one complete performance with pauses is about 70 minutes. In the course of the year it is practiced daily in the open air for about 6 months, when nature is in its period of flowering and growth: from March 22 to September 22 (for the northern hemisphere of the Earth). For the other 6 months, classes in Paneurhythmy for beginners are usually organized. The intensity of exercises in Paneurhythmy for healthy physically active people is usually low to average. With people of lower physical capacity or illness, the relative intensity of the exercises could be greater (Beinsa Douno, 1938; Beinsa Douno, 2004; Chervencova, Ishev, 2015).

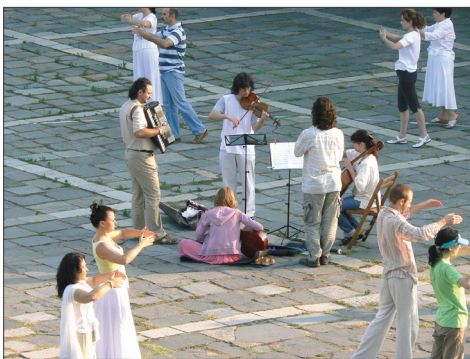


Figure 1. Paneurhythmy in Plovdiv, Bulgaria

Source: Photo by Zhsivko Stoilov.

On a global scale, Paneurhythm has no analogy – it is a unique Bulgarian and European kind of physical activity. It combines the positive influence of a number of powerful factors on the participants, such as motion, music, poetry, words, songs, breathing, concentration of thought, abstract thinking, positive emotions, light, fresh air, connection with nature and social contacts. Since Paneurhythm involves a great variety of arts – movement-based creative expression, music, poetry, speech and theatrical elements (there is a story line, tells stories through movement), it is rightfully also considered as an art therapy. Paneurhythm is very attractive as it is easily accessible, very pleasant, and in accordance with the latest interests and trends of development of the modern world. In less than 100 years since the creation of Paneurhythm, it has won legions of fans from many countries around the world (Deunov, 2015; Naydenova, 2003; Chervencova, 2013).

Paneurhythm was created in Bulgaria in the first half of the previous century by the Bulgarian theologian, philosopher and musician Peter Deunov, who was recognized by Bulgarians and foreigners as their devoted spiritual teacher (Chervencova, 2013; Bachev, 2017). According to him, Paneurhythm aims to improve and sustain physical health in all its aspects – physical, psychological and social, and it is also an effective means of harmonizing the thoughts, feelings and actions of its participants and of helping the progress of man and society (Beinsa Douno, 1938). Practising Paneurhythm could be a means of education and self-education for the acquisition and development of important qualities for modern man; moral strength, will power and social skills (Boycheva, Donevska, Vancheva, 2001; Anchev, 2003; Matanova, Yankova, 2007a, 2007b).



Figure 2. Paneurhythm in Rila Mountain (before 1940)

Paneurhythm was created to be a widely accessible means of sustaining human health and for the all-round development of people. The flowing and beautiful movements of Paneurhythm, its musical variety and the contact with nature during the performances, are pleasant and attractive for children, adults and elderly people. Modern research on Paneurhythm has revealed that both the beginner course and further practice of Paneurhythm bring psychological and physical benefits. The following significant positive changes have been measured after 5–6 months of Paneurhythm training (these were not observed in the control group): improved static balance; improved dynamic functional balance and general mobility; improved strength endurance of some muscle groups; decreased level of state anxiety, trait anxiety, perceived stress, negative emotions, aggression and depression; at the same time there are increased positive emotions, subjective happiness, self-esteem, hope, general self-efficacy,

optimism, resilience, sense of coherence and life satisfaction; improved quality of life, increased general subjective health and working capacity (Chervencova, 2012, 2013).

Paneurhythm contains non-traumatic strengthening and aerobic exercises that are good for maintaining flexibility. Paneurhythm significantly improves balance in middle-aged people and is suitable for effective early prevention of falls in elderly people. It is extremely accessible regardless of financial condition or physical characteristics of the participants and can be performed by people aged from 5 to 95 (Figures 2 and 3). It does not require expensive equipment or facilities and it is also suitable for people with certain compensated chronic diseases (Chervencova, Ishev, 2015).



Figure 3. Paneurhythm

Source: Photo by Zhsivko Stoilov.

The specific characteristics of Paneurhythm and the positive results are shown in Table 1. Characteristics numbered 1 to 7 describe Paneurhythm in general, while those numbered 8–11 are more closely related to developing partnership skills. Actually, all components of Paneurhythm are created so that they enhance successful communication and the improvement of skills towards a creative partnership.

Table 1. Specific characteristics in the performance of Paneurhythm exercises

Specific characteristics	Results
1	2
1. Relatively slow and always smooth movements	Opportunity for conscious control of movements. Great accessibility with reference to movement (accessible from the age of about 5 to 95)
2. Rhythmic performance	Easier to learn. Develops a sense of rhythm. A sense of union through the performance in the same rhythm
3. Specific gait (always stepping on toes first)	Decreased micro commotions while walking. Improved gait. Strengthened calf muscles
4. Music is a key element in the exercises	The practice is more pleasant. Music has an emotional and an aesthetic influence. Music therapy
5. Poetic text and basic philosophical idea for each exercise	Influence through the spoken word (the song lyrics, the names of exercises). Adequate thought stimulation and connecting the activity with noble ideas.
6. A requirement that participant movements should be meaningful and beautiful	Greater involvement of thought. Creativity – participants seek to discover those beautiful movements
7. Performing in the open air close to beautiful nature	Healing effect of natural factors (sun, wind, water, cleanliness, ionization of the air, and etc.). Stress relieving and aesthetic influence of the natural environment

1	2
8. Geometry and coordination. The exercises are performed in pairs and movements require time and/or space coordination (with music, the partner in the pair, adjacent pairs, other pairs, the performance of joint geometric figures, outside natural objects)	Conditions are provided for considerable and constant involvement of thought. Development of intellectual skills (space orientation, improvement of concentration of attention, abstract thinking, etc.). Attention span is improved naturally with increased practice, and special skills of awareness to group activities are developed, on several levels
9. Group performance (approximate number of participants: from 10 to 500–1000 and more) forming of geometric figures in common	Very good conditions for development of team-working skills in an informal environment. Social contacts
10. Performance in pairs which are organized in circles and/or form many groups of 10 or 12 people, arranged in complex regular geometric figures	Higher requirements towards the coordination of individual and collective movements. Great potential for improvement of concentration and the scope of attention. Forming a sense of partnership. Forming an awareness of social roles
11. Ideas and Philosophy. Each Paneurhythmy exercise symbolizes a sublime idea implied in its name. The arrangement of the participants and the directions of their movements also have a symbolic meaning	Development of abstract thinking. Development of attitudes that create and sustain peaceful societies. Seeking correspondence between ideas, music and motion. A purely mechanical execution of the exercises is avoided. There are conditions for the mind to be active all the time

The author of Paneurhythmy received his education at the end of the XVIII century in Europe and America. Peter Deunov was familiar with the contemporary philosophy of his time and also with the philosophy of antiquity, along with the cultural and philosophical trends of development of the East and the West in general (Bachev, 2017). M. Bachev defines the teaching of P. Deunov as “representing the meeting between man and the source of life, wisdom and intellect, East and West, prophetic and philosophical, culture and nature” (Bachev, 2015, p. 37). According to David Lorimer, the teachings of P. Deunov are part of the “Western esoteric tradition, steeped as it was not only in Platonism but also the original spirit of Christianity” (Kraleva, 2001, p. 9).

Paneurhythmy appeared and developed as a system of exercises between 1932 and 1944 in the cultural environment of an ancient European and Christian country. At about the same time, in 1936, Carl Jung stated that he expected the appearance of a psycho-physical and spiritual practice in Europe, similar to yoga, originating from the Christian tradition and the Western cultural heritage (Jung, 2014). Paneurhythmy, even though quite different from yoga, has similar general characteristics: it is a psycho-physical practice, aimed at providing human health and development in all its aspects; it could be used as a practice for self-development; it has a profound philosophical basis; it has unique specific aspects and is an attractive means of sustaining good health and wellbeing of modern man. Consequently, Paneurhythmy may be called the Yoga of the West, developed on the basis of Christianity, the practice which Carl Jung expected to be created.

Importance of the research

Paneurhythmy still has not been studied enough scientifically. Over 100 research works on Paneurhythmy have been published so far. Among them there is not even one work devoted on the profound, purposeful study of the multi-aspectual potential of this practice in the field of communication. There are results from separate studies, pointing to the fact that Paneurhythmy can be very useful for the improvement of communication skills. Nevertheless, there is no basic analysis or general review of the studies on this topic, stating why and how Paneurhythmy in particular has the potential to improve social relations. That kind of analysis can be the necessary theoretical basis, showing the potential of Paneurhythmy to improve social relations, and providing a broad framework for future research in this direction.

The objective of this article is to reveal the potentials of Paneurhythmy to stimulate partnership and social relations.

Research methods

1. A theoretical analysis of the specific characteristics of Paneurhythmy, enhancing the improvement of partnerships and social relationships. This article is aimed at a detailed and complete outline, based on theoretical analysis, of the components of Paneurhythmy, which have a positive influence on social relations and communication. The author's personal experience in practicing and teaching Paneurhythmy is the basis on which 11 characteristics of Paneurhythmy have been identified and stated here, helping to improve relationships and communication.

2. A review of current research of Paneurhythmy has been done in order to determine what is proven about its influence on the social sphere.

Characteristics of Paneurhythmy developing partnership and groupwork skills

Group practice, performed in pairs

The mere fact that Paneurhythmy is a group motor practice (Figure 4) with a variety of interactions between the participants during its performance is a condition for the development of partnership and social skills.



Figure 4. The first part of Paneurhythmy ("28 exercises"). Paneurhythmy in Plovdiv, Bulgaria

Source: Photo by Zhsivko Stoilov.

The aim of the practice

Most importantly during the performance of Paneurhythmy is for the whole group to do the Paneurhythmy exercises beautifully and in harmony. Consequently, the aim of the practice is not to elect a winner, to compete or to dominate in competition, which could lead to contradictions. Paneurhythmy requires constructive cooperation, leading to the creation of harmony and beauty. So, each Paneurhythmy performance requires the right attitude in an effort to offer help and partnership.

Group rhythm and synchronization of movements

According to J. Phillips-Silver, C. Athena, C. Aktipis and G. Bryant (2010), probably there is no other kind of human behavior uniting people as much as coordinated rhythmic movement. Grounded on a vast literary review on the subject, the authors point out that the human ability to follow the rhythm of another human or external stimulus is rooted in the physical, emotional and social aspects of the human experience, which are essentially connected with music and dance (Phillips-Silver et al., 2010). Performing all Paneurhythm exercises, participants do many similar (actually almost similar or completely the same) synchronized rhythmic movements with their limbs. This circumstance increases their sense of union. Due to the fact that Paneurhythm always presents a reasonably coordinated and rhythmic group movement, it has the power to unite its practitioners, helping them feel a sense of belonging to the group.

Types of distances and movements in the pairs

All movements which the participants perform with their limbs and body, are smooth and calm, they do not aggressively enter other people's personal space, which instills a peaceful atmosphere. The members of a pair are nearest to each other, at varying distances, but not less than an arm's length away from one another. According to the "body language" code accepted in our culture, such a distance is normally used in situations of common professional activities and friendly (but not intimate) relations, to express feelings of friendship and cooperation.



Figure 5. Moments of exercise no. 22 – “Acquaintance”

Source: Photos by Svetla Neykova.

At the beginning of Paneurhythm, interaction between partners in each pair increases gradually – as if they are given time for internal harmonization before their physical contact. In the first exercises of Paneurhythm, partners dance in synchrony, parallel to each other, later they exchange their places for the first time (in exercise no. 13 – “Weaving”) and only in exercise no. 22 (Figure 5) do they hold hands from time to time, this also happens in some of the following exercises (exercises no. 22–24 and 26). The type of movements for each couple when holding

hands shows friendly relations: all types of holds are palm to palm, they are performed smoothly and express introduction, exchange and mutual support (a wide hold with both hands, holding only the palms of the hands or holding the palm and then the top of the hand, and with more difficult balance exercises, holding the palm of the partner sometimes helps to keep their balance) (Figure 6).

From another aspect, holding hands in Paneurhythmy exercises almost always leads to a forward movement of both partners in the direction of the general movement in the circle. Since in most cultures and in Paneurhythmy itself, forward movement symbolizes evolution and progress, holding hands while moving forward is an expression of mutual support of the pair, aiming at the same goal of progress and development.

With reference to the meaning of the movements in Paneurhythmy, the level at which partners hold their hands symbolizes their sphere of partnership. For example, holding palm to palm (which is the only way of holding hands in Paneurhythmy), as well as positioning the hands held together above shoulder level, symbolizes communication with an exchange of thoughts. Hand movement at breast level, and holding palms at that level, symbolizes an exchange of feelings. According to those symbols, predominating hand movements in exercises, where partners hold their hands, show communication with an exchange of thoughts/ideas and feelings/emotions between partners.

The types of movements, the distance between the partners, holding hands in pairs while performing Paneurhythmy, all helps to create an atmosphere of friendly communication and support in the name of mutual progress.



Figure 6. Moments of Paneurhythmy exercises

Source: Photos by Svetla Neykova.

Sharing space

A very important detail, through which Paneurhythmy stimulates the development of partnership skills, is the necessity while practicing to share the space (Figure 7). For example, while moving forward, partners in the pair try to do the exercises together, taking care to keep an adequate distance between each other, so that each has enough space to do the Paneurhythmy movements without obstructing the other. The same thing happens with the

adjacent pairs from the moving circle formed by the whole group – they have to take care with the length of their strides and the distance from other pairs, their strides should be enough to maintain the required space to others. In the second and third part of Paneurhythmy, sharing space becomes much more complicated as there are many groups of 10, 12 and more people performing exercises with more complex geometric figures in the groups.

Thanks to the variety of ways to share space while performing Paneurhythmy, participants are taught to be careful about the need of space for others in a situation of creative partnership, while doing an activity together. We believe that everyone who practices Paneurhythmy long enough manages to develop the skills of sharing space with others due to this practice. This teaches awareness of, and respect for, providing space for others in common activities while performing Paneurhythmy. When the skills of providing space for all participants at the same time and in a fair way are developed through Paneurhythmy, a communication model has been created which could be naturally applied in many other situations in life.



Figure 7. Moments of Paneurhythmy exercises

Source: Photos by Ludmila Chervencova.

The general arrangement of participants

All pairs participating in Paneurhythmy form one geometric figure specific for each part of Paneurhythmy (Figure 4). For example, in the first part, all pairs are arranged in one circle (or more) with one center. In the second part, groups of 6 pairs (12 persons) are formed, arranged in lines radiating from the centre and facing it, together with an external circle of pairs (Figure 8a). In the third part of Paneurhythmy, all participants are arranged in groups of 10, forming lines radiating from the center (with their left shoulder to it) (Figure 8b). Taking initial positions for the collectively shaped figures before the start of the performance, as well as preserving these shapes during the performance, requires special attention and the joint effort and cooperation of all participants to keep the general design of Paneurhythmy. This situation naturally promotes partner relations in the group, and with the regular practice of Paneurhythmy, it cultivates the skills and habits for successful cooperation.

The arrangements of the participants in the second (Sunrays) and third (Pentagram) parts of Paneurhythmy are visible in Figure 8.



Figure 8. Photos of the largest Paneurhythmic performances in the world: Bulgaria, August 19–21, Rila Mountain

Source: Photos by Zhsivko Stoilov.

The type of music

There is variety in the music of Paneurhythmy, but without any strong or dramatic notes in it, which might suggest anxiety, hostility or aggression. The tempo, tonality and other musical forms vary in the music for Paneurhythmy exercises, but a general a positive note is constantly present. In the language of music, it is an expression of peace and harmony.

The lyrics of the songs for Paneurhythmy

Each performance of Paneurhythmy is accompanied by instrumental music and vocal singing (out loud, or silent) of the songs. In the beginner training course, they are sung or listened to during the exercises practiced during the course. The poetic lines of Paneurhythmy songs form a strong element in the general message of Paneurhythmy.

D. Ancheva (2003) made a detailed analysis of the Paneurhythmy song lyrics and found the complete set of lyrics contains 438 words (with repetitions it amounts to 2,536 words) with the majority of them related to the beauty of nature. The most frequently repeated topics in the text are: “There is light” and “Positive feelings and emotions” (their frequency respectively 273 and 270 words including repetitions). In the group of positive feelings and emotions, the most frequently repeated words are: “love” (52 times), “happiness” (46 times), “peace” (23 times), “sweet” (13 times), “I enjoy” and “gentle” (each one 11 times), “sweetness” and “grace” (each one 10 times) (Ancheva, 2003, 2007a). We believe that listening and singing these words in Paneurhythmy creates an environment which helps participants focus on the experience of these positive emotions. Thus, a positive atmosphere is created for friendly relations, a basic condition for a fruitful partnership.

Another aspect of the Paneurhythmy song lyrics we find important with reference to partnership, is the proportion of words related to the “Ego” and to the “group”. Words related to the “Ego” are used 30 times in the songs, while words related to the “group” 132 times, a proportion of 1:4 approximately. Also, verbs expressing “I am doing something” are used with a frequency of 21, while those, expressing “we are doing something” with a frequency of 98, again roughly a proportion of 1:4 (Ancheva, 2003). D. Ancheva has good reason to conclude that each person and their “Ego” are placed in the centre of the lyrics. However, personal “Ego” is expressed in words four times less often than social “Ego”, in favor of the message “we are all together” (Ancheva, 2003). Consequently, the lyrics of the Paneurhythmy songs in a natural way help the participants realize they are not only individuals, but also partners in their pair and in the group.

According to D. Ancheva (2007a), it is important to note that in the lyrics of the Paneurhythmy songs there are two imperative forms about human attitude to the world: rejoice with the world and help the world.

The meaning of Paneurhythmy is revealed through three messages of global empathy in the song lyrics – a bright future for the whole of mankind; brotherhood and love among people; peace, freedom, beauty, happiness and love for all reasonable souls (Ancheva, 2007a).

The philosophy of Paneurhythmy

The basis of Paneurhythmy is a philosophy seeking to create in man qualities stimulating good human relations. Peter Deunov determines as most important the basic principles of Love, Wisdom and Truth, and the virtues ensuing from them – magnanimity, mercy, love, sweetness, gentleness, justice, peacemaking, good reason, bravery, mutual aid, generosity, brotherhood, patience, perseverance, etc. Most of these virtues are mentioned or described in the song lyrics of Paneurhythmy. In the training course of Paneurhythmy for children, focusing children's attention on some of these virtues in a manner suitable for their age, helps their better understanding and application in life. Adults practicing Paneurhythmy also listen/sing about those virtues in the song lyrics, and some of them read about them in the lectures of the author of Paneurhythmy. All that experience stimulates the desire of people studying and practicing Paneurhythmy to acquire these valuable qualities, fundamental for their good interpersonal and social relations.

Acting out social roles

The geometric figures, formed by groups in Paneurhythmy have special meaning, and their understanding becomes clear and more powerful during the performance of particular social roles in the group. We can give an example of understanding particular role situations in the group through Paneurhythmy in the performance of the third part called Pentagram. Participants are divided into groups of five pairs, each group symbolically represents one greater parson (one pentagram), whose components are related to particular virtues (Figure 9). According to the author of Paneurhythmy, the Pentagram, inserted into a circle, symbolizes man in the course of evolutionary development, each peak and side of the pentagram is related to a definite virtue: Love, Wisdom, Truth, Justice, and Virtue (Duno, 2008, p. 5). The five pairs in the pentagram change places five times, each pair goes through all positions including the position of "leader". When a certain pair is at the top, corresponding to the human "head", that is, to the virtue of "Truth", they take the role of "leader", responsible for the movement of the whole group. When the pair is situated at one of the other four peaks of the pentagram, it abides by the leading role of the pair in the place of "head", and acts according to their other role of following the "leader".

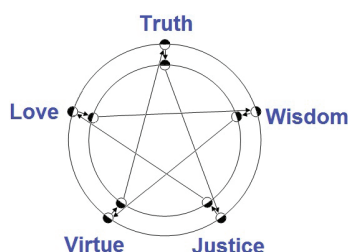


Figure 9. Group figures as part of the exercise "Pentagram" (the third part of Paneurhythmy)

Widening the range of awareness

While performing Paneurhythmy, everyone should coordinate his/her own movements with the music, together with the movement in space of the other participants, who, in most cases, are also in motion. An experienced practitioner watches and coordinates his/her movements with those of the other participants on several levels (the pair, adjacent pairs, a small group, larger groups, etc.), taking appropriate actions. Performance of the most complex group geometric figures in Paneurhythmy requires that good practitioners synchronize their own movements with the music and with their partner, and to be aware of, to create, to keep or to go from one to other regular geometric figures while moving in space, participating in several different size groups which form these various figures. This is a higher level of coordination in groups which requires widening of the attention span, and practically trains skills for more complex group interactions.

Discussion

This article for the first time presents a detailed theoretical analysis, revealing more completely and clearly the potentials of Paneurhythmy to improve personal relations. In addition to that it provides available research data, showing that practicing Paneurhythmy improves partner skills and social functioning with children and adults.

Paneurhythmy resembles dancing very much and probably influences relationships in a similar way to that recorded in group dancing. There is research information on the social-cognitive aspects of dance-related forms of rhythmical full body movement (Sevdalis, Keller, 2011).

Dance is a form of physical activity to promote physical and mental health to some who are not otherwise active and may be a form of activity that is more acceptable than others in certain cases (Olvera, 2008). The same refers to Paneurhythmy. Our study (Chervencova, 2012) reveals significant improvements in the psychological state, physical indicators and the subjective health as a result of the participation in a Paneurhythmy course. Besides, for 29% of the participants that Paneurhythmy course was the first step of getting over the state of hypokinesia (Chervencova, 2013).

Research with children trained in Paneurhythmy

S. Mihalkova (2001) has found that one school year of initial training in Paneurhythmy exercises for children leads to a significant improvement of their concentration and attention span. This is considered to be due to the necessity to pay special attention to a number of dynamic elements while practising Paneurhythmy. Mihalkova (2001) points out that when performing Paneurhythmy, participants have to meet high requirements with reference to the characteristics of their attention:

concentration – participants should not distract their attention during the entire performance, they should synchronize their movements with the music; distribution – participants should be in constant connection with their partners, as well as, with the others in the circle, they should perform the separate exercises in synchronism with their partners; volume – participants should follow the general movement in the circle and keep the distance between the pairs, and the distance from the centre; switching over – they should follow the sequence of exercises and perform each one of them with the necessary movements and rhythm (Mihalkova, 2001).

The author's practical experience as a lecturer and practitioner of Paneurhythm shows that a Paneurhythm performance requires attention and alertness to the many components, a large number of them connected with watchfulness and adequate interaction with other participants – the partner, adjacent pairs and participant groups of different size. That is why practicing Paneurhythm develops habits and skills of awareness and attention to partner and group processes. Once acquired, these habits and skills are applicable not only in Paneurhythm, but in many other areas of life, where one acts as a social being.

J. Zukauskas (1998) underlines that elementary school children often exhibit a lack of social skills that interferes with positive classroom interaction. On the other hand, a significant amount of TV models negatively foster anti-social and careless behavior (Zukauskas, 1998). In this situation, widening the pathways for teaching social skills is an important task. That is why it is important to study practices such as Paneurhythm, which are accessible and can effectively develop children's social skills.

Grounded on the analysis of projection tests and thematic drawings, G. Kubratova (2003) points out that with 82 children (aged 9–11) having completed a three-year course of education in Paneurhythm, there is a "stable trend to form inclinations to tolerance, cooperation and altruism in communication with others". V. Matanova and A. Yankova (2007b) found in their controlled study of Paneurhythm training, based on the program "Health through movement in the open nature", that with 167 children (aged 5–7), the greatest changes due to Paneurhythm practice are in the field of social contacts and social skills. The same authors have come to the conclusion that practicing Paneurhythm at pre-school age helps to reveal children's potential abilities and enhances the process of socialization, based on their proper cognitive and emotional development.

The majority of teachers (82%) of over 100 children participating in the program "Health through movement in the open nature", which includes Paneurhythm training, share the opinion that as a result of the program, the children have become calmer and share more positive emotions, which has a beneficial influence on their interpersonal relations and on the whole process of their education and cooperation in class (Boyadjieva, Yankova, 2007). This shows that the participation of children in Paneurhythm training increases their positive emotions, positive behavior and creates prosocial classroom environment. The sociometric status is an indicator of social competence. The sociometric status is not widely used, but it is the best measure of social skills (Cillessen, Bellmore, 2004). Matanova and Yankova (2007a) apply socio-metric methods in their study of interpersonal relations with 129 school pupils (in the 1–4 form), practicing Paneurhythm (once per week) and 134 children of the same age who formed the control group. The results show that in the group of children practicing Paneurhythm, there is a greater desire for cooperation and friendliness. Matanova and Yankova (2007a) note that the informal group organized for the Paneurhythm practice had a positive influence on interpersonal relations at primary school age. This positive attitude is expressed mainly through a high level of solidarity and desire to help and support others. The authors point out: "the Bulgarian school system teaches children many things, but it does not teach them social skills, so any kind of influence in this direction should be supported" (Matanova, Yankova, 2007a).

Research with adults

Two studies involving adult subjects show improvements in the social sphere as a result of their participation in a Paneurhythm training course. O. Anchev (2003) found that a six-month training in Paneurhythm of 12 adults (aged 20–65) expanded their circle of social relations and helped them overcome social isolation.

A study on health-related quality of life with 149 adults (74 trained in Paneurhythmy and 75 in a control group), confirms that the beginner training in Paneurhythmy significantly improves subjective health, the item "Social functioning" shows an increase of 18 % compared to the initial results (Chervencova, 2013, p. 165).

Research studies on persons already practicing Paneurhythmy also show that they have noticed important changes in their relations and communication with others, which they believe are due to their Paneurhythmy practice. L. Chervencova (2004) published the results of an enquiry with 140 subjects (aged 47 on average) already practicing Paneurhythmy. The subjects of the enquiry reported various positive changes as a result of their Paneurhythmy practice to the moment of the enquiry. It is interesting to note that the most frequent changes refer to improving their relations – this has been noted by 83.6% of the subjects practicing Paneurhythmy (Chervencova, 2004).

Twenty-two teachers by profession (graduated or graduating special training as teachers in Paneurhythmy at the National Sports Academy) completed an enquiry with reference to the usefulness of Paneurhythmy for them personally. They noted the following positive changes in their relations with other people as a result of practicing Paneurhythmy: more patience, tolerance (noted by 55% of subjects in the enquiry); accepting others, forgiveness (36%), widening the circle of acquaintances (31%), responsiveness (31%); improving personal relations (27%) (Ancheva, 2007b).

Conclusion

Analysis of the components of Paneurhythmy reveals its great potential for the development of partnership skills and for the improvement of social functioning. In this respect, the most significant characteristics of Paneurhythmy are: group practice, the appropriate aim of the practice, the right music, common rhythm and synchronization of movements, specific distances between participants, typical characteristics and expressiveness of participant movements, Paneurhythmy philosophy, sharing space, suitable lyrics of Paneurhythmy songs, figures for the arrangement of participants, acting social roles, and broadening the range of awareness. When so many factors work together for the improvement of social contacts, it makes them easier to be improved. That is why better social skills are achieved through the practice of Paneurhythmy.

The last statement is confirmed by existing scientific studies on the subject to date, revealing that with children and adults, both the initial training and further practicing of Paneurhythmy leads to the improvement of interpersonal relations and social skills.

We hope that the present article will motivate scientists to do further research on the subject and many more pedagogues and people, interested in their personal development, will use Paneurhythmy as an effective practice for improvement in the sphere of social contacts.

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A SUMMARY OF THE USE OF MAIZE IN NUTRITIONAL PRODUCTS FOR SPORTSPEOPLE

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Abstract The aim of the investigation was to review experimental articles and patents referring to corn-based nutritional products for sportspeople published in the period 1970–2019. Publications were searched in the ISI Web of Science and Scopus databases, as well as the Google Scholar and Google Patents internet search engines. Factorial combinations of the keywords (“*Zea mays*” or “maize” or “corn”) and (“athlete” or “sport”) were applied. Most papers and patents were published in the period 2010–2019 by researchers affiliated to the USA and China – the two largest global producers of corn. Altogether, 65 patents and 16 articles were recorded. Inventors patented food supplements based on corn-derived saccharides and proteins. Empirical articles were devoted to the impact of corn-based food products on health of sportspeople, evaluation of the impact of length of consumption on the metabolism and performance of athletes, as well the frequency of use and acceptance of nutritional products based on corn by sportspeople.

Despite growing interest in the application of corn constituents in nutritional products for sportspeople, further investigations are strongly desirable.

Key words corn, dietary supplements, health, kernel, nutrition

Introduction

The recent decades have seen a growing interest in the impact of plant constituents on sporting health and performance. Maize or corn (*Zea mays* L.) ranks third after wheat and rice as a staple food for a large proportion of the population worldwide, particularly in Asian and African countries (Sandhu, Singh, Malhi, 2007; Chaudhary, Kumar, Yadav, 2014). Numerous authors (Nuss, Tanumihardjo, 2010; Wildman, Kerksick, Campbell, 2010; Shah, Prasad, Kumar, 2016) have argued that the corn kernel is an edible and nutritive part of the plant, reporting that it contains carbohydrates, proteins, fats, as well as minerals (i.e. phosphorus, sodium, sulphur, calcium, iron, potassium, magnesium, selenium, and copper) and vitamins (C, E, K, B1, B2, B3, B5, B6, B12). Moreover, it is an essential source of various phytochemicals, such as carotenoids, phenolic compounds, and phytosterols, providing human health benefits and reducing the risk of major chronic diseases (see e.g. Lopez-Martinez et al., 2009;

Yongfeng, Jaylin, 2016; Sheng, Li, Liu, 2018). In contrast, Q. Shao and K.V. Chin (2011) have noted disadvantages in eating corn, such as obesity.

Taking this into consideration, the application of products containing constituents from *Zea mays* for sportspeople seems to be a very interesting issue. A bibliographic study focusing on use of corn-derived products in a sporting diet was conducted by B.I. Sorin (2015). However, given the low state of knowledge, the aim of this study was to overview the literature on the application of corn-derived products in diet of sportspeople.

Material and methods

Study species

Maize or corn (*Zea mays* L.) is a tall monoecious annual grass with overlapping sheaths and broad conspicuously distichous leaf blades. The plants have staminate spikelets in long spike-like racemes that form large spreading terminal panicles (tassels) and pistillate inflorescences in the leaf axils, in which the spikelets occur from 8 to 16 rows on a thickened, almost woody axis (cob). The whole structure (ear) is enclosed in numerous large foliaceous bracts and a mass of long styles (silks) protrude from the tip as a mass of silky threads (Hitchcock, Chase, 1971). Corn is wind pollinated with both self and cross pollination usually possible. The shed pollen usually remains viable for 10 to 30 minutes, or longer under favorable conditions (Coe, Nueffer, Hoisington, 1988). Following successful pollination, numerous rows of kernels appear along a rachis (cob); these mature kernels are the edible grains harvested for consumption and processing.

Although the exact origin of corn is unclear, most experts (e.g. Brown, Zuber, Darrah, Glover, 1985; Galinat, 1988; Benz, 2001; Piperno, 2011) agree that it emerged in Mesoamerica before 5000 BC. Cultivated corn derives from teosinte *Zea mexicana* (an ancient wild grass found in Mexico and Guatemala) and it was introduced into the Old World in the sixteenth century. During its domestication from teosinte, corn has gained many agronomically significant attributes, but it has lost the ability to survive in the wild. It has become so domesticated that seeds cannot be separated from the cob and disseminated without human intervention. Corn seeds show poor dormancy, especially in the northern ranges of the crop's distribution. Plants occasionally grow in uncultivated fields and by roadsides or occur as volunteers in cultivated crops in the year following cultivation of a corn crop.

Method of publication search

For this survey, a systematic approach was applied through a dedicated step-wise process for selecting available peer-reviewed literature sources. The authors searched for peer-reviewed original full-text articles, dissertations, and patents, about the application of soybean-derived products for sportspeople, using the ISI Web of Science (All Databases) and Scopus-indexed publications. These search engines were selected as they provide a comprehensive all-encompassing database for various interdisciplinary domains. The review focused on literature documenting the application of corn published from 1970 to 2019. More publications were sought by browsing the Google Scholar and Google Patents internet search engines. Factorial combinations of the following keywords in the searches: ("*Zea mays*" or "maize" or "corn") and ("athlete" or "sport") were used. The selection terms were examined from the title, abstract, and keywords of the articles. The results comprised 4104 hits from the ISI Web of Science (All Databases), 169 hits from Scopus, 5,978 from the Google Scholar internet search engine, and 2,308 hits from Google Patents on 7 September 2019. After the removal of grey literature (blog posts, reports, conference

proceedings, and notes) from the lists of searches, we selected publications from 54 records through the ISI Web of Science, 17 through Scopus, 22 from the Google Scholar, and 93 from the Google Patents internet search engine. The abstracts were then screened for relevance and eligibility. The sole inclusion criterion for patents was their usefulness for sportspeople. The other inclusion criteria for the articles were as follows: (i) investigations are relevant to the main subject of presented review, (ii) participants are people (clinical trials), (iii) no limits in age, weight, sex, nationality and number of participants, (iv) no limits in geographical location, as well as time period of investigations, and (v) abstract in English. The exclusion criteria of the articles were as follows: (i) studies irrelevant to the main subject, (ii) investigations conducted on non-human species, (iii) repetitive publications (different parts of a single study were presented in two or more papers or studies based on a population that was part of an earlier publication), (iv) abstract written in a language other than English. Finally, the author selected publications based on the scope which resulted in 42 records through the ISI Web of Science, 10 through Scopus, 12 from Google Scholar and 56 from the Google Patents internet search engines. Following the removal of duplicates (publications indexed in at least two databases) from all searches and an initial screening of full-texts, a final total of 114 records were selected to be reviewed. The inclusion criteria of the articles were as follows: (i) observational, descriptive studies (case report/ case series), (ii) observational, analytical studies (case-control studies, cross-sectional studies, cohort

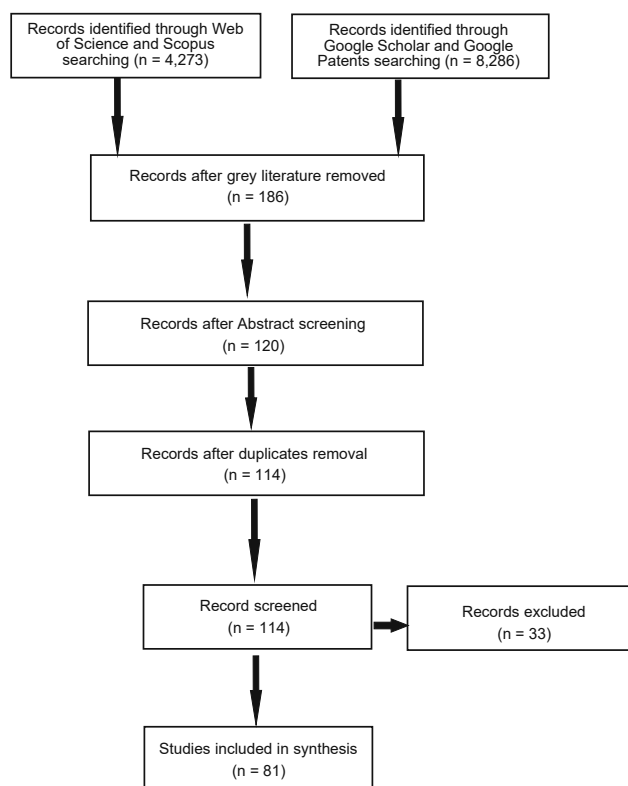


Figure 1. The simplified PRISMA flow chart detailing search results

Source: after Moher, Liberati, Tetzlaff, Altman (2009).

studies), (iii) experimental studies (randomized controlled trials). The exclusion criteria of the articles were as follows: (i) meta-analyses and (ii) systematic reviews, (iii) lack of full text, and (iv) lack of full text in English. Following the initial screening of abstracts from all the searches, a final total of 81 records were selected to be reviewed. A chart detailing the search results is presented in Figure 1. A statistical analysis based on non-parametric Kruskal-Wallis H test for multiple comparisons was used to check the statistical significance of differences among the numbers of records in particular decades.

Results

Most publications focusing on the application of corn-based products for sportspeople were published in the period 2010–2019 (Table 1). The authors of the majority of patents/publications are affiliated to the USA and China (Table 2). The inventors had patented food supplements (in the majority), sportswear, and devices enhancing sporting activities, while the empirical publications were devoted to nutritional products. The results of the literature survey are presented below.

Table 1. The number of experimental publications and patents connecting with application of corn products for sportspeople in particular time periods

Time period (years)	Mean number of publications per year ($\pm$ SD)	The value of H Kruskal-Wallis test; p value [*]
1970–1979	0.10 ($\pm$ 0.32) ^a	H = 39.51, p < 0.001
1980–1989	0.20 ($\pm$ 0.42) ^a	
1990–1999	0.30 ($\pm$ 0.48) ^a	
2000–2009	2.70 ($\pm$ 1.91) ^b	
2010–2019	5.50 ($\pm$ 2.72) ^b	

The different letters (a and b) in superscripts mean that differences among time periods are statistically significant. The same letters in superscripts mean that differences among time periods are statistically insignificant.

Table 2. Geographic distribution of literature^{*}

Author affiliation	Number of publications	Percentage
1	2	3
USA	31	38.2
China	13	16.2
Australia	4	5.0
Spain	4	5.0
Canada	2	2.5
Armenia	2	2.5
Austria	2	2.5
France	2	2.5
Great Britain	2	2.5
Japan	2	2.5
Netherlands	2	2.5
Russia	2	2.5
Argentina	1	1.2
Brasil	1	1.2
Chile	1	1.2

1	2	3
Denmark	1	1.2
Etiopia	1	1.2
Germany	1	1.2
India	1	1.2
Malaysia	1	1.2
New Zeland	1	1.2
Norway	1	1.2
Sweden	1	1.2
Switzerland	1	1.2
UK	1	1.2

* In case of multi-authored publications affiliation of the first author was considered.

Mono-, oligo- and polysaccharides

Several scientists had invented a recipe for carbohydrate blends comprising extracts from maize (corn syrup) that might be used as sweeteners in sport nutrition products, such as powders, pre-mixes, juices, energy bars, isotonic drinks and gelatine, and starch-based or pectin jellies (Table 3).

Table 3. The patented recipes for carbohydrate blends comprising extracts from corn

Patent	Patent number	Inventor(s)	Year
Use of novel carbohydrates and carbohydrate blends to provide a sports beverage with increased absorption	US20100129497A1	V. Rinaldi, J. Zachwieja, X. Shi, Z. Ali	2010
Natural sweetener	US20150208703A1	R. Turner	2015
High carbohydrate food product	ES2603436-A1	M.B. Sorinas	2017
Sugar extracts	US9572852B2	L.L. Ilag, J. Smythe, T.P. Ellis, R.S. Weisinger	2017

Source: <https://patents.google.com/patent>.

Most patents were devoted to methods of producing nutrient products containing high fructose corn syrup as a sweetener. Such products are represented by beverages suitable for reducing fatigue, diminishing muscle soreness, maintaining blood sugar level during exercise, improving cardiovascular function, increasing athletic performance, enhancing vitamin absorption, as well as reducing calories. Other researchers had patented energy bars used for relieving tension and supplementing energy before running, nutritious puree compositions suitable for sportspeople, as well as energy gels suitable for increasing available energy during exercise and for replenishing electrolytes that are depleted during exercise. Moreover, corn glucose syrup might also serve as an important ingredient in foods suitable for sportspeople. Also, the process of acquiring steviol glycoside mixtures with other ingredients such as corn syrup to be used as sweeteners and flavours composition, among others, in sport drinks, was patented (Table 4).

Table 4. The patents of nutritive products for sportsman containing glucose corn syrup or high fructose corn syrup

Patent	Patent number	Inventor(s)	Year	Source
Beverages suitable for reducing fatigue	CN102845801-A; CN102845801-B	Y. Liu	2013	2
Beverage suitable for reducing fatigue	CN107874054-A	Y. Zhan, Y. Yang, Y. Luo, J. Li, D. Yang, B. Wang et al.	2018	2
Reducing muscle soreness with glucosamine compositions	US9089156B2	V. Rinaldi, W. Racicot, J.J. Zachwieja, R. Murray	2015	1
Beverage maintaining blood sugar level during exercise	CN105614612-A	X. Xia, Y. Yang, G. Zhang, X. Zhang	2016	2
Beverage improving cardiovascular function	CN103315347-A; CN103315347-B	Y. Chen, M. Fu, J. Li, S. Liao, D. Tang, J. Wen et al.	2013	2
Performance enhancing sports beverage and methods of use	US20120128815A1	S.P. Poulos, J. Boza, R.O. Scott	2012	1
Athletic performance enhancing beverage	US20150272196A1	J.Ch. Anthony, K.D. Kent, B.L. Winters, H.W. Yeom	2015	1
Beverages containing water-soluble vitamin E	US20070141203A1	P. Cook	2007	1
Use of erythritol and D-tagatose in diet or reduced-calorie beverages and food products	US20020160090A1	T. Lee, G. Olcese, Z. Bell, G. Roy, W. Mutilangi, R. Hirs et al.	2002	1
Energy bar as sweetener	CN107149142-A	X. Sun, J. Zhang, D. Mei	2017	2
Bite-size carbohydrate nutritional products and methods for using same	US20090239803A1	M.G. Feuvrier-Roy, D.J. Leonard, A. Mittal, A. Jeukendrup, A. Stellingwerff, E. Zaltas	2009	1
Puree compositions having specific carbohydrate ratios and methods for using same	US20130115329A1	V.D. Savant, T. Haile, F.C. Jimenez, C.M. Boice, K.R. Welsh, E.S. Zaltas et al.	2013	1
Electrolyte energy gel	US20050095271A1	M. Mathewson	2005	1
Encapsulated energy gel compositions	US20060280777A1	A. Schydrowsky	2006	1
Food composition enriched with babaçu coconut oil	BR102016026844-A2	F. Franca Silva, S.B. Do Desterro, M. Do Carmo Lacerda Barbosa, E. Bouskela, M.C. Pires Costa, R.M.T. Fernandes	2018	1
Sustained release of nutrients in vivo	WO2010080557A1	F. Sexton, S. Krishnan, V.K. Vendra	2010	1
Glucosyl stevia composition	US8911971-B2	A. Markosyan	2014	1
Stevia composition, production method and uses	WO2016049315-A1	A. Markosyan	2016	1

Source: <https://patents.google.com/patent>; <https://apps.who.int/iris/handle/10665/254722>

Corn starch as a main source of polysaccharides might be the basis of energy supplements, nutritive foods reducing the feeling of hunger, and overcoming the problems of rehydration after prolonged strenuous exertion. Other authors patented nutritive products balancing blood sugar levels and prebiotic combinations containing a high amylose corn starch suitable for sportspeople that diminishes the risk of gastrointestinal infection, and supports the uptake of important minerals such as calcium and magnesium (Table 5).

1 2 3 4 5 6 7 8 9 10 11 12

Patent	Patent number	Inventor(s)	Year	Source
Carbohydrate and medium chain triglyceride gel as an energy supplement	WO1997007690A2	R. Jones	1997	1
High-protein pancake mix	JP2015142542-A	T. Kiyota, K. Suzuki, Y. Morimoto, K. Kondo, G. Masaoka, S. Nakano	2015	1
Corn starch and also corn flours and food comprising this corn starch	WO2008080630A1	C. Froberg	2008	1
The nutritional food	CN103549412-A	H. Xu	2014	2
Nutritionally balanced food or beverage product	US20150017309A1	G.W.C. Pope-Mayell, R.D. Rotherham, J.P. Rogers	2015	1
Proficiency beverage	US7582324B2	A.G. Blank	2009	1
Food product with high viscosity	US7320810B2	P. Wuersch, O. Ballevre, H. Milon, B. Sievert	2008	1
Heat moisture treated starch for the treatment of hypoglycaemia	CA2544965C	X. Qi, R. Tester	2005	1
Compositions and uses thereof	US8507462B2	X. Qi, R. Tester	2013	1
Heat moisture treated carbohydrates and uses thereof	WO2010077635A2	S. Murali, P. Kaufman, J.S. Volek	2010	1
Prebiotic combination products	WO2005056023A1	J.Y. Piene	2005	1

Source: <https://patents.google.com/patent>; <https://apps.who.int/iris/handle/10665/259052>.

Oligopeptides, polypeptides and proteins

Numerous researchers have patented methods of preparing protein hydrolysates, as well as a way of fractionating the nutritive proteins from plant material such as corn that could be useful in food products suitable for sportspeople during and after physical exercise (Table 6).

Table 6. The patented methods of preparing corn protein hydrolysates

Patent	Patent number	Inventor(s)	Year	Source
Protein hydrolysates	WO200203232A2	V. Delest, L. Edens, J.G. Kortés, T.J-B. Naeye	2002	1
Protein hydrolysate rich in tripeptides	US20080220470A1	L. Edens, P.J.T. Dekker, De A.L. Roos	2008	1
Protein hydrolysate compositions stable under acidic conditions	EP2299839A2	T.M. Wong, P.S. Kerr, P.S. Ghosh, J.F. Lombardi, G.B. Lynglev, T. Hoff et al.	2011	1
The recipe for preparation of multi-nutrition active polypeptide	CN103168983-A	S. Wang	2013	2
Protein hydrolysate compositions having enhanced cck and glp-1 releasing activity	WO2012141795-A1	E.S. Krul, B. Tulk, M.K. Pawlik, J.F. Lombardi, E. Krul, M. Pawlik et al.	2012	1
The recipe for preparation high-value oligopeptide by hydrolyzing corn protein solution	CN107760750-A	Q. Cui, Y. Wang, X. Song, Y. Feng, Y. Liu, Y. Xiao	2018	2
Charged nutritive proteins and methods	US8809259B2	D.A. Berry, B.A. Boghigian, N.W. Silver, G. von Maltzahn, M. Hamill, R. Chillakuru	2013	1

Source: <https://patents.google.com/patent>; <https://apps.webofknowledge.com>.

Several researchers have invented recipes for nutritional drinks promoting recovery of fatigue and reducing the degree of injury, improving the athletic ability of teenagers, enhancing stress resistance, promoting growth of the brain and body, strengthening the physique and improving immunity, increasing bone calcium content and enhancing weight loss, supporting glucose uptake into the muscle and extending endurance during physical exercise, as well as optimizing muscle performance during exercise.

Simultaneously, other nutritional inventions worth noting are nutritive soups, chocolate for repairing body tissues, relieving physical fatigue, promoting digestion and preventing obesity, energy bars and food compositions provided in a ready-to-eat form or incorporated into a bar, chew, filling or paste suitable for sportspeople. Also, a dietary, prophylactic and functional food product suitable for sport alimentation and containing, among others, chapped grains of corn was patented. Furthermore, patents of sport nutritional supplements (provided in different forms) supporting lipolysis, promoting bone and muscle growth, as well as relieving sports fatigue, as well as enhancing recovery after physical exercise should be mentioned (Table 7). It should also be mentioned that S.A. Duvick, L.M. Pollak and P.J. White (2003) prepared a method of growing improved corn lines having high protein and/or oil content suitable for producing foods for sportspeople.

Table 7. The patents of nutritive products for sportspeople based on oligopeptides, polypeptides and proteins derived from corn

Patent	Patent number	Inventor(s)	Year	Source
1	2	3	4	5
Method for the formulation of a gel-format foodstuff for use as a nutritional foodstuff enriched with peptides and maltodextrins obtained from quinoa flour	WO2013091125A1	J.I. Cáceres, P. Enrione, D. Calderon, F.O. Lira	2013	1
The sport drink promoting recovery of fatigue and reducing injury degree	CN103704808-A	J. Hong, Z. Hu	2004	2
The sport drink improving the athletic ability of teenagers, enhancing stress resistance, promoting growth of the brain and body, strengthening physique and improving immunity	CN108094786-A	Anonymous	2018	2
The sports nutrition milk tea powder increasing bone calcium content and enhancing weight loss	CN103549015-A; CN103549015-B	W. Li	2014	2
Sports drink composition for enhancing glucose uptake into the muscle and extending endurance during physical exercise	US7740893B2	R. Portman	2010	1
Sports beverage and method of making	WO2009085928A2	W.L. Constantine, A.S.A. Dixon, S. Kramer, M.W. Varhol	2009	1
Method for manufacturing protein-containing drink	WO2019004271-A1	S. Hata, M. Banno, M. Takakura	2019	1
The chocolate used for repairing body tissue, relieving physical fatigue and removing redundant free radicals	CN103960436-A	J. Liu, M. Zhang, Y. Zhang, Y. Wang, H. Zhao	2014	2
The energy bars	CN106108027-A	J. Ma, K. Yu, X. Liu, Y. Sun, X. Yan	2016	2
The energy bars	IN201711014441-A	N. Yadav	2019	2
Composition based on quinoa and gofio, as well as other components such as cocoa and rice flour	ES2564739-A1	M. Gazmira, M. Toledo	2016	1
Dietary, prophylactic and functional food product for sport alimentation	RU2445797-C1; RU2458538-C1	A. Malyshev	2012	1
The sport nutritional supplements supporting lipolysis	CN108606269-A	B. Wang, X. Liu, G. Zheng, Y. Du, L. Zhang, R. Qian	2018	2

1	2	3	4	5
Composition comprising carbohydrate and peptide material and its use as an energy supplement after or during physical exercise or as a metabolic nutrient for oral consumption	US6713082B2	L.J.C. Van Loon, A.A.J. Wagenmakers, A.D. Siemensa, A. Kunst, M.J.J. Hakkaart, W.H.M. Saris	2004	1
Functional food paste	WO2010030944A2 EP2348891B1	W.C. Smith, J.A. Brown, S.K. Holt	2009	1
Altered fatty-acid, protein, oil, and starch corn lines and method for producing same	US6639132B1	S.A. Duvick, L.M. Pollak, P.J. White	2003	1

Source: <https://patents.google.com/patent/>; <https://apps.webofknowledge.com>.

Other constituents

Many authors patented methods of processing the corn grain to obtain an oil for the production of food suitable in sporting nutrition, as well as recipes for nutritional products (Table 8). Also, the Table contains patented compositions enabling increased bioavailability of carotenoids derived from corn and anthocyanin, which can be directly incorporated into food products, and a method of obtaining ferulic acid.

Table 8. The patents of nutritive products for sportspeople based on oils derived from corn

Patent	Patent number	Inventor(s)	Year
Process for increasing throughput of corn for oil extraction	CA2562670A1	M. Van Houten, M.J. Beaver, A.M. Eyal, E.J. Fox, J. Ingvalson, N.T. Jakel et. al.	2005
Products comprising corn oil and corn meal obtained from high oil corn	WO2002014459A2	J.F. Ulrich, N.T. Jakel, T.T. Lohrmann, P.J. Mc Williams, M.J. Tupy, M.J. Beaver et al.	2002
Products comprising corn oil and corn meal obtained from high oil corn	US20040058052A1	J. Ulrich, N. Jakel, D. Kotowski, J. Ingvalson, B. Aufdembrink, M. Tupy et al.	2004
Compositions and methods to increase bioavailability of carotenoids	WO2009063333A2	T. Eidenberger	2009
Stabilized anthocyanin compositions	US8449927B2	T. Eidenberger	2008
Bioproduction of ferulic acid and uses thereof	WO2008116319A1	S. Parakash, J. Bhatena	2008

Source: <https://patents.google.com/patent/>.

Investigations of products

Several authors focused on the frequency and acceptance of using corn-derived food. Investigations of the frequency of using nutritive corn products by sportspeople were conducted by M. Mamo, P. Singh (2018) and A.R. Pérez, A.J.C. Andújar, C.S. Muñoz, J.J.M. Molina and M.Z. Díaz (2012). In the study by M. Mamo and P. Singh (2018), on a group of 165 male and 135 female senior runners, they showed that the frequency of eating corn was rather low. The study by A.R. Pérez et al., (2012), on a group of 27 young international elite motorcyclists, showed that the majority of them ate corn cereals at least once a day. The study by D.L. Christensen, G. van Hall and L. Hambraeus (2002), on 12 adolescent male Kalenjin runners in Kenya during a 2-week field study, determined that their energy intake was mainly derived from the vegetable sources – with corn and kidney beans as the staple food. The results of the physico-chemical, functional, nutritional and sensorial tests by V.C. Del Castillo, M. Armada and J.C. Gottifredi (1999) showed a considerable preference of supplementary sporting foods based on corn in

comparison to commercial food. The study by Y. Carrera, R. Utrilla-Coello, A. Bello-Pérez, J. Alvarez-Ramirez and E.J. Vernon-Carter (2015) relate the extensive use of pinole (a traditional energy food based on flour obtained from toasted ground corn grains) by high performance ultra-runners, where the hydrolysis rate and *in vitro* digestibility of starch are greatly improved by the toasting process.

Other authors compared the metabolism and performance of sportspeople after consuming corn products and alternative nutritional foods. The investigation conducted in a group of 31 elite footballers from the Australian Football League (AFL) at the height of outdoor summer training demonstrated a better rehydration from a drink containing high amylose corn starch and glucose in comparison to other rehydration drinks (O'Connell et al. 2018). The study by A. Ahmad, N. Jusoh and R. Tengah (2019) on physiological responses and performance following subsequent repeated high intensity exercise with consumption of corn juice in a group of 17 hockey and football players, found that *Zea mays* juice containing carbohydrates (mainly glucose and fructose), proteins, and sodium has potential as an alternative recovery beverage to promote repeated exercise with a short rest time. The study by A.C. Snyder, L.O. Schulz and C. Foster (1989) found that the consumption of a carbohydrate supplement (made by the partial hydrolysis of corn starch) by elite speed skaters resulted in substantial increases in energy. The study by K.J. Cole, P.W. Grandjean, R.J. Sobszak and J.B. Mitchell (1993) examined the effects of incremental consumption of various carbohydrate solutions during prolonged exercise in 10 trained male cyclists, where the drinks with high fructose corn syrup provided a significantly higher level of carbohydrates in comparison to solutions containing glucose and sucrose. The study by G.A. Wallis, D.S. Rowlands, C. Shaw, R.L.P.G. Jentjens and A.E. Jeukendrup (2005) on a group of 8 trained cyclists showed that by drinking large amounts of maltodextrin and fructose during cycling exercise, exogenous carbohydrate oxidation can reach greater values than from ingesting maltodextrin alone. The study by J.B. Mitchell, W.A. Braun, F.X. Pizza and M. Forrest (2000) aimed at determining the influence of drinking solutions containing mixtures of carbohydrate types on pre-exercise glycemic response, exercise-induced hypoglycemia, metabolic responses, and 10-km treadmill running performance in a warm environment, on a group of 10 trained runners, found that the type of carbohydrate (high fructose corn syrup solution, glucose solution, sucrose and glucose mixture, banana with water) did not influence running performance or metabolic responses during exercise.

The study by M. Kern, N.D. Lagomarcino, L.M. Misell and V. Schuster (2000) focused on assessment of the blood lipid levels following consumption of a low-fat diet, medium-chain triacylglycerol or long-chain triacylglycerol in male endurance runners, where the long-chain triacylglycerol oil derived from corn has a positive impact on the blood profile of sportspeople. Further investigations by L.M. Misell, N.D. Lagomarcino, V. Schuster and M. Kern (2001) found that long-term consumption of medium-chain triacylglycerols (compared to corn-derived long-chain triacylglycerols) neither enhances endurance nor significantly alters performance-related metabolism in trained male runners.

Several investigations concentrated on the effect of the timing of ingestion of corn food products on the metabolism and performance of sportspeople. The study by M.D. Roberts, Ch. Lockwood, V.J. Dalbo, J. Volek and Ch.M. Kerksick (2011) on the impact of hydrothermally modified starch and maltodextrin on metabolic and hormonal responses in 9 male cyclists, found that ingestion of low-glycaemic hydrothermally modified starch before prolonged cycling exercise blunted the initial spike in serum glucose and insulin, and increased the breakdown in fat compared to maltodextrins. The study by R.B. Parks, H.F. Angus, D.S. King and R.L. Sharp (2018) aimed to characterize the metabolic response from consumption of modified amylomaize or dextrose before exercise,

showing that consumption in the hour before exercise of corn-derived starch modified by partial hydrolysis (compared to dextrose consumption) resulted in a more stable serum glucose concentration, but it did not offer a performance advantage in the high-intensity cycling trial. The study by M.G. Flynn et al. (1987) examined the influence of carbohydrate consumption on exercise performance and muscle glycogen use, in a group of 8 well-trained male cyclists, demonstrating a greater blood glucose level at 90 min after consumption of high fructose corn syrup compared to consumption of artificially sweetened water, maltodextrin and fructose.

Discussion

Most publications focusing on the use of corn-based products by sportspeople were published in the period 2010–2019, and mainly by researchers affiliated to the USA and China. Such a phenomenon might be linked to the largest global producers of corn as noted by the two specific countries (USDA, 2019). The investigated studies have shown that the numerous beneficial constituents of corn are widely applied in the production of nutritional food. At the same time, it should be noted that there is a discrepancy in the evaluation of the influence of high fructose corn syrup on people's health. Numerous researchers (see e.g. Bray, Nielsen, Popkin, 2004; Morrill, Chinn, 2004; Bocarsly, Powell, Avena, Hoebel, 2010) link the consumption of high fructose corn syrup with increased obesity and metabolic disorders, while many scientists (see e.g. Klurfeld, Foreyt, Angelopoulos, Rippe, 2013 and literature cited herein) have highlighted a lack of evidence of high fructose corn syrup as a cause of obesity. Additionally, J.J. Johnson and R. Murray (2010) argued that for sportspeople, a positive aspect of fructose metabolism is that in combination with other simple sugars, fructose stimulates rapid fluid and solute absorption in the small intestine and helps increase exogenous carbohydrate oxidation during exercise – an important response for improving exercise performance. The aforementioned authors observed that additional research is required to clarify the possible health-related implications of a long-term intake of large amounts of dietary fructose among sportspeople.

Conclusions

Most publications focusing on the application of corn-based products by sportspeople were published between 2010 and 2019, and mainly by researchers affiliated to research centers USA and China. Inventors have patented food supplements containing mostly corn derived saccharides and proteins. Despite a substantial number of empirical articles testing the quality and social acceptance of products, further investigations seem to be strongly desirable.

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FUNCTIONAL STRENGTH EXERCISE AND BLOOD-FLOW RESTRICTION PROTOCOLS: A SYSTEMATIC REVIEW

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Abstract Objective: To assess current literature focused on the influence of functional training with blood flow restriction (BFR) on muscular adaptation in adults below the age of 65 years.

Methods: A systematic literature search was performed with the following databases: PubMed, CINAHL Complete EBSCOhost, and ScienceDirect. Two researchers filtered the articles according to the criteria and quality, supported by the Consolidated Standards of Reporting Trials (CONSORT) tool. Studies were limited to those with participants with a mean age between 18 and 65 years. Articles were peer-reviewed, available in English, and utilized either multi-joint resistance exercises or functional exercise as the intervention.

Results: The search yielded 16 studies on uninjured, older adult, injured and athletic subjects. Regardless of the population, the studies tended to favor BFR training for improvements of strength, but this was highly dependent on cuff pressure and training load.

Conclusions: Current literature suggests that BFR with functional and or multi-joint strength training is successful in improving strength, hypertrophy, function and in pain reduction. Favorable results with functional BFR included procedures using relative and well-controlled occlusion pressure. More research is necessary to understand the effect of BFR on self-reported outcomes and hypertrophy in athletic and older adults.

Key words resistance training, arterial occlusion, low intensity, muscle hypertrophy

Introduction

Blood-flow restriction (BFR) training, also known as arterial occlusion training, utilizes low-intensity movements as a way to stimulate musculoskeletal adaptation and provides an alternative method to traditional heavy-load resistance training (Loenneke, Wilson, Marin, Zourdos, Bembien, 2012; Takarada, Takazawa, Sato, Takebayashi, Tanaki, Ishii, 2000). Many studies have confirmed the positive effect of BFR on increasing muscular hypertrophy and strength, similar to traditional resistance training (Cook, Kilduff, Beaven, 2014; Giles, Webster, McClelland,

Cook, 2017; Godawa, Credeur, Welsch, 2012; Loenneke, Wilson, Marin, Zourdos, Bembien, 2012; Madarambe, Ochi, Tomioka, Nakazato, Ishii, 2011; Ozaki et al., 2013; Takarada, Tsuruta, Ishii, 2004; Teramoto, Golding, 2006; Yasuda, Fujita, Ogasawara, Sato, Abe, 2010). With traditional resistance training for the general population, the American College of Sports Medicine (ACSM) guidelines suggest a frequency of 2–3 days per week at an intensity of 60–70%, 1 repetition maximum (1RM) and 8–12 repetitions, to achieve muscle adaptation over a 6–8 week period (Garber et al., 2011). BFR training requires a frequency of 2–3 days per week at a reduced intensity of 30–50%, 1RM and 15–30 repetitions, resulting in muscle adaptations in as little as 3–5 weeks (Cook et al., 2014; Credeur, Hollis, Welsch, 2010; Garber et al., 2011; Loenneke et al., 2012; Takarada et al., 2000; Takarada et al., 2004). Low-intensity high repetition training without BFR does not elicit substantive improvements in muscular strength and hypertrophy, as it does not provide the hypoxic environment necessary to promote the appropriate metabolic stress for these gains (Hughes et al., 2018; Loenneke et al., 2012). Further, traditional resistance training is often difficult in a rehabilitation setting due to patient limitations in completing a high number of repetitions or going to failure.

Research has shown the benefits of BFR training in many populations, such as: older adults (Araujo et al., 2015; Segal, N., Davis, Mikesky, 2015; Segal, N.A., Williams, Davis, Wallace, Mikesky, 2015), individuals who are recovering from injury or surgery (Giles et al., 2017; Hughes et al., 2018; Tennent et al., 2017), and those who cannot tolerate high-intensity resistance training (Araujo et al., 2015; Giles et al., 2017; Hughes et al., 2018; Segal, N. et al., 2015; Segal, N.A. et al., 2015; Tennent et al., 2017). This is relevant in a healthcare setting, where injured and older adult patients are seeking muscular adaptation during rehabilitation, but are unable to follow ACSM guidelines. Although BFR strength gains may be delayed and the magnitude of these gains are lower than in high-intensity resistance training, BFR training may provide a safe alternative to achieve therapeutic goals (Brandner, May, Clarkson, Warmington, 2018; Hughes et al., 2018; Loenneke et al., 2012; Patterson et al., 2019).

Much of the early BFR research included single-joint isotonic exercises in males, with results strongly focused on strength and hypertrophy (Hughes et al., 2018; Lixandrao et al., 2018). More contemporary BFR work has expanded to a variety of populations, such as females (Araujo et al., 2015; Credeur et al., 2010; Giles et al., 2017; Segal, N. et al., 2015; Teramoto, Golding, 2006), those with kidney disease (Clarkson et al., 2017), chronic fatigue syndrome (McCully, Smith, Rajaei, Leigh, Natelson, 2003), and older adults (Araujo et al., 2015; Segal, N. et al., 2015; Segal, N.A. et al., 2015). Most studies in these populations have focused on improvements in hypertrophy and strength, with limited transference into function in these populations, unless exercises are salient and specific (Pelletier, Higgins, Bourbonnais, 2015). The use of BFR as a clinical rehabilitation tool has been established (Hughes et al., 2018), but further carry-over into function, multi-joint exercises and strength improvements is lacking. Specifically, research related to BFR training and functional outcomes such as gait speed, sit-to-stand, balance, and timed up and go, are often conducted with participants over 65 years old (Clarkson et al., 2017). Expanding to younger populations, few studies have captured how BFR could be implemented in a manner which elicits reductions in pain at rest and with movement, subjective and functional outcome measures, and subjective quality of life. Therefore, the purpose of this systematic review was to assess current available literature focused on the influence of functional and multi-joint BFR training on muscular adaptation and improvement in adults below the age of 65 years.

Materials and Methods

Search strategy

A literature search was performed to gather high-quality peer-reviewed research papers concerning functional BFR training. The following keywords were utilized to search the PubMed, CINAHL Complete EBSCOhost and ScienceDirect databases: (“vascular occlusion” OR “kaatsu” OR “blood flow restrict”) AND (“strength training” OR “low-load” OR “low-intensity” OR “resistance training” OR “exercise training” OR “function” OR “weight lifting” OR “walking OR cycling”), and (“vascular occlusion” OR “kaatsu” OR “blood flow restrict” OR “BFR”) AND (“strength training” OR “low-load” OR “low intensity” OR “resistance training” OR “function” OR “athlete” OR “pain” OR “performance” OR “improve”). Search filters for all databases covered: January 2004–January 2019, all adult, academic journals, English, peer-reviewed, human, and randomized control trials. The most recent 15 years of literature was chosen because this includes the bulk of BFR literature. The search was limited to adults below the age of 65 years to remove the potential effects of aging on the musculature.

Inclusion and exclusion criteria

Research studies were included for review if the population was human, participant mean age was between 18 years and 65 years, were peer-reviewed, available in English, and they utilized functional or multi-joint resistance exercises (e.g. functional exercise) as the intervention. Studies were excluded if they only used single-joint resistance exercises not related to a task or functional movement, or only utilized BFR during recovery from another exercise or intervention, participants were older than 65 years, or they included a population outside of the inclusion criteria.

Study selection

The total search from all three databases yielded 840 articles. Irrelevant and duplicate articles were removed, shortening the list to 34 articles ($n = 34$). Researchers NH and JB removed nine further studies ($n = 25$) that focused on aerobic conditioning, as well as ten ($n = 15$) that utilized practical BFR methods with elastic straps and little control for measuring occlusion. The final article removed ($n = 14$) focused on the effects of BFR on detraining, which was deemed irrelevant for this review. Figure 1 depicts the search process. The Consolidated Standards of Reporting Trials (CONSORT) tool was utilized to help discriminate which high-quality studies were to be included. The tool was helpful in identifying the study's design, criteria, randomization, blinding, attrition rate with reasoning, limitations, and generalizability. Randomized controlled trials (RCTs) were preferred, but studies were not excluded if they used a different study design.

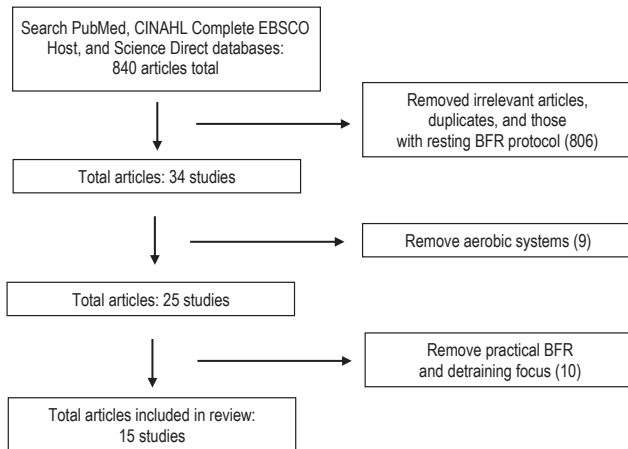


Figure 1. Flow chart of selection research article process for systematic review

Results

The sixteen ($n = 16$) studies reviewed were grouped into four different population categories: uninjured young adult ($n = 7$), older adult ($n = 3$), rehabilitation ($n = 3$), and athletes ($n = 2$) ($n = 15$). Grouping was utilized to better differentiate the outcomes of functional BFR training across multiple populations, and to clarify gaps in literature. All studies are organized by population of interest in Table 1.

Table 1. Summary of articles organized by population of study. Age is represented as mean (SD), and studies were conducted in active individuals unless otherwise noted. RCT is randomized control trial, BFR is blood flow restriction, 1RM is one-rep max, MVC is maximal voluntary contraction, CSA is cross-sectional area, CMJ is counter movement jump, HI is high intensity, LI is low intensity, CB is combination of high and low intensity training, TUG is timed up and go, ACL is anterior cruciate ligament, ADL is activities of daily living, PT is physical therapy, KOOS is Knee Injury and Osteoarthritis Outcome Score, VR12 is Veterans RAND 12-item Health Survey, PCr is phosphocreatine

Author, year	Participants: n-size, % male, age, any other special IC/EC	Study design and groups	Methods: length of intervention, BFR cuff procedures, reps, sets, load	Outcomes
1	2	3	4	5
Uninjured young adult population				
D.P. Credeur et al., 2010	N = 12, 41.7% male, 22 (1) yrs	RCT; subjects served as own control; trained BFR side vs control side	4-wk training, 3 sessions/wk; 60% MVC handgrip 15x/minute for 20 min at 80 mm Hg or no occlusion	MVC and forearm circumference: BFR and control increased, but no group differences. Blood artery flow-mediated dilation: Control > BFR
H. Madarama et al., 2011	N = 17, 100% male, 19.9 (1.6) yrs, Untrained young men	Groups allocated for similarity; no randomizing or blinding; BFR vs normal training groups	10-wk training, 2 sessions/wk; Both groups performed 30–40% 1RM leg press 30-15-15-15 reps; BFR started at 200 mmHg and increased to 250 mmHg as program progressed	Squat: BFR > control . CSA: both groups increased, but no group differences. CMJ: no significant change with training

1	2	3	4	5
H. Ozaki et al., 2013	N = 19, 100% male, 23.5 (1) yrs	RCT; Groups: BFR, HI group	6-wk training, 3 sessions/wk of bench press; HI: 3 × 10 reps at 75% 1RM; BFR: 30-15-15-15 reps at 30% 1RM; BFR started at 100 mmHg for first session and increased by 10 mmHg each session until 160 mmHg pressure was reached	Bench press, arm CSA, chest CSA: both groups increased, but no group differences. Decreased carotid arterial compliance: HI > BFR
M. Teramoto, L.A. Golding, 2006	N = 19, 45% male, 23.9 (4.5) yrs, College students	RCT; cross-over design; trained BFR side vs control side; examiners counterbalanced dominant and non-dominant legs among participants	5-wk training, 3 sessions/wk; Step exercise of 2 × 5-min step exercise was performed each session; BFR was set at mean occlusion pressure of 95.4 (6.9) mmHg	Leg press strength: BFR > control. Muscular endurance, muscle size: both groups increased, but no group differences
T. Yasuda et al., 2010	N = 10, 100% men, 25.7 (5.1) yrs	RCT; groups: BFR, control	2-wk training, 2 sessions/d, 6 d/wk; Groups performed 30-15-15-15 reps at 30% 1RM; BFR started at 100 mmHg and increased by 10 mmHg increments each session until 160 mmHg was reached	Bench press: BFR > control. Muscle thickness: BFR > control. Anabolic hormones: no change in either group
T. Yasuda et al., 2011b	N = 40, 100% men, 23.8 (2.5) yrs	RCT; groups: HI, LI-BFR, CB, non-training control	6-wk training, 3 sessions/wk of bench press; HI: 3 × 10 reps at 75% 1RM; LI-BFR: 30-15-15-15 reps at 30% 1RM; CB: performed 2×/week LI-BFR and 1×/week HI; BFR started at 100 mmHg and increased by 10 mmHg at each session until 160 mmHg was reached	Bench press: HI and CB > LI-BR. Muscle size: groups increased, but no group differences
T. Yasuda, R. Ogasawara, M. Sakamaki, M.G. Bemben, T. Abe, 2011a	N = 30, 100% men, 25.3 (2.9) yrs	RCT; groups: HI, LI-BFR, non-training control	6-wk training, 3 sessions/wk of bench press; HI: 3 × 10 reps at 75% 1RM; LI-BFR: 30-15-15-15 reps at 30% 1RM; BFR started at 100 mmHg and increased by 10 mmHg at each session until 160 mmHg was reached	Bench press: HI and LI-BFR > control. Muscle CSA: HI and LI-BFR > control
Older adult population				
J.P. Araujo et al., 2015	N = 28, 0% male, 54 (4) yrs, postmenopausal women	RCT; groups: water exercise, water + BFR, non-exercise control	8-wk training, 3 sessions/wk; Groups performed 30-15-15-15 reps with water resistance exercises. BFR at 80% arterial occlusion	Knee extension: water + BFR > water. TUG: both groups improved, but no significant group difference
N. Segal et al., 2015	N = 44, 100% men, 56.1 (7.7) yrs, community-dwelling adult men	RCT; groups: BFR, LI control	4-wk training, 3 sessions/week with bilateral leg press; BFR: 30-15-15-15 reps at 30% 1RM; Control: 30-15-15-15 reps at 30% 1RM; BFR started at 30 mmHg and increased throughout session and program until final exercise pressure of 200 mmHg was reached	Leg press: both groups improved, but no significant group difference. Pain improvement: LI > BFR
N.A. Segal et al., 2015	N = 45, 0% men, 55.3 (5.5) yrs, community-dwelling adult women	RCT; groups: BFR, LI control.	4-wk training, 3 sessions/week with bilateral leg press; BFR: 30-15-15-15 reps at 30% 1RM; Control: 30-15-15-15 reps at 30% 1RM; BFR started at 30 mmHg and increased throughout session and program until final exercise pressure of 200 mmHg was reached	Leg press: BFR > LI. Knee extensor strength: BFR > LI. Muscle CSA, power, pain: both groups improved, but no significant group difference
Rehabilitation Setting				
L. Giles et al., 2017	N = 69, 38% male, 27.7(5.5) yrs, patellofemoral pain syndrome	RCT; groups: low intensity BFR, HI standard control	8-wk training; 3 sessions/week of leg press and leg extension; HI 3 × 7–10 reps at 70% 1RM; BFR: 30-15-15 reps at 30% 1RM; BFR set to 60% arterial occlusion	Pain reduction: BFR > HI. Knee extensor torque: BFR > HI for those with painful resisted knee extension. Worst pain, Kujala Patellofemoral Score, pain with ADL, and knee extensor torque: Improvements, but no group differences
L. Hughes et al., 2018	N = 30, 76.7% male, 29 (7) yrs, 3 weeks post-ACL repair	Partially randomized, cross-sectional; Groups: non-injured resistance exercise, ACL repair LI-BFR, ACL repair HI	1 session: Non-injured and BFR groups did 4 sets 30-15-15-15 reps of unilateral leg press at 30% 1RM. ACL repair heavy load exercise did 3 × 10 reps at 70% 1RM. BFR at 80% arterial occlusion	RPE: BFR > non-injured. Muscle pain: BFR > ACL repair heavy load. Knee pain: BFR < ACL repair heavy load exercise

1	2	3	4	5
D.J. Tennent et al., 2017	N = 17, 71% men, 37 (7) yrs, post knee arthroscopy	Pilot RCT; Groups: BFR augmented PT, regular PT	12 training sessions; BFR: added additional 3 exercise of leg press, extension, and reverse press to regular PT regime for 30-15-15-15 reps at 30%1RM; Control group did not perform the 3 additional exercise; BFR set at 80% arterial occlusion	Thigh girth: BFR > PT. Stair climb: BFR > PT. KOOS, other physical function tests: both groups improved, but no significant group difference VR12: BFR > PT. Strength: BFR > PT
Athletic population				
C.J. Cook et al., 2014	N = 20, 100% male, 21.5(1.4) yrs, semiprofessional rugby players	Cross-over design; training: BFR, standard training	3-wk training blocks; Both groups performed squat, bench press, and weighted pull-up at 70% 1RM; 5 × 5 reps with 90-sec rest between sets, 3-min rest between exercises; BFR set at 180 mmHg	Squat: BFR > standard. Bench press: BFR > standard. Sprint time improvement: BFR > standard. Testosterone and cortisol responses: BFR > standard
T.W. Godawa et al., 2012	N = 18, 78% male, 21.5 (2.3) yrs, competitive collegiate power lifters	RCT; groups: BFR, control	10-wk training following detailed staggered linear progression model with wave pattern of progression for all relevant lifts in both groups (squat, deadlifts, bench press); Groups completed identical training with the only difference being BFR; BFR pressure was personalized and determined in supine position	Squat training volume: BFR > Control. Squat strength: BFR > Control. Deadlift, bench press, or total score: Improvement, but no significant group differences

Uninjured young adults

Studies involving uninjured young adults had in total 147 participants. The majority of these studies focused on outcomes for hypertrophy and strength, rather than function. The functional aspect was related to the training methods used in each study, which included exercises such as leg press, bench press, isometric handgrip – which has been associated with improving muscle function and blood flow (McGowan et al., 2007; Shephard, Montelpare, Plyley, McCracken, Goode, 1991) – and stepping. Five studies incorporating BFR training with the uninjured young adult population demonstrated that BFR training significantly increased the strength of the involved musculature (Credeur et al., 2010; Madarama et al., 2011; Ozaki et al., 2013; Teramoto, Golding, 2006; Yasuda et al., 2010). However, two of these studies showed no difference between BFR and the control groups, suggesting that low-load BFR training may result in similar results to traditional resistance training (Credeur et al., 2010; Ozaki et al., 2013). In the study by D.P. Credeur et al. (2010), participants performed identical exercise protocols using an isometric handgrip, with the inter group difference being the added BFR; thus, a group difference should have been likely. In contrast, participants in the H. Ozaki et al. (2013) study trained with either low intensity and BFR or at a high intensity without BFR. Group differences would be less likely in this scenario because the added benefit of BFR with low intensity work creates similar physiological effects to high intensity exercise. However, this is difficult to truly decipher without details to compare training volume differences between the groups. Three studies found that the addition of BFR was more effective in increasing strength than traditional resistance training of the same intensity and volume (Madarama et al., 2011; Teramoto, Golding, 2006; Yasuda et al., 2010). BFR was also found to significantly increase the cross-sectional area of the involved musculature (Credeur et al., 2010; Ozaki et al., 2013; Teramoto, Golding, 2006; Yasuda et al., 2010), yet studies were divided regarding the lack difference from traditional resistance training groups (Ozaki et al., 2013; Teramoto, Golding, 2006), and BFR training resulting in a larger increase in cross-sectional area of musculature than traditional resistance training (Credeur et al., 2010;

Yasuda et al., 2010). Collectively, two studies from T. Yasuda et al. demonstrated that BFR training was less effective in increasing strength and cross-sectional area than high-intensity resistance training (Yasuda, Ogasawara, Sakamaki, Bemben, Abe, 2011; Yasuda et al., 2011b). Each study in this section utilized an absolute occlusion pressure, apart from M. Teramoto et al. (2006), which used a relative occlusion pressure based on the midpoint between systolic and diastolic blood pressures. The remaining studies in this group utilized pressures as low as 80 mm Hg with no change throughout the study (Credeur et al., 2010), beginning at 100 mm Hg and increasing to 160 mm Hg with training (Ozaki et al., 2013; Yasuda et al., 2010; Yasuda et al., 2011a; Yasuda et al., 2011b), or beginning at 200 mm Hg and increasing to 250 mm Hg with training (Madarama et al., 2011).

Older adults

The total studies involving older adults (mean age below 65 yrs) consisted of a total of 117 participants. Two relevant studies incorporating BFR training with an older adult population demonstrated that low-load BFR training significantly increased the strength of the involved musculature (Araujo et al., 2015; Segal, N. et al., 2015). Both of these studies utilized the same low-load (30% 1-RM) training protocol for two exercise groups with one using BFR. N.A. Segal et al.'s (2015) study of older women with osteoarthritis (OA) was the only study that showed significant improvement over low-load resistance training without BFR. Interestingly, N. Segal et al.'s (2015) similar study of older men with OA showed no significant improvement in strength following BFR training, and both groups performed identical training with the only exception being the added benefit of BFR for one group. Studies demonstrated improvements in functional outcome measures such as the timed up and go (TUG), sit to stand (STS), and stair limb (Araujo et al., 2015; Segal, N. et al., 2015). But only Araújo et al.'s (2015) study demonstrated that the BFR training group had significant functional improvement over the non-BFR group. Interestingly, Araújo et al. (2015) used a relative occlusion pressure at 80% of arterial occlusion, and the two studies by N. Segal et al. (Segal, N.A. et al., 2015) used an absolute pressure starting at 30 mm Hg and increasing up to 200 mm Hg with training.

Rehabilitation

Studies involving those undergoing rehabilitation involved a total of 116 participants. Three relevant studies incorporating BFR training with the rehabilitation population demonstrated that BFR training significantly increased strength and reduced pain from the injury after the session or training period (Giles et al., 2017; Hughes et al., 2018; Tennent et al., 2017). L. Giles et al. (2017) reported this significant benefit of low intensity BFR training over high intensity resistance training without BFR in patients with patellofemoral pain. Both studies with ACL reconstruction rehabilitation patients showed less knee pain with low-load BFR training compared to high-load traditional training. D.J. Tennant et al. (2017) also reported increased function and perceived health and improvements in strength compared to standard physical therapy care. Changes in cross-sectional area for this population was equivocal as D.J. Tennant et al. (2017) has demonstrated an improvement over traditional training, while L. Giles et al. (2017) demonstrates less improvement. However, the BFR group in Tennet et al. performed extra exercises compared to the control group. All three studies utilized relative occlusion set at 60% (Giles et al., 2017) or 80% arterial occlusion (Hughes et al., 2018; Tennent et al., 2017).

Athletes

Studies involving athletes included a total of 38 participants. The two studies showed that incorporating BFR training with an athletic population significantly increased strength and power. Both studies were conducted with training groups performing identical training volume, with the only difference being the addition of BFR. T.M. Godawa et al. (2012) only demonstrated improved strength in squats with no group differences in deadlift or bench press, and C.J. Cook et al. (2014) was able to demonstrate that BFR training significantly improved strength and power over traditional training with the ability to maintain sprint performance longer. Further, Cook et al. (2014) showed an increased testosterone and cortisol response in the BFR group compared to the control, where BFR was set at an absolute arterial occlusion pressure of 180 mm Hg throughout the three weeks of training. T.M. Godawa et al. (2012) utilized a personalized method and varied cuff pressures throughout training, but details regarding the pressure are not reported.

Discussion

Current literature suggests that functional BFR resistance training is effective, with more than 80% of the studies analyzed showing strength gains (Araujo et al., 2015; Cook et al., 2014; Credeur et al., 2010; Giles et al., 2017; Godawa et al., 2012; Madarama et al., 2011; Ozaki et al., 2013; Tennent et al., 2017; Teramoto, Golding, 2006; Yasuda et al., 2010). Of those studies, nearly two-thirds reported that BFR training was more effective than the control exercise group who trained at identical intensity and repetition ranges (Cook et al., 2014; Godawa et al., 2012; Madarama et al., 2011; Segal, N. et al., 2015; Tennent et al., 2017; Teramoto, Golding, 2006; Yasuda et al., 2010). The majority of the studies that compared low intensity BFR training to a more traditional high intensity training regime showed no differences between the groups in regard to strength and hypertrophy. Nine of the studies included in this review measured changes in muscle size, with all of them showing a significant increase in size with functional BFR training (Credeur et al., 2010; Madarama et al., 2011; Ozaki et al., 2013; Segal, N. et al., 2015; Tennent et al., 2017; Teramoto, Golding, 2006; Yasuda et al., 2011a; Yasuda et al., 2011b). Two of these studies showed a greater change in muscle size in high-intensity training compared to the low intensity BFR training (Yasuda et al., 2010; Yasuda et al., 2011b).

It seems that many studies used different BFR protocols in the training sessions. Most studies set the intensity for functional BFR at 20–30% 1RM, in accord with previous studies to date (Hughes et al., 2018; Madarama et al., 2011; Ozaki et al., 2013; Segal, N. et al., 2015; Segal, N.A. et al., 2015; Yasuda et al., 2010; Yasuda et al., 2011a; Yasuda et al., 2011b). Many also chose to use a training pattern of one set of 30 repetitions followed by three sets of 15 repetitions with 30 seconds rest (Araujo et al., 2015; Giles et al., 2017; Hughes et al., 2018; Ozaki et al., 2013; Segal, N. et al., 2015; Segal, N.A. et al., 2015; Tennent et al., 2017; Yasuda et al., 2010; Yasuda et al., 2011a; Yasuda et al., 2011b). Some studies set an absolute occlusion pressure (Cook et al., 2014; Credeur et al., 2010), others used a prescribed incremental protocol to raise the pressure during an “acclimation period” (Madarama et al., 2011; Ozaki et al., 2013; Segal, N. et al., 2015; Segal, N.A. et al., 2015; Yasuda et al., 2010; Yasuda et al., 2011a; Yasuda et al., 2011b), but many chose a relative occlusion pressure ranging from 60–80% occlusion (Araujo et al., 2015; Giles et al., 2017; Hughes et al., 2018; Tennent et al., 2017). Studies that set their pressures lower than 100 mmHg tended to have no difference between the experimental groups, probably not providing sufficient occlusion to stimulate the factors needed for muscular adaptation (Credeur et al., 2010; Teramoto, Golding, 2006). While there appears to

be no consensus on occlusion prescription, setting the occlusion pressure relative to each person may be more appropriate to elicit improvements in strength and enhance safety for the exercising individual.

In the case of a clinical population who is unable to adhere to ACSM guidelines for traditional strength training, functional BFR may be an effective alternative to achieve similar if not better strength adaptations than traditional resistance training alone (Araujo et al., 2015; Cook et al., 2014; Credeur et al., 2010; Giles et al., 2017; Godawa et al., 2012; Madarama et al., 2011; Ozaki et al., 2013; Segal, N. et al., 2015; Tennent et al., 2017; Teramoto, Golding, 2006; Yasuda et al., 2010). Functional training with BFR was shown to be highly effective in a rehabilitation population who either experienced significant pain or were unable to perform high intensity functional training (Giles et al., 2017; Hughes et al., 2018; Tennent et al., 2017). This may be a key factor for decreasing the rehabilitation time for post-injury or post-surgery patients. The added benefit of BFR with functional exercises was also shown in the studies conducted with uninjured older adults (Araujo et al., 2015; Segal, N. et al., 2015).

In an athletic population, the study by Cook et al. (Cook et al., 2014) is unique as it was the first multi-joint BFR study to find significant strength gains in a short three-week training period. This time frame is exceptionally short for traditional strength gains which require about six weeks (Garber et al., 2011). This study incorporated BFR training with high intensity work, which may have led to quick gains, but more research is necessary to discern the physiological rationale for the improvements. The use of functional BFR training in athletes could provide some salient exercises required in the sport while reducing load to decrease risk of overtraining and injuries, while dynamic exercises may provide the best opportunity for neural adaptation (Madarama et al., 2011; Pelletier et al., 2015; Yasuda et al., 2011a; Yasuda et al., 2011b).

Current literature also suggests that functional BFR resistance training is overall effective in increasing muscle CSA in the involved musculature (Credeur et al., 2010; Ozaki et al., 2013; Tennent et al., 2017; Yasuda et al., 2010; Yasuda et al., 2011a; Yasuda et al., 2011b). Of these studies, 43% report that functional BFR training was more effective than the control exercise group for increasing muscle CSA (Credeur et al., 2010; Tennent et al., 2017; Yasuda et al., 2011a). After comparing all relevant studies, it is difficult to make a strong conclusion, but most suggest that muscular strength gains are likely due to hypertrophy rather than neural adaptation and fiber recruitment patterns during BFR (Loenneke et al., 2012; Madarama et al., 2011; Segal, N. et al., 2015; Yasuda et al., 2011a; Yasuda et al., 2011b). It is important to understand the degree of neural adaptation in functional BFR training, as it contributes to the overall success and performance of the participants. Yasuda et al. (2010) suggests that BFR training only increases strength through hypertrophy without neural adaptation. Subsequently, combining functional BFR with high-intensity exercise might be best to achieve maximal strength gains through both hypertrophy and neural adaptation (Yasuda et al., 2011a). This is similar to the conclusion from a previous BFR systematic review that reported superior muscular adaptations in high-load resistance training due to the contribution of neural adaptations and proper muscle fiber firing (Lixandrao et al., 2018). The present study did not assess neural changes in the exercised muscle groups.

When applying functional BFR to a clinical population, improvements in neural adaptations to ensure proper function should not be neglected. This is especially important in treating chronic conditions because the restoration of proper motor activity through neuroplasticity principles are necessary to encourage proper functioning that continues after rehabilitation (Pelletier et al., 2015). Functional BFR training has positive effects on functional outcomes, functional performance, pain reduction and quality of life (Araujo et al., 2015; Cook et al., 2014; Giles

et al., 2017; Godawa et al., 2012; Hughes et al., 2018; Tennent et al., 2017). Tennent et al. (2017) was the only study that performed a subjective outcome measure to analyze the perspective of wellness and quality of life, which also improved significantly with the use of functional BFR. Future research utilizing more subjective measures of the success of functional BFR in the perspective of the participant would help to determine its effect on life participation rather than performance. Literature is lacking in studies that provide self-reported quality of life and pain after functional BFR training, which is limiting its clinical utility. Of the three studies that analyzed pain after the session in the rehabilitation group, all reported reduced pain after using functional BFR exercises (Giles et al., 2017; Hughes et al., 2018; Tennent et al., 2017). Hughes et al. (2018) suggest that using light loads during early rehabilitation will prevent further inflammation, and will lead to improved outcomes in self-reported function and overall pain.

Conclusion

Current relevant literature suggests that functional BFR exercise training is successful in improving strength, hypertrophy, pain reduction, and function in injured and uninjured populations of various ages. Clinicians who wish to use functional BFR training should be aware that strength improvements may be more from increased muscle hypertrophy than from neural adaptations. Choosing occlusion pressures for effectiveness is difficult as the studies showed great variation. Utilizing a relative pressure of 60% arterial occlusion or greater would likely create the advantageous hypoxic environment necessary to induce the desired physiological response. More research is necessary to understand the effect of BFR functional training on these neural adaptations, self-reported outcomes, hypertrophy in athletic and older adults, and the musculature adaptations that occur in those that are unconcluded.

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SELECTED NUTRITIONAL BEHAVIORS AND THE LEVEL OF PHYSICAL ACTIVITY OF HIGH SCHOOL STUDENTS

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Abstract The aim of the study was to assess selected nutritional behaviors and the level of physical activity of high school students in the West Pomeranian Voivodship. The research included questionnaires regarding the consumption of breakfast, detailing school days and weekends, the amount of vegetables, fruit, sweets and sugary drinks consumed, as well as questions about physical activity during school and extracurricular classes, intensity of exercises and participation of parents in joint sport. Anthropometric measurements were performed including: body weight, height, BMI, fat mass, lean mass, muscle mass. Body composition analysis was based on the bio-electrical impedance analysis (BIA). There were many irregularities in the way students were eating: lack of breakfast, too little consumption of vegetables and fruits and frequent consumption of sweets and sugary drinks. Physical activity in the majority of students was at a correct level. Despite the nutritional mistakes made, the average BMI of the tested students was correct.

Key words children, nutrition, physical activity

Introduction

The way we eat has a huge impact on our current state of health and has an impact on our condition in the future. Childhood and the period of early youth are the most appropriate period for shaping proper eating habits that ensure health, while mistakes made during this time bring negative effects in adulthood. In addition, the eating habits of children and youth are usually repeated in later life. Nutritional behaviors depend on a variety of aspects, i.e. economic, political, cultural, geographical, social and religious aspect (Ward-Begnoche, Gance-Cleveland, 2005; Jeżewska-Zychowicz, 2004). The habits of parents and carers, advertising of food products and current dietary fashions, fulfill an overriding role in the nutrition of children and adolescents. Developments in civilization have promoted changes in eating behaviors as well as in the whole lifestyle, resulting in a progressive

development of diet-related diseases (Gronowska-Senger, 2007; Trujillo, Davis, Milner, 2006; Zimna-Walendzik, Kolmaga, Tafalska, 2009).

Diet-related diseases, i.e. cardiovascular diseases, diabetes, osteoporosis, obesity, gastrointestinal cancers, anemia, tooth decay etc., are increasingly common in all age groups.

The percentage of obesity, which is currently referred to as an epidemic (Barry, 2000), is particularly dynamic. Obesity is a systemic disease that is characterized by excess body fat in the body. It has been shown that a child who is obese at the age of 10–13 is about 6 times more likely to remain obese in the future compared to a child with normal weight (Epstein, 1996). This is due to the fact that the number of fat cells cannot be reduced, even as a result of slimming treatment – then only the fat content is reduced. Therefore, in children and adolescents who experience excessive body mass or obesity, a large number of adipose tissue cells will remain for a lifetime, which causes a high inclination to obesity even with small dietary mistakes in adulthood.

The main cause of obesity as well as other diet-related diseases are abnormal eating habits. Incorrect diet not only causes the development of these diseases, but also negatively affects physiological development, slows down the ability to learn and reduces concentration (Harton, Sa'eed Bawa, Weker, 2002; Szczepaniak, Flaczyk, Górecka, 2002).

According to the basic principles of proper nutrition, children should consume at least 4–5 meals to provide all the necessary nutrients, and breaks between them should be no more than 4 hours. Vegetables and fruits should be consumed as often and as much as possible. The menu should contain wholegrain cereal products, dairy products, fish, legume seeds, eggs and lean meats. Young people should limit animal fats in favor of vegetable oils, avoid sugar (sweets and sugary drinks), salt (salty snacks, fast food) and drink at least 1.5 litres of water a day (Zasady Prawidłowego Żywienia, 2016).

Typical mistakes made by adolescents include a lack of variety and a monotonous menu, a high consumption of simple sugars – sweets, sweetened carbonated beverages, meat products, fats (Gawęcki, Roszkowski, 2009) and increasingly popular fast foods (Gawęcki, Roszkowski, 2009; Wierzbicka, Roszkowski, 2005; Świdarska-Kopacz, Marcinkowski, Jankowska, 2008; Szponar, Rychlik, 2000; Wierzbicka, Stosio, 2007). Young people usually eat too little fruit, vegetables, dairy products, whole grains and fish products. Often observed issues include irregularity in eating meals (Gawęcki, Roszkowski, 2009; Wierzbicka, Roszkowski, 2005; Gronowska-Senger, 2001; Iłow, Rogulska-Iłow, Sarzała-Kruk, Biernat, 2008; Jeżewska-Zychowicz, 2007), skipping meals (Gawęcki, Roszkowski, 2009; Wierzbicka, Roszkowski, 2005; Iłow et al., 2008; Hamułka, Gronowska-Senger, Tomala, 2002; Szewczyński, Ostrowska, Gajewska, 2005; Rampersaud, Pereira, Girard, Adams, Metzl, 2005; Gould, Russell, Barker, 2006; Dzielska, Kołoto, Mazur, 2008), in particular breakfast before class activities or snacking between meals (Iłow et al., 2008; Jeżewska-Zychowicz, 2007; Szewczyński et al., 2005). This leads to too low or high energy supply, excess fat and sucrose, too little fiber, a shortage of minerals such as zinc, magnesium, copper, calcium, iron and B vitamins, vitamin C, D and polyunsaturated fatty acids (Omega 6 and Omega 3) (Jarosz, Bułhak-Jahymczyk, 2008).

Overweight and obesity during childhood and early childhood beyond abnormal nutrition also results from low activity levels or inactivity and the increasing popularity of a sedentary lifestyle (Knapik, Plinta, Saulicz, Kuszewski, 2004; Brytek, 2005; Korczak, 2000). Low physical activity, in addition to increasing the risk of developing obesity, increases the likelihood of coronary heart disease, diabetes, hypertension and osteoporosis (Zielona Księga..., 2005). Physical activity is a key element of a healthy lifestyle, especially for children and adolescents. It is an

essential factor in normal physical, mental and social development (Knapik et al., 2004; Nosko, 1990; Riddoch, 1998; Żolnierczuk-Kieliszek, 2002).

The aim of the study was to analyze the eating habits and physical activity of high school students in cities of various sizes and check the composition of the body in relation to the diet.

Materials and methods

A diagnostic survey method was used and the students were asked about their eating habits and physical activity based in the questionnaire. Using the electrical bioimpedance method, a body composition analysis including body weight, BMI, fat mass, lean mass and muscle mass was performed. The student's body height was measured in accordance with the principles of anthropometry.

Findings

The study involved 3,537 high school students (Table 1) between 15 and 20 years of age (Table 3). The average age was 17 years (Figure 2). In the study group, 46.7% were girls and 53.5% boys (Figure 1). Most of the students came from medium-sized towns (from 11,000 to 19,000 inhabitants). 23.95% were from towns up to 11,000 inhabitants, 23.10% from big cities from 20,000 to 50,000 inhabitants, and 23.66% from very big cities (over 50,000 inhabitants) (Table 2, Figure 3).

Table 1. Group characteristics – number of students in individual poviats

No.	District	n	No.	District	n
1.	Choszczno	187	11.	Darłowo	187
2.	Szczecin	341	12.	Pyrzyce	142
3.	Świdwin	130	13.	Świnoujście	159
4.	Chojna	180	14.	Kamień Pomorski	151
5.	Police	164	15.	Łobez	120
6.	Złocieniec	155	16.	Nowogard	88
7.	Białogard	95	17.	Kołobrzeg	187
8.	Myślibórz	147	18.	Biały Bór	210
9.	Trzebiatów	186	19.	Koszalin	194
10.	Wałcz	212	20.	Stargard	302
Total: 3,537					

Source: own study.

Table 2. Group characteristics – number of students in individual districts, taking into account the number of inhabitants

No.	Town/City	n	%
1.	Small up to 11,000	847	23.95
2.	Medium 11–19,000	1,036	29.29
3.	Big 20–50,000	817	23.10
4.	Very big over 50,000	837	23.66
Total		3,537	100.00

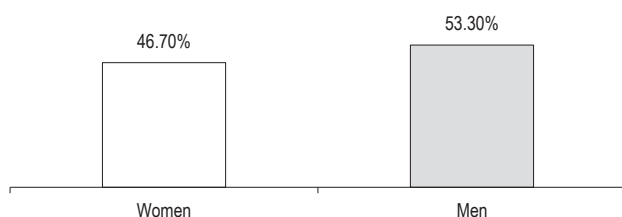
Source: own study.

Table 3. Age of students in individual districts, including the number of inhabitants

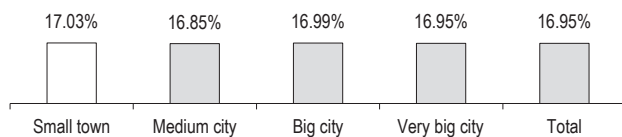
Town/city	n	x	SD	v	min	max
Small	847	17.03	0.97	5.70	15	20
Medium	1036	16.85	0.97	5.76	15	19
Big	817	16.99	1.07	6.28	15	20
Very big	837	16.95	1.03	6.07	15	20
Total	3,537	16.95	1.01	5.95	15	20

n – number; x – arithmetic mean; SD – standard deviation; v – coefficient of variation; min – minimum sample value; max – maximum sample value.

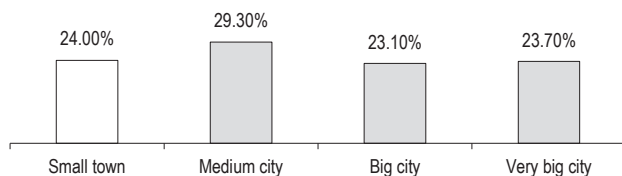
Source: own study.

**Figure 1.** Gender of the students

Source: own study.

**Figure 2.** Age of students in individual districts, taking into account the number of inhabitants

Source: own study.

**Figure 3.** Place of residence of the students

Source: own study.

The questionnaire asked about eating habits – breakfast, the share of fruit and vegetables in the diet, consumption of sweets, and the physical activity practiced by the students and their parents.

When asked about breakfast, 15% of the students answered that they never eat breakfast on school days, 57.5% eat breakfast each day, and the remaining 27.5% eat 2–3 times within 5 days (Figure 4). At weekends, 9.3% of students do not eat breakfast, 81.6% always eat it, others only eat on Sunday (3.8%) or on Saturday (5.3%).

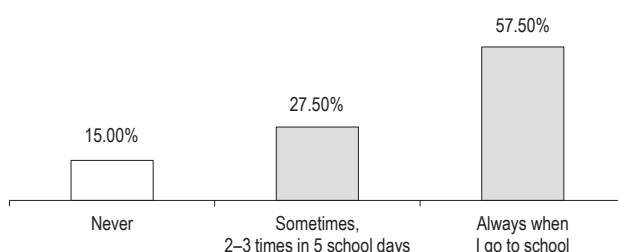


Figure 4. Frequency of breakfast (i.e. something more than a glass of milk, tea or other drink) on school days

Source: own study.

Every day, 23.3% of the students eat fruit, 11.3% of which more often than once a day, almost 15% eat fruit 5–6 times a week, and 42.8% eat fruit from 2 to 4 times a week. The group also included persons (12.8%) who eat fruit only once a week, and even less frequently (5.8%) (Figure 5).

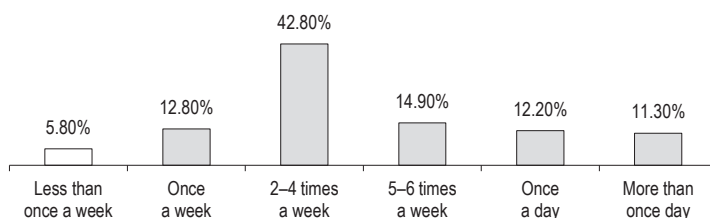


Figure 5. Frequency of fruit consumption per week

Source: own study.

The data from Figure 6 shows that only 3.7% of students eat fresh vegetables more often than once a day, 6.6% eat one portion per day, 50.4% eat them 2–4 times a week, and 7.7% eat 5 to 6 times a week. A disturbing fact is that as many as 18.4% of the students eat fresh vegetables only once a week, and 13.1% less than once a week.

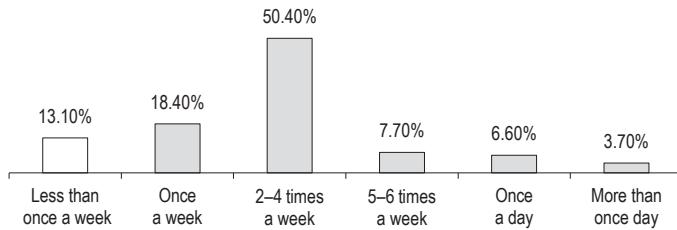


Figure 6. Frequency of consumption of vegetables or salads from fresh vegetables within a week

Source: own study.

When asked about the frequency of consumption of sweets and sugary drinks (Figure 7), almost 20% of students declared every day, including 8.7% more than once a day, 42.1% eat sweets 2–4 times a week, and 13.8% eat them from 5 to 6 times a week. Only 14.2% of students eat sweets once a week. In the study group there were also students who consumed them less often than once a week (9%). Over half (50.2%) of the students eat sweets while at home (during homework and free time), others eat them mostly during school time (25.7%), and others both at school and at home (24.1%) (Figure 8). The place of purchase of sweets for the majority of the students (53.2%) are shops on the way to school, 17.3% buy in school shops or use sweet machines, and for 29.6% of students, sweets are bought by the parents (Figure 9).

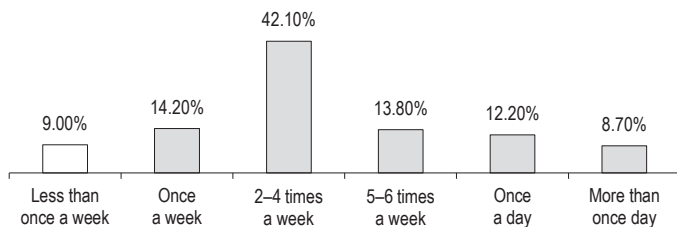


Figure 7. Frequency of sweets consumption (candies, chocolates, cookies, bars), cocoa or other sweetened beverages

Source: own study.

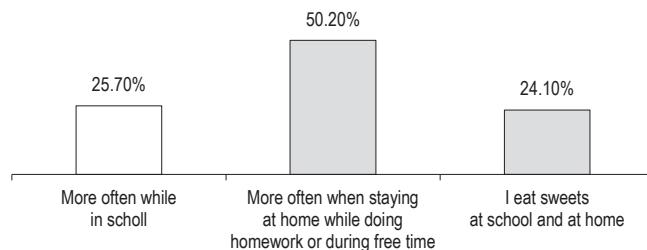


Figure 8. Time and place of the most frequent consumption of sweets and sweetened drinks

Source: own study.

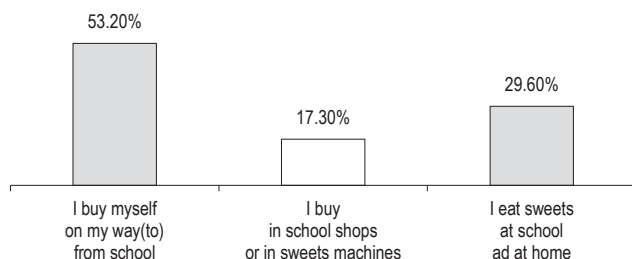


Figure 9. Place of purchase of sweets and sweet drinks consumed by the students

Source: own study.

Almost 80% of students always participate in physical education classes, but 11.5% try to avoid this type of lesson, and 8.7% did not take part in such classes (Figure 10).

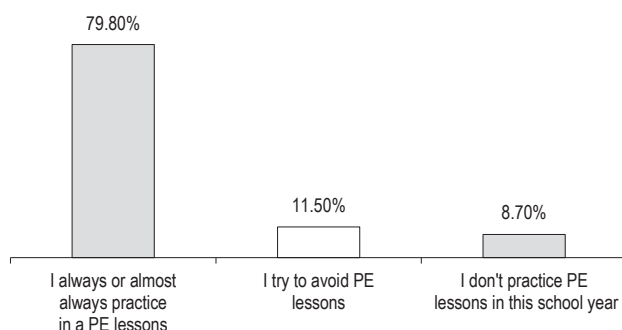


Figure 10. Frequency of participation in school physical education classes

Source: own study.

In addition to school lessons, 41.8% of students participate in other forms of physical activity under the care of a trainer, and 83.2% practice various forms of physical activities outside school PE lessons (cycling, swimming, running, playing football, etc.) (Figures 11, 12).

Physical exercise of high intensity is practiced daily by 24.7% of the students, with 45% practicing several times a week (15.8% from 4 to 6 times, 30.5% from 2 to 3 times a week), 14.4% once a week, others once a month (6.0%), less frequently than once a month (4.4%) or never (4.2%) (Figure 13). 10% of the students spend over 7 hours a week on exercise, 10.1% spend about 4–6 hours, and 24.1% spend about 2–3 hours. The largest number of students (27.3%) spend about an hour on additional physical activity, 16.6% less than an hour (about half an hour). As much as 11.4% do no exercise at all (Figure 14).

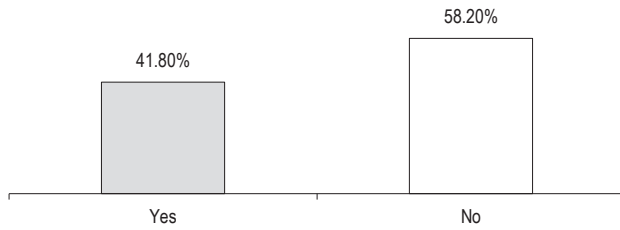


Figure 11. Participation in organized forms of physical activity under the supervision of an instructor, trainer outside school PE lessons

Source: own study.

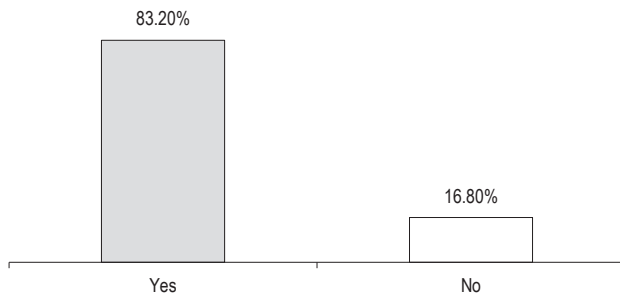


Figure 12. Practicing various forms of sports (cycling, swimming, running, playing football, etc.) outside school PE lessons

Source: own study.

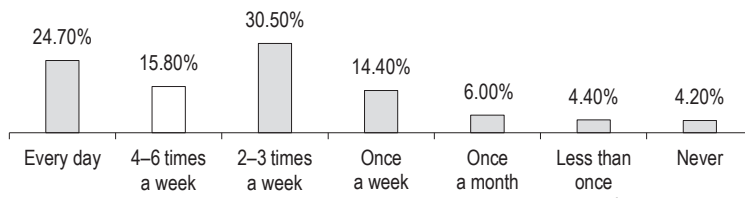


Figure 13. Frequency of intense physical exercise

Source: own study.

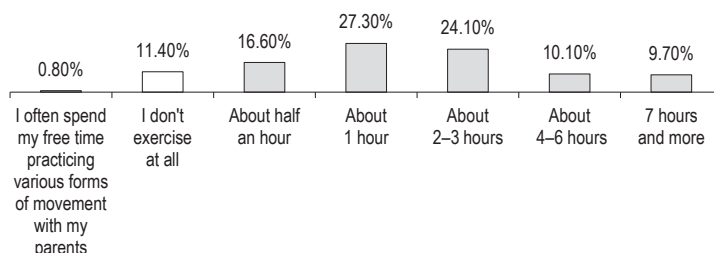


Figure 14. Time spent on additional high intensity physical activity

Source: own study.

Over 45% of students never engage in physical activity with their parents, some only exercise from time to time with both parents (17.5%) or only with one of their parents (6.2% only with father, 6.4% only with mother). Only 12.7% of the students spend time doing physical activity together with their parents, 6.2% only with their mother and 5.7 only with their father (Figure 15).

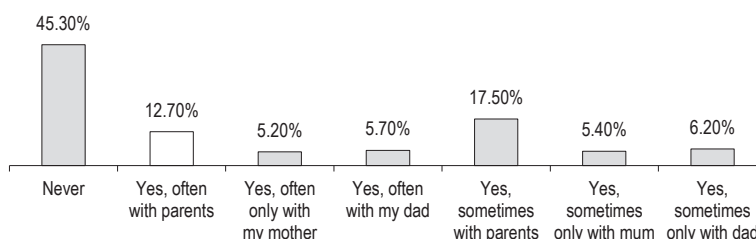


Figure 15. Parent participation in common physical activity

Source: own study.

The questionnaire also included questions about the physical activity of the parents of the students. The obtained answers indicate that both mother and father of over 50% of students engage in physical activity during the week (minimum once a week (2-3 times, 4-6 times a week or daily). Unfortunately, some parents only practice once a month, less than once a month or never (Figures 16, 17).

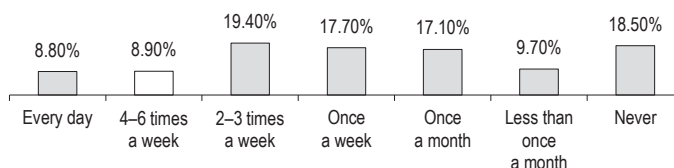


Figure 16. Frequency of physical activities by the mothers of the students

Source: own study.

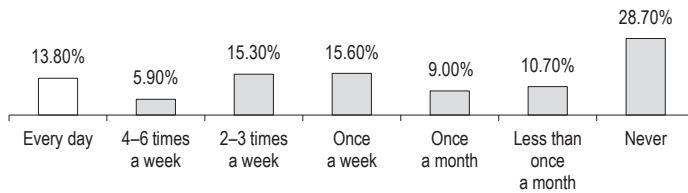


Figure 17. Frequency of physical activities by the fathers of the students

Source: own study.

Almost 30% of the students examined have a swimming card, 25% can swim (backstroke, any, classic style), 23% do not swim but can float and not sink. As many as 18% of students cannot swim and 4.7% are afraid of going into the water (Figure 18).

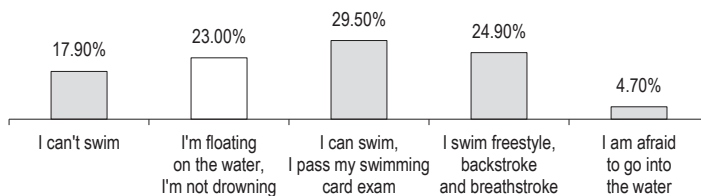


Figure 18. Assessment of swimming skills by students

Source: own study.

Thirty-seven percent of students would be interested in participating in a "WOPR Youth Team", acquiring the rights of a WOPR Junior Lifeguard and becoming a volunteer leader in the Team activities. 35% did not want to participate, while other students were undecided ("I do not know") (Figure 19).

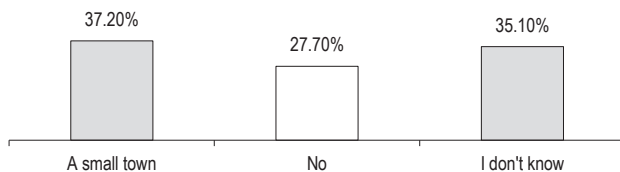


Figure 19. Student interest in participating in a "WOPR Youth Team", acquiring the rights of a WOPR Junior Lifeguard and becoming a volunteer leader in the Team activities

Source: own study.

The average BMI of the students examined was 22.58 and did not differ significantly between the students from cities of different sizes. The highest mass and height was characteristic of students from very large cities, with the lowest fat mass and the highest fat-free and muscle mass (resulting in the highest body weight). Students from small, medium and large cities with a higher fat mass had a lower lean and muscle mass than students from very large cities (Figures 20, 21, 22, 23, 23, 24, 25).

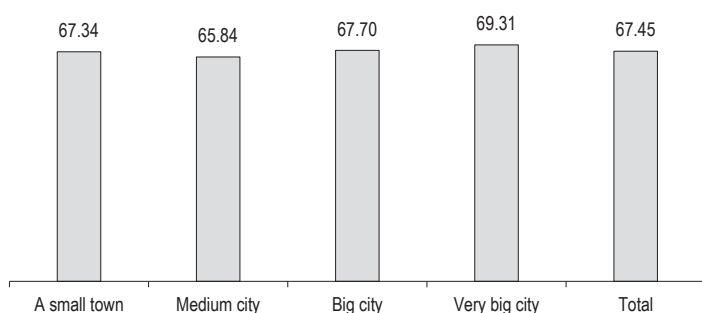


Figure 20. Body mass of students in individual districts, taking into account the number of inhabitants (kg)

Source: own study.

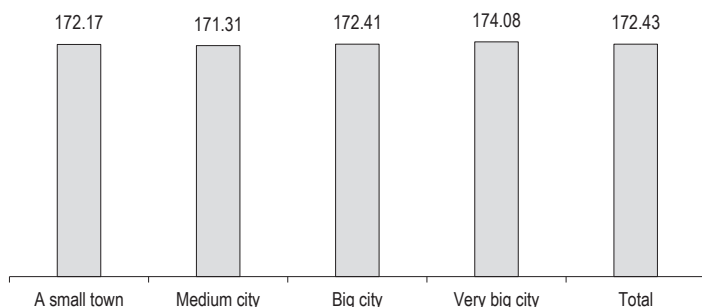


Figure 21. Height of the students in individual districts, taking into account the number of inhabitants (cm)

Source: own study.

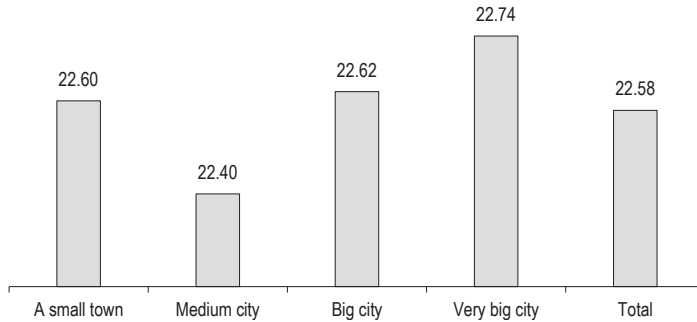


Figure 22. BMI of the students in individual districts, taking into account the number of inhabitants
Source: own study.

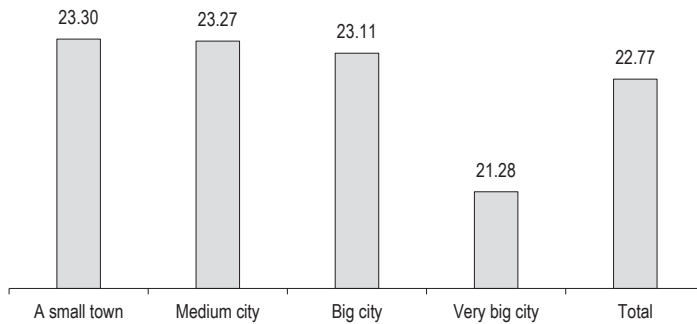


Figure 23. Fat mass of the students in individual districts, taking into account the number of inhabitants (%)
Source: own study.

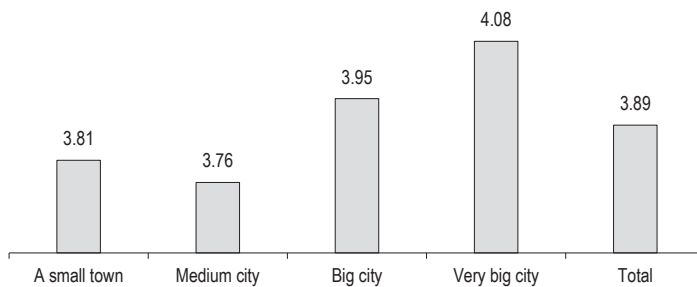


Figure 24. Lean mass of the students in individual districts, taking into account the number of inhabitants
Source: own study.

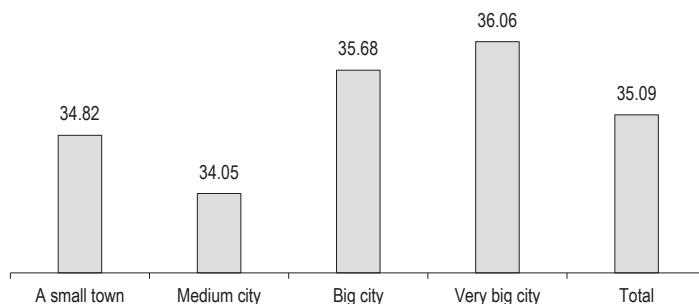


Figure 25. Muscle mass of students in particular districts, taking into account the number of inhabitants

Source: own study.

Discussion

Proper nutrition that provides essential nutrients and the right amount of energy determines the appropriate body weight, proper growth and both physical and mental development of school-age children. Changes occurring during puberty cause an increase in interest in corporeality and external appearance, which may also contribute to various, not necessarily correct, dietary shifts. Incorrect nutrition increases the risk of developing many civilization diseases such as obesity, type II diabetes, cardiovascular disease and some cancers. The most common adolescent dietary irregularities include too few vegetables and fruits, milk and milk beverages, dark bread, with a high consumption of sweet drinks, sweets, and salty snacks. Nutritional mistakes made are associated with a low level of health education. Research carried out in various places in Poland show many mistakes in the diet of the adolescents examined.

In the presented study, a frequent dietary mistake was the lack of breakfast on school days, with the majority of breakfasts being on the days off school. Similar results were obtained by the 2010 HBSC research in which only 52.2% of high school students in Poland eat breakfast every school day, and as many as 26.6% do not eat breakfast at all. At the weekends, 82.8% of students declared eating breakfast. The results regarding the amount of vegetables and fruit consumed, as well as sweets and sugary drinks in both studies showed too little vegetables and fruits in the diet, with a high consumption of sweets and sugary drinks (Raport techniczny...).

Also, in studies conducted among students of Warsaw high schools (mainly from general schools), it was shown that the majority of students eat 3–4 meals a day, do not eat breakfast, and the vegetables in their diet are only in the dinner meal. A relationship between the number of meals and gender was shown. In the female diet, just 2 meals a day was more prevalent, while the boys more often consumed 6 meals or more during the day. In the study, 84% of students consumed snacks between meals (Czarniecka-Skubina, Namysław, 2008). Also, in the study conducted by E. Sikora, T. Leszczyńska and P. Szymański (2007), most students (85%) eat snacks between meals – mainly fruit, sandwiches and chips.

In studies carried out by I.M. Batyk (2012) as many as 5% of students consumed only one meal a day, 15% of students have two meals, 45% have breakfast, 25% have no breakfast. In the diet, 62.5% of students have a second breakfast, however, most often in the form of sweet rolls, sandwiches and sweets, which also indicates

a high sugar intake by the students. Over half (65%) of the students eat snacks between meals. Of the students studied, as many as 56.5% eat fast-food products every day.

According to other researchers (Czarniecka-Skubina, Namysław, 2008; Czarnocińska, Wądołowska, Dymkowska, Szelc, 2001; Gacek, Fiedor, 2005; Kowieska, Biel, Stanisławski, 2007), adolescents usually consume 3–4 meals a day. According to G.C. Rampersaud et al. (2005), 30% of adolescents aged 15–18 do not eat breakfast, with girls most often. According to B. Szczepaniak et al. (2002), about 12–14% of teenagers eat too few meals during the day.

As a result of research carried out by M. Wojtaś and A. Kołajtis-Dołowy (2011) it was found that the diet of high school students is not very varied, and most meals are sandwiches. As in the presented study, a low intake of vegetables, fruits and dairy products by the study group was demonstrated. Most of the students kept the right time between the last meal and the time of going to sleep. Only 40% of students declared eating breakfast every day. In spite of their normal weight, students chose diets with reduced caloric value (Wojtaś, Kołajtis-Dołowy, 2011). This may be due to the fact that adolescents often have difficulty with a proper body weight assessment, describing it as abnormal (Kołoło, Woynarowska, 2004). Many national and European studies point out that perceiving your body weight as high may be the reason for different psychophysical problems (Ter Bogt et al., 2006) and uncontrolled transition to various diets and the belief in the necessity of their use (Kołoło, Woynarowska, 2004; Ojala, Tynjälä, Välimaa, Villberg, Kannas, 2012).

The research carried out on students of high schools in the Mazowieckie Voivodship shows that a large part of the surveyed youth skip meals and eat irregularly. Only 47% of students eat a minimum of 4 meals or more. The study discussed above yielded different results on vegetable consumption – only 2.6% of students do not eat them, 47.5% eat them often. Physical activity of the students was also examined and it was shown that almost half of the students show insufficient physical activity, and it is more often abandoned by girls. Only 25% of students participate in sports activities outside of school lessons (Saracen, 2010).

Analysis of selected nutritional behaviors of students from the Świętokrzyskie Voivodship showed that more than a half consume from 4 to 5 meals a day, about 1/3 of students eat only three or fewer meals, only 3/4 of students eat dinner every day. As in the previously described studies, the majority of students (as much as 91.8%) declare snacking (Gajda, Jeżewska-Zychowicz, 2010).

The presented research in this paper and the analysis of other studies show that the nutrition of young people is often irrational and unsuitable for their developmental age.

Conclusion

1. Evaluation of the diet of the students showed a lot of irregularities in a significant number of adolescents, as indicated by skipping breakfast, too few fresh vegetables and fruits, and frequent consumption of sweets and sugary drinks.

2. Nutritional mistakes can be made by a lack of time on school days (eating breakfast for a much larger percentage of students on days off-school) and the availability of unhealthy products in the school shop (purchase of sweets in school shops).

3. Nutritional education for young people and intense health promotion in order to correct dietary mistakes and shape correct habits should be introduced.

4. Most students show adequate physical activity during school and outside school. A small percentage of people engage in physical activity together with their parents.
5. Despite the irregularities in eating habits, the average BMI of the tested students was correct.

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TRACKING DAILY STEPS: AN INVESTIGATION ON A SMALL POST-SECONDARY CAMPUS

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Abstract The production of mood-regulating chemicals (e.g. serotonin) may be impacted through prolonged or acute stress events. If a serotonin-deficit exists, depression-related illnesses may result, with such illnesses projected to become the second highest lifetime burden of disease. Critically, physical activity has been found to assist in increasing serotonin levels, positively impacting adult neurogenesis and mood. The purpose of this study was to track daily steps (physical activity) employing a step-counting technology across a small Canadian university. Guided by the research questions: *Can tracking daily steps encourage elevated levels of physical activity?* and *What differences, if any, exist between physical activity levels amongst students and faculty/staff?*, such an understanding may add to the current body of knowledge concerning physical activity levels in educational institutions. Over a 9-week period, students ($n = 32$) took significantly more steps than faculty/staff ($n = 16$), and significantly more in Week 9 than in Week 2.

Key words physical activity, post-secondary faculty/staff, post-secondary students, physical activity technology, daily steps

Introduction

Neuroendocrine functions in the human brain are impacted by stressful events which, in turn, influence moods (Lupien, McEwan, Gunnar, Heim, 2009). The production of mood-regulating chemicals such as serotonin may be negatively impacted through prolonged or acute stress events. Hence, if a deficit of serotonin exists, depression-related illnesses may result, with such illnesses projected to become the second highest lifetime burden of disease, exceeded only by heart disease (Greenwood, Fleshner, 2011; World Health Organization [WHO], 2017). Critically, physical activity has been found to help increase serotonin levels (Valim et al., 2013), having a positive effect on adult neurogenesis and positively impacting mood (Ernst, Olson, Pinel, Lam, Christie, 2006). Likewise, higher

physical activity levels are associated with a reduction in chronic conditions such as Type 2 diabetes, obesity, cardiovascular disease, and premature death (Go et al., 2014; Warburton, Nicol, Bredin, 2006).

To combat such chronic conditions and other health-related issues, post-secondary campuses are aiming to include wellness programs to improve and/or maintain student and faculty/staff wellness. For example, Concordia University of Edmonton in Alberta, Canada, has developed a range of initiatives through the School of Physical Education & Wellness (e.g. drop-in intramurals, fitness classes) and other campus wellness teams (e.g. Mental Health Action Team) to support students and faculty/staff wellness. Other such initiatives organized across Canadian post-secondary campuses include: peer support centres; international student services; health clinics; etc.

With such initiatives occurring across post-secondary campuses, it seems fitting to study an essential component of wellness (e.g. physical activity levels). Hence, this quantitative study examined physical activity levels (i.e. daily steps) employing step-counting technology (e.g. pedometers, Fitbits) worn by students and faculty/staff. Step-counting technology has been found to be effective in ascertaining accumulative physical activity levels and can be a valid predictor of daily activity (Craig, Tudor-Locke, Cragg, Cameron, 2010; Husted, Llewellyn, 2017), and due to the wide commercial availability, wearable step-counting technology has increased in popularity throughout the years (Market Realist, 2017; Rote, 2017; Science Daily, 2017). Hence, guided by the general research questions: *Can tracking daily steps encourage elevated levels of physical activity?* and *What differences, if any, exist between physical activity levels amongst students and faculty/staff?*, such an understanding may add to the current body of knowledge concerning physical activity levels on post-secondary campuses. Additionally, participants may become more aware of their physical activity levels, along with a better understanding of how physical activity impacts their daily lives (e.g. lowering stress).

Review of related literature

Physical activity has been linked to several health benefits, such as in physical, mental and emotional health (Go et al., 2014; Hales, Lauzon, 2015). According to A.L. Morgan, D.A. Tobar, and L. Snyder (2010), physical activity has been found to prevent, reduce and manage many chronic health conditions. Surfacing in the mid-1980s, physical activity recommendations aimed at promoting public health outcomes have continued to evolve, while new evidence and scientific methods for measuring physical activity have emerged (Physical Activity Guidelines Advisory Committee, 2008). For example, ParticipACTION (2019) specifies an amount of time (i.e. 150 minutes per week) that individuals from 18–64 years old should undertake in moderate to vigorous physical activity in order to experience potential health benefits.

In terms of physical activity, this study focused on daily walking steps as the operationalized variable. Hence, in order to track daily steps, pedometers and other wearable technology items (e.g. Fitbits) are well suited for the task (Freak-Poli, Wolfe, Backholer, de Courten, Peeters, 2011; Kovelis et al., 2012). Pedometers, for instance, have grown in popularity over the years (Market Realist, 2017; Kovelis et al., 2012; Tudor-Locke, Bassett, 2004) as inexpensive tools that can easily and accurately advise about and enumerate the number of daily steps, and have greatly advanced the objective measurement of physical activity patterns for individuals (Baskerville, Ricci-Cabello, Roberts, Farmer, 2017; Bassett et al., 1996; Husted, Llewellyn, 2017; Schneider, Crouter, Bassett, 2004).

Although 10,000 steps per day has been suggested as an effective target for physical activity for the general population (Choi, Pak, Choi, Choi, 2007; Morgan, Tobar, Snyder, 2010; Tudor-Locke, Bassett, 2004), B.C. Choi et al. (2007) contended that 10,000 steps daily is not usually achievable in normal daily routines. Moreover, that particular

number of steps was originally arrived at with no empirical evidence, and has received much attention in recent years; reaching 10,000 steps may not equate to a sufficient amount of physical activity (Science Alert, 2016; White et al., 2013). According to Science Alert (2016), there is certainly nothing wrong with walking 10,000 steps daily as it is much better than the 3,000 to 4,000 average, but they also emphasize that we should not treat 10,000 steps per day as a scientifically proven goal.

Walking is the simplest form of exercise. Employing a pedometer is a good way to get yourself to do it (Harvard Health Publications, 2017).

According to R.P. Pangrazi and A. Beighle (2013), counting steps is an effective way to measure physical activity levels, and although pedometers cannot measure swimming or cycling, they still represent one of the best ways to measure common physical activity, as most daily physical activity accumulated by individuals (about 90%) is *over land* (Pangrazi, Beighle, 2010). When individuals are asked to recall and self-report their previous day's physical activity level, most find it difficult to quantify the true answer; recall may have been done on an atypical day, thus resulting in an under or overestimation (Sallis, 1991; as cited in Pangrazi, Beighle, 2010).

Step-counting studies

The use of pedometers or other step-counting technology has been found to be associated with significant increases in physical activity, weight loss, improvements in blood pressure (Stanford Medicine, 2007), reductions in body mass index (BMI), and increased cardiovascular fitness (Bravato et al., 2007; Chan, Ryan, Tudor-Locke, 2004; Freak-Poli et al., 2011). Moreover, step-counting technology devices (e.g. pedometers) have become key research tools by measuring "steps", and providing immediate feedback, as motivational tools within intervention programs, to enhance physical activity levels and to elevate quality of life, across an array of clinical conditions such as: hypertension (Lee, Watson, Mulvaney, Tsai, Lo, 2010), diabetes (Diedrich, Munroe, Romano, 2010; Furber et al., 2008), inactivity in overweight and obese older people (Sugden et al., 2008; Pal, Cheng, Egger, Binns, Donovan, 2009), cardiovascular risk (Tully, Cupples, Chan, McGlade, Young, 2005), obesity (Tessier et al., 2010), and in healthy adults (Marshall et al., 2009; Tudor-Locke, Lutes, 2009), to name a few. As well, other studies have described a range of pedometer walking research protocols for adults with lower back pain (Krein et al., 2010; McDonough et al., 2010) to assess the effects on pain-related disability and functional interference.

As a motivational tool, several findings have indicated that step-counting technology can assist in motivation for physical activity. In 2007, Stanford researchers analyzed 26 studies and summarized the results in *The Journal of the American Medical Association*: pedometer users walk more than 2,000 additional steps per day than do those without, and their overall physical activity levels were higher by 27% (Harvard Health Publications, 2017).

Moreover, an array of pedometer-based interventions promoted achievement and sustainability in 10,000 steps per day (Araiza, Hewes, Gashetewa, Vella, Burge, 2006; Schneider, Bassett, Thompson, Pronk, Bielak, 2006; Swartz et al., 2003), while others have advocated for alternative activity goals which typically involve incremental increases over baseline throughout the intervention (Croteau, 2004; Moreau, Degarmo, Langlet, 2001; Tudor-Locke et al., 2004). In a systematic review of 18 observational pedometer studies and 8 randomized controlled trials, D.M. Bravata et al. (2007) concluded that participants exhibited significant decreases in systolic blood pressure. Generally, other health outcomes have also shown positive improvements among pedometer users such as waist circumference, serum glucose concentrations and lipid profiles (Swartz et al., 2003; Moreau, Degarmo,

Langlet, 2001; Chan, Spangler, Valcour, Tudor-Locke, 2003). According to the Physical Activity Guidelines Advisory Committee (2008), pedometer-associated health benefits have been established in a variety of adult populations, such as in overweight adults and at-risk individuals for diabetes.

Likewise, physical and psychological benefits were found following a 15-week walking program in which participants added 2,200 steps per day, up to approximately 8,000 (Morgan, Tobar, Snyder, 2010), supporting the idea that counting steps can be motivational, leading to increased physical activity levels, while also being a cost-effective intervention (Kang, Marshall, Barreira, Lee, 2009).

Step-counting studies in educational settings

Throughout the years, step-counting studies have been undertaken at all educational levels. Z. Butcher, S. Fairclough, G. Stratton, and D. Richardson (2007) examined pedometer use and its effects on physical activity levels in primary schools ($n = 177$, mean age = 9). It was found that immediate pedometer feedback was associated with significant physical activity increases when fused with additional strategies; pedometer feedback alone did not elicit significant increases in steps per day.

Likewise, at the secondary school level, L. Schofield, W.K. Mummery and G. Schofield (2005) investigated physical activity levels through pedometer employment as an intervention. Over a 12-week period, Schofield and colleagues compared pedometer use in combination with daily step count targets and the use of time-based goals for physical activity involvement ($n = 85$ females; mean age = 15). Pedometer use and daily step count targets were found to significantly improve physical activity levels over 6 weeks, and when compared with traditional time-based physical activity prescriptions, pedometer use helped enhance physical activity involvement over a 6-week period.

Similarly, at the post-secondary level, E.M. Jackson and A. Howton (2008) assessed the effectiveness of a pedometer intervention to improve physical activity levels on a college campus ($n = 290$ college students) through a 12-week period. During Week 1, which was used as a baseline, instructors briefly discussed recommended daily steps, goal setting, and strategies to elevate physical activity levels. A significant increase in steps was found throughout the intervention. Likewise, A.E. Rote (2017), who studied a sample of post-secondary students, found an increase in steps per day by employing step-counting technology. However, Rote's findings were lower than in other such studies (e.g. Jackson, Howton, 2008).

On the contrary, not every study has been quite so positive regarding step-counting technology. According to Harvard Health Publications (2017), a British review of interventions to promote walking published the same year as the Stanford review, noted that the effect of the pedometer on walking may decrease as time goes on – an issue found with many exercise programs. Likewise, in 2008, Norwegian investigators found no difference in results for pedometer users and participants who were instead counseled to increase the number of steps per day. Their argument was that it may not be the step-counting (i.e. pedometer use) that motivates people to “move” so much as regular counseling and setting and following goals. This is found to be consistent with the Stanford researchers' discoveries; the three pedometer studies that did not include set goals showed no significant physical activity improvement (Harvard Health Publications, 2017).

Although it is not widely known whether or not step-counters are motivators, Harvard Health Publications (2017) contended that the possibility lies in the idea that step-counting technology quantifies the physical activity efforts (i.e. number of steps) and most people respond to numbers, especially when related to exercise. For example,

runners count miles, swimmers count laps, and perhaps, walkers count steps, which may serve as a motivational tool.

Although some experts invoke the self-efficacy theory as an explanation to step-counting technology as a motivator – developing a level of confidence that a task can be performed – what is being asked while “counting steps” (e.g. pedometer use) is to take more steps. Taking the commonly suggested 10,000 steps a day may seem like an unachievable goal for some, but it is within reach given that most people consistently step between 6,000 and 7,000 times daily (Harvard Health Publications, 2017). In other words, an additional 3,000 to 4,000 steps can add up to approximately 30 minutes (Harvard Health Publications, 2017). Hence, it is suggested that people can find the time to take these extra recommended daily steps, even during busy days. And, to support this notion further, walking, for instance, can take place in bouts of 10 minutes, which has been found to lead to an array of health benefits (Evans, 2011; Harvard Health Publications, 2017).

Procedures

After obtaining approval from the University Research Ethics Board, a convenience sample was employed at Concordia University of Edmonton. All students and faculty/staff were invited to participate via posters displayed throughout campus. 52 participants agreed to volunteer, and 48 participants completed the study (four chose to withdraw during the 9-week period).

Participants were provided with a pedometer or were permitted to use their own step-counting tool (e.g. pedometer, Fitbit, iPhone) to track their daily steps. Daily steps were self-reported by each participant at the end of each week on Sunday evening by emailing the totals to the principal investigator (PI) (i.e. Monday to Sunday totals) for nine consecutive weeks during the mid- to late-part of the Winter Semester (i.e. February–April). Along with the daily step recording, participants were asked to email their weight measurement recorded each Sunday evening throughout the 9-week period (i.e. one weight measurement per week – Sunday evenings).

Although the participants emailed their weekly totals for nine consecutive weeks, there was no return communication by the research team. There were no motivational messages, offerings of encouragement, notes of what the research stated regarding physical activity, etc. by the research team. Non-verbal intervention was intended to test if using a self-monitoring tool (i.e. step-counting technology) motivates people to modify their number of daily steps. Moreover, the only time participants were contacted by the PI was throughout the study's first week when it was discovered that a few participants were changing their research tool (e.g. pedometer to Fitbit). Via email, the PI asked the participants to ensure they employ the same research tool for the duration of the study.

Data analysis

Prior to data analysis, missing data points were handled in the following ways as agreed upon by the research team: when there was no data for a particular day, the average for the specific week was calculated and inputted; when a weight measurement was missing, the overall average of the participant's weight was calculated and inputted; when anomalies occurred (i.e. data that could not be used due to non-numerical data [e.g. 166+]), the average for the participant's particular week was calculated and inputted. With an already small sample, the inputting of averages in these few areas permitted a participant who missed submitting a data point, or unknowingly inputted unusable data, to remain a participant whose data could be included in the analysis process.

Initial trends

Initially, descriptive statistics illustrated some trends worthy of discussion. According to Figure 1, all participants as a group of 48 showed an increase in average daily steps from Week 1 (7,169) to Week 9 (8,358). As illustrated in Figure 2, the group of students increased their daily steps while the faculty/staff remained relatively static. Figure 2 also depicts that the student group consistently took more steps than faculty/staff through the duration of the study (e.g. in Week 9, the student group averaged 9,666, while faculty/staff participants averaged 5,828). According to Figure 3, there was not much difference of daily steps taken between the days of the week by the whole group of participants. The lowest mean was 7,097 on Sundays, while the highest mean was 8,039 on Saturdays. All other days had a mean in the range 7,360–7,794. When divided into the two groups of Students and Faculty/Staff, the same trends occurred (see Figure 4); the student group means were, again, consistently higher than faculty/staff. For example, on Fridays, student means equaled 8,774, while faculty/staff averaged 5,865.

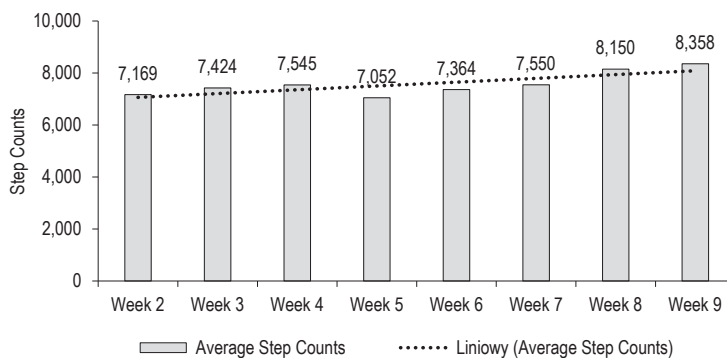


Figure 1. Average Step Counts: All Participants (n = 48)

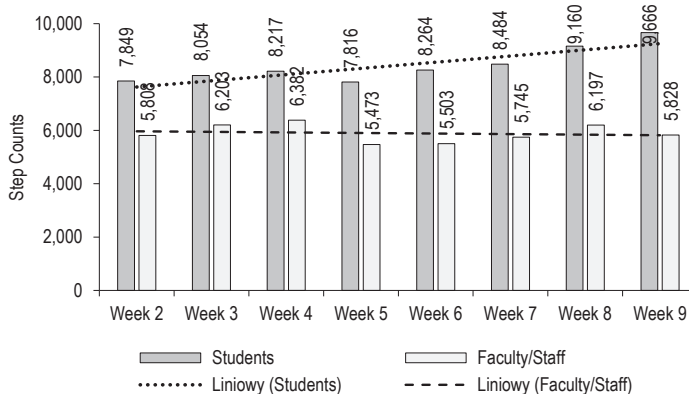


Figure 2. Average Step Counts: Students (n = 32) & Faculty/Staff (n = 16)

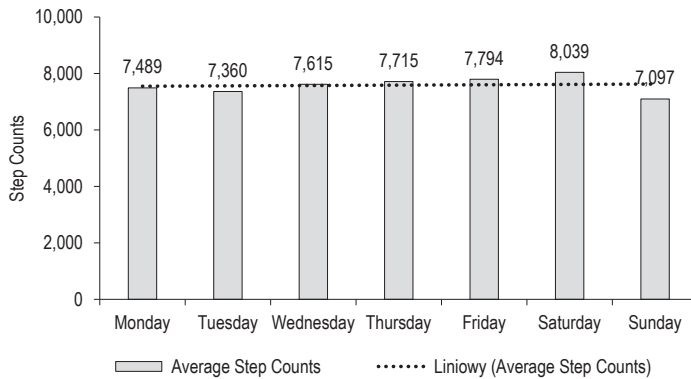


Figure 3. Average Step Counts: All Participants (7-Day Week)

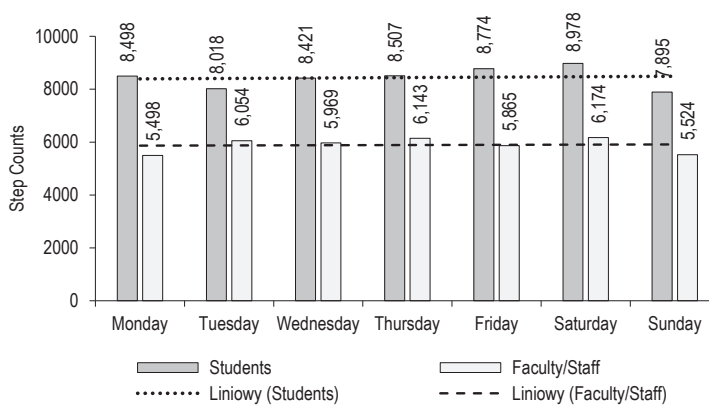


Figure 4. Average Step Counts: Students & Faculty/Staff (7-Day Week)

Inferential statistics

Independent sample t-tests were employed to search for differences between student and faculty/staff groups, and dependent sample t-tests were used to look at differences within the groups. Overall, there was a significant increase in the number of steps taken over the course of the study. A comparison of Week 2 and Week 9 indicated significantly more steps were taken in Week 9 than Week 2, ($t(42) = -2.3$, $p = 0.011$). When examined by participant type (i.e. student versus faculty/staff), students took significantly more steps than faculty/staff ($t(41) = 3.23$, $p = 0.001$), and students' step counts increased over the course of the study (i.e. students took significantly more steps in Week 9, than in Week 2), ($t(28) = -2.5$, $p = 0.009$). However, there was no significant difference in number of steps taken by faculty/staff over the course of the study.

There was a significant overall negative correlation between average steps and overall weight ($r = -0.43$, $p = 0.004$). For faculty/staff, there were significant negative correlations between steps and weight in Week 2 ($r = -0.617$, $p = 0.019$) and Week 8 ($r = -0.547$, $p = 0.043$). While levels of significance are mentioned here, it is important to note that results reporting statistically significant do not necessarily imply practical significance. The significance is likely due to the small sample size as several weeks showed similar correlation coefficients, but were not large enough to be considered significant.

Limitations

This research study did not go without limitations. Although step-counting technologies (e.g. pedometers, Fitbits, iPhones) measure the value of physical activity in steps and time, they do not measure the intensity of physical activity (e.g. walking vs. running) nor differentiate the many physical activities (e.g. on land [biking, weight lifting], off land [swimming]) (Lystrup, West, Olsen, Ward, Stephens, 2016; Pangrazi, Beighle, 2010). A second limitation was that the research tools were handled by each participant, and it was their choice to use either a pedometer, Fitbit or iPhone throughout the study. One such research tool may have recorded daily steps more accurately than others.

Third, although some results reported statistically significant, this does not necessarily imply practical significance. The low sample size may be associated with the low ability to detect significant differences. Also, the low sample size may make it challenging to generalize the findings beyond the participants.

Discussion

Throughout the 9-week study, the research team made a variety of discoveries. While investigating what differences, if any, existed between physical activity levels amongst students and faculty/staff, other interesting findings included the fact that students took a significantly higher number of steps on a daily basis than did faculty/staff.

This section will discuss each significant finding and elaborate on some noteworthy non-significant results.

1. Students took significantly more steps than faculty/staff ($\bar{x}$ student = 8,442 $\bar{x}$ faculty/staff = 5,890).

This finding helps raise the question of differences between student and faculty/staff activities while on campus. Most commonly, students need to travel from class to class, which may be in different buildings and/or on different floors, whereas faculty/staff may not be required to travel as much during the day. For example, a professor may teach a variety of classes in the same room or within the same vicinity. This finding could help faculty/staff to recognize more deeply that their daily travel needs are minimal; perhaps faculty/staff could build within their daily schedule a walk around an athletics field, or up and down some stairs prior to and/or after class.

2. Students took significantly more steps in Week 9 than Week 2 ($\bar{x}$ week2 = 7,849, $\bar{x}$ week9 = 9,666).

Interestingly, students took a significantly higher number of steps per day in Week 9 than Week 2. According to Figure 2, students seemed to demonstrate more willingness to engage in physical activity (i.e. steps) as the study progressed. This could be the result of several reasons such as, the step-counting technology helped motivate them to take more steps (e.g. motivated by technology's immediate feedback), the daily schedule required more steps as the semester progressed, the weather could have played a factor as the months from February to late-April can bring on some very cold to much warmer weather in northern Alberta, Canada. For example, as the weather warmed up, perhaps the students decided to become more physically active. Further, it seemed as if the participants were keenly motivated in the beginning, then slowed down, as reflected in the lower step counts in the middle, and were possibly more motivated towards the end of the study. This may be a qualitative question in

the making: *What were participants experiencing through the study's different time periods?* Overall, the students appeared to have higher motivation to increase their step productivity. Faculty/staff data reflected a steady output; it could be that their routines were fixed. Whereas, the students have a more or less flexible schedule and, with the added step-count study, could consciously make an effort to increase their output. That said, an interesting question raised by a student was: *How many participants were students from a particular program (e.g. Education)?* In this individual's words: *I know my steps increased throughout the study due to my professional practicum experience.*

3. There was a significant overall negative correlation found between average steps and overall weight ($r = -0.43$). Although there might be a connection between steps and weight (i.e. as weight goes up, number of steps tend to stay the same or decrease), the direction of the relationship remains unclear. Moreover, another statistically significant finding included *significant negative correlations in Week 2 ($r = -0.617$) and in Week 8 ($r = -0.547$) between steps and weight for faculty/staff*, but not for the other weeks, which is likely due to the small sample size as several weeks showed similar correlation coefficients but were not large enough to be considered significant. While it is important to not rule out other factors when interpreting these findings, the information may help lead to further research questions in terms of physical activity and weight.

4. There was no significant difference found in steps taken by faculty/staff between Weeks 2 and 9. Unsurprisingly, no significant difference was found here if it is thought that faculty/staff responsibilities during the day remain quite close to a classroom, office, etc. With this, it is noteworthy that faculty/staff took the most steps on Saturdays ($n = 6,174$), while Sundays could be noted as a true 'day of rest' as the number of steps decreased to 5,524. This information again helps raise the question of whether faculty/staff could use some additional physical activity during the day such as a walk around the athletics field prior to and/or after class. However, this non-significant finding helps explain that throughout the 9-week study, faculty/staff maintained a level of consistency in daily steps; as the study progressed, there was no sign of the effect of faculty/staff becoming motivated by the immediate daily step-counting technology feedback.

5. There was no significant correlation found for students between steps and weight. Although weight measurements were not a focal point of the study, the research team thought the weekly recordings may add another level of understanding. Although it was found that the students recorded significant increases in daily steps throughout the study, exercise intensity was not recorded. Although more steps were taken in Week 9 than Week 2, this does not reveal the level of exercise intensity. Hence, although more steps were taken by students as the 9-week study progressed, their level of exercise intensity could have remained low, without any weight change.

Implications for future research

These findings can add to literature results by furthering understanding about physical activity levels on an academic campus. Although the findings cannot be generalized beyond the participants, what has become most helpful is the plethora of questions that arose for future research, such as:

- did the time of the academic year (i.e. Winter Semester) impact the data?
- can tracking daily steps (i.e. step-counting technology) provide extrinsic motivation for increased physical activity levels?

Future research should explore such queries, and whether or not other post-secondary institutions discover similar findings. Also, further research could focus upon exploring potential barriers impacting physical activity levels on all sizes of post-secondary campuses.

Conclusion and recommendations

Physical activity is an essential wellness component, and with post-secondary campuses focusing more and more on campus wellness, it is clear that physical activity levels must remain a considered variable. This study took aim at discovering if any physical activity level differences (i.e. steps per day) exist between students and faculty/staff on a small Canadian post-secondary campus.

Stemming from the findings, the differences between student and faculty/staff daily responsibilities may impact their physical activity levels. That said, it is worth noting that faculty/staff should strive to include more steps per day (i.e. increasing their physical activity levels) by setting aside a few moments at different times for a quick walk or exercise break.

Clearly, this study provides a basis for further investigative work in the area of physical activity levels measured through step-counting technology, along with continuing to inform students and faculty/staff across post-secondary campuses about the importance of daily physical activity and its direct relation to wellness. The findings add to literature related to tracking daily steps (i.e. step-counting technology) and physical activity levels. Therefore, the prescription of a walking program as an example of a first step toward a healthy level of wellness is recommended. This is particularly important as walking limits few, is easily accessible for most individuals, and requires no expensive equipment, and time rather than steps can be used as a target goal (Morgan, Tobar, Snyder, 2010).

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RATING TRAINING LOAD OF DISABLED SWIMMERS IN GENERAL PREPARATION SUB-PERIOD

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Abstract The aim of the work was to assess the training loads of disabled swimmers in the comprehensive preparation sub-period. The research was carried out on 12 swimmers of the WZSN "START" Wrocław swimming club section. All swimmers started in the "S" start group. The average age of swimmers was 24 years and the average training time was 8 years. The pulse rates were analyzed 6 times during the training, just before the training, in the 10th minute of the warm-up, in the 45th minute at the peak of the training, in the 80th minute, in the 90th minute immediately after the training, and in the 105th minute after the rest. A Polar 810i Sport-tester was used to evaluate the heart rate. Statistical analysis was used. For all the swimmers the average heart rate values after 15 minutes of rest did not return to resting heart rate values. In addition, the swimmer's fatigue was assessed using the Borg scale. The training load was moderate, and on the Borg scale, the swimmers assessed their fatigue as very heavy.

Key words training loads, swimming by people with disabilities, general preparation sub-period

Introduction

The level of sport swimming in people with disabilities has increased significantly in recent years. Competitors divided into groups and starter classes are achieving increasingly better sporting results in virtually all swimming competitions (Seidel, Bolach, Kachnikiewicz, Walowska, 2012; Zając, Seidel, 2007).

In the functional classification, three starter groups are distinguished: "S" – freestyle, backstroke and butterfly, "SB" – classic, and "SM" – medley (Uścińowicz, Seidel, Zastawa, Klich, 2013). In the annual training cycle, three periods are distinguished: preparatory, starting, and transitional. According to W. Seidel et al. (2012), the preparatory period is a long training cycle and is divided into three sub-periods:

- general preparation to develop strength, endurance, speed, and swimming technique,
- targeted preparation of increased effort,

- special preparation of improving swimming technique and speed endurance.

The training load consists of increasing the amount and intensity of swimming across the training sub-ranges. The easiest method of evaluating training intensity is by measuring the heart rate (HR). The training load and selection of training measures are related to many factors such as: age, gender, fitness, and the degree and type of disability. The principle of “super-individualization” is the individual adaptation of the training to these factors, as well as to the predisposition, and the distance the athlete chooses. Therefore, the training process for disabled swimmers is much more difficult than with able-bodied people, both in planning and implementation (Costill, 1998; Karpiński, Sachnowski, Oprychał, 2005; Szafraniec, Seidel, Kruszyna, Żurowska, 2012; Zatoń, Jaszak, 2008; Żurowska, Seidel, 2009).

Aim of the study

The aim of the study was to assess the training loads of disabled swimmers in the general preparation period.

Material and research methods

12 swimmers from WZSN “Start” Wrocław were studied. The competitors started from four sporting and medical groups:

1. From group I – classes B2 and B3.
2. From group III – classes A2, A3, A4 and A8.
3. From the fifth class group – LA5 and LA6.
4. from the sixth class group – CP5, CP7 and CP8.

In terms of functionality, they participated in in classes “S7” to “S13” of the “S” start group. The most numerous groups were amputated and dysfunctional swimmers with lower limb dysfunctions. Six of the swimmers used orthopedic equipment for mobility. The age of the swimmers ranged from 14 to 43 years (average 24 years) and had a swimming experience from 3 to 16 years (average 8 years) (Table 1).

Table 1. Characteristics of the disabled swimmers

Age	Experience (in years)	Education	Sporting medical class	Start class	Type of dysfunction
34	11	Secondary	B2	S12	Visually impaired
21	6	Secondary	B3	S13	Visually impaired
20	13	Secondary	A2	S9	Unilateral thigh amputation
19	4	Secondary	A3	S8	Bilateral amputation of the lower leg
14	7	Basic	A4	S10	Unilateral amputation of the lower leg
16	7	Basic	A8	S9	Dysmelia – hypoplasia of the left upper limb
17	9	Basic	LA5	S10	Limiting the range of motion in the hip joint
30	3	Higher	LA5	S10	Ankle joint stiffness
29	12	Higher	LA6	S10	Total hand failure
19	5	Secondary	CP5	S7	Cerebral Palsy
27	16	Higher	CP7	S7	Cerebral Palsy
43	3	Higher	CP8	S8	Spasticism of both lower limbs following craniocerebral trauma

Research Method

The tests were performed in January 2018 during the comprehensive preparation sub-period, in the final 10-day microcycle. Heart rates (HR) were analyzed at 6 moments of the training unit: immediately before training, in the 10-minute warm-up, at the peak of the training (at 45 minutes), in the final part of training (at 80 minutes), immediately after the training (at 90 minutes) and after 15 minutes of rest. A Polar 810i chest mounted heart rate sensor was used to assess heart rate. Additional braces were also used to hold the strap around the chest at high speeds. The level of fatigue was assessed using the Borg scale (no fatigue – 1, maximum fatigue – 20).

The level of significance in the analysis was $p < 0.05$. Calculations were made using the Statistica program. The relationship between the pulse rate and the factors considered was assessed using Student's t-test in independent groups, and the Pearson linear correlation coefficient was determined (Luszniewicz, Słaby, 2001).

Results

Heart rates during the general preparation training period

A noticeable increase in pulse was seen during the first 45 minutes, up to the training peak, after which it progressively decreased. The heart rate variation was not very high (coefficient of variation did not exceed 10% at each of the tested training moments). After the 15-minute rest, the heart rate gradually slowed toward the initial value, but did not reach it (Table 2).

Table 2. Average heart rates (HR) during the general preparation training units

Pulse	$\bar{X}$	SD	Minimum	Maximum
Resting	77.0	3.9	72	84
At 10 min.	142.3	6.8	131	153
At 45 min.	200.0	10.4	182	216
At 80 min.	160.3	6.4	147	171
At 90 min.	114.8	6.5	104	126
After 15 min. rest	84.6	5.4	75	91

The fastest changes in average heart rate were found in the first and last 10 minutes of training. The rate of increase between 10 and 45 minutes was faster than the decreases between 45 and 80 minutes (Figure 1).

In the first 10 minutes of warmup exercises, the average heart rate rose by 6.5 ($142.3 - 77 = 65.3$) beats per minute (bpm). A similar result could be seen in the last 10 minutes, where the value was 4.5 bpm. It should be noted that the rate of decline in average heart rate after 15 minutes of training was slower than during 10 minutes of dissolution (Figures 2 and 3).

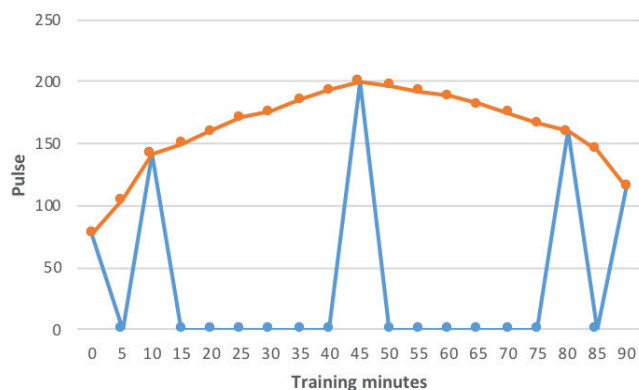


Figure 1. Average heart rates during the general preparation training

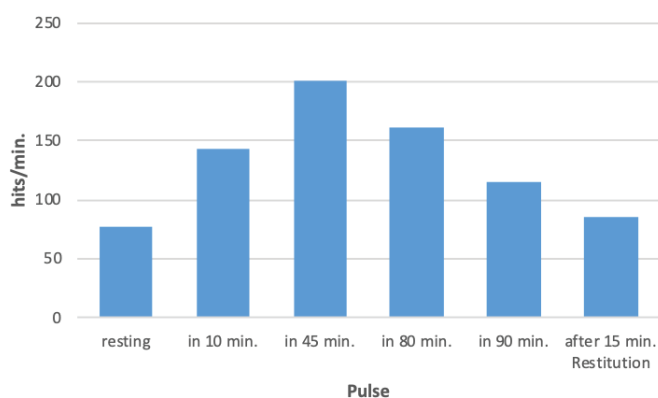


Figure 2. Average heart rates at selected moments of the general preparation training

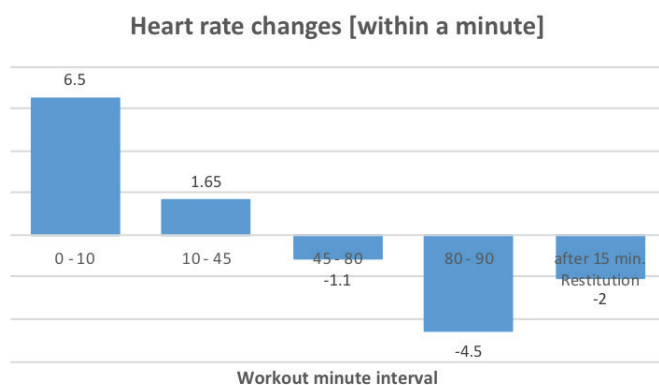


Figure 3. Average rate of pulse change [HR] at selected times of the training units in the tested microcycle (a negative value means a decreasing heart rate)

After 15 minutes of rest, the average HR value was higher than the average resting heart rate. These differences ranged from 2 to 16 bpm. The difference between these measurements was statistically significant (Table 3).

Table 3. Comparison of average resting heart rate (HR) and after 15 minutes rest

Pulse	$\bar{X}$	SD $\pm$	Average difference	Student Test	
				t	p
Resting [T0]	77.0	3.9	+7.6	5.71	0.0001
After 15 min. rest	84.6	5.4			

Changes in heart rate after a 15-minute rest were correlated with mean resting heart rate values ($r = -0.5$). The negative sign of the correlation coefficient was surprising, which means that the swimmers who had a higher peak heart rate after 15 minutes of rest had a similar heart rate value to the resting value than people who had a lower peak heart rate (Table 4).

Table 4. Average peak heart rate values depending on the difference between resting heart rate and after a 15-minute restitution

Difference between resting heart rate and pulse after rest [T0 – Test]	Peak heart rate (bpm/bpm)		Student Test	
	$\bar{X}$	std. dev.	t	p
<5	205.3	8.8	1.96	0.108
>10	190.7	11.0		

The rate of change in average heart rate in the first and second half of training had a correlation to the difference between the resting heart rate and the rate after 15 minutes of rest. Both correlations were negative, which shows that the faster the average heart rate increased in each part of the training, the closer the pulse rate after 15 minutes of rest was to the resting pulse rate. The most significant difference was the change in average heart rate from the peak to the final. This correlation was stronger and statistically significant (Table 5).

Table 5. Correlation of average heart rate changes between resting heart rate and after 15 min rest

Changes in heart rate	Correlation with ($T_0 - T_{rest}$)	
	r	p
$T_{max} - T_0$	-0.43	0.165
$T_{max} - T_{90}$	-0.65	0.023

Average changes in heart rate and fatigue according to Borg scale

Disabled swimmers described their fatigue after training as severe, with most of them as very severe (Table 6).

The examined swimmers rated their level of fatigue within 15–19 points of the Borg scale ranking, with an average of 17.25 points and a standard deviation of 1.22 points. The fatigue felt by the swimmers was slightly related

to the peak pulse value. The Pearson linear correlation coefficient $r = 0.13$ and was not statistically significant. However, it was found that clearer correlations of the subjective feeling of fatigue were associated with the pace of changes in the second half of the training, and the difference between the average resting heart rate and after the rest. Correlations had opposite signs, which meant that a greater decrease in heart rate between 45 and 90 minutes of exercise were related to higher fatigue after training (Table 7).

Table 6. Subjective assessment of fatigue of disabled swimmers according to the Borg scale

Evaluated effort	Borg score	Indications	
		n	%
Hard	15–16	3	25
Very hard	17–18	7	58
Maximum	19–20	2	17

Table 7. Correlations of average heart rate changes with subjectively felt fatigue according to the Borg scale

Changes in heart rate	Correlations with fatigue on the Borg scale	
	r	p
$T_{\max} - T_0$	0.19	0.553
$T_{\max} - T_{90}$	0.31	0.328
$T_0 - T_{\text{rest}}$	-0.30	0.338

Summary

Training loads depend on many factors, such as the style in which a sportsperson specializes (Jeffrey, Bauerle, 2004; Karpiński et al., 2005; Morouco et al., 2011; Neiva, Fernandes, Vilas-Boas, 2011; Ogonowska, Hubner-Woźniak, Kosmol, Gromisz, 2009; Skórka, Ogiermann, Wilk, 2011). In styles where the lower limbs do more work, more energy is derived from anaerobic sources. Over long distances, energy sources derive from oxygen sources. In training at an intensity of approximately 80% $VO_{2\max}$, the heart rate should be between 120 and 150 bpm (Kosmol, Hugner-Woźniak, Staniszewski, Słomiński, 2000; Morouco et al., 2011; Neiva et al., 2011; Skórka et al., 2011; Szafraniec et al., 2012). Similar values were obtained for the tested disabled swimmers from “Start” Wrocław in the initial and final phases of effort. However, with an increase of training load to 90% $VO_{2\max}$, the heart rate rose to 170 bpm. In this case, one could speak of shaping aerobic fitness. The swimmers obtained similar pulse rates at 30 and 70 minutes of training. In contrast, heart rate values at the peak of the training unit indicated a training load of up to 95% $VO_{2\max}$, which meant that the load is anaerobic lactic acid.

K. Zatoń and M. Jaszczak (2008) examined a group of 9 athletes from the Polish Olympic swimming team and found that the intensity of effort of the competitors was within the scope of aerobic training. Anaerobic and mixed effort was much less frequent. According to D.L. Costill (1998), training should oscillate more within the range 120–150 bpm, i.e. medium oxygen intensity training. However, at the time of the main training task, anaerobic loads should prevail. This training pattern is designed to increase the strength of players.

In conclusion, it should be noted that the load during training is significant, as indicated by the fatigue values given by the competitors on the Borg scale and peak heart rate values, as high as 185 bpm. This is also confirmed by the fact that none of the competitors had a pulse rate return to the resting heart rate after the 15-minute rest. Aerobic effort prevailed in the training unit, while at the time of the main task this effort was mixed, and even anaerobic.

Conclusions

1. The pulse value of any of the swimmers after 15 minutes of rest did not return to the resting value.
2. Disabled swimmers experienced significant training loads in the studied microcycles of the general preparation sub-period.
3. On the Borg scale swimmers rated their fatigue as very severe.

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SENSE OF GENERALISED SELF-EFFICACY AND PRO-HEALTH BEHAVIOURS OF POLISH AND SPANISH PHYSICAL EDUCATION STUDENTS

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Abstract The aim of the study was to assess the relationship between the sense of generalised self-efficacy and the level of pro-health behaviours among Polish and Spanish physical education students.

The study was conducted among 499 physical education students (219 Polish and 280 Spanish). The Inventory of Health Behaviours (IZZ) by Z. Juczyński and the Generalised Self-Efficacy Scale (GSES) by R. Schwarzer, M. Jerusalem and Z. Juczyński were used. Among the categories of healthy behaviours included in the Inventory of Health Behaviours (IZZ), the physical education students obtained the highest average results in the area of positive mental attitude (22.26), less in the pro-health practices (20.10) and proper eating habits (19.85), and less again in the area of preventive behaviours (18.97). Statistically significant positive correlations were found between the intensification of the generalised sense of self-efficacy and the levels of positive mental attitude ($p = 0.024$) and preventive behaviours ($p < 0.001$). The moderating influence regarding home country on relationships between the generalised sense of self-efficacy and general index of pro-health behaviours ($p = 0.024$) was also demonstrated; in the case of the Spanish students the level of pro-health behaviours increased, but for the Polish students it decreased.

Key words pro-health behaviours, generalised self-efficacy, physical education students

Introduction

A pro-health lifestyle, e.g. rational food choices, physical activity, avoidance of psychoactive substances, constructive coping with stress, and implementing preventive behaviours, is the basic determinant of holistically defined health (WHO, 2004; Gray, 2017). In many countries, physical activity and a rational nutrition model as basic health-promoting behaviours have been included in the canon of basic aspects of a healthy lifestyle (<http://www.fao.org/nutrition/education/food-dietaryguidelines/regions/europe/en>).

The key significance of lifestyle and pro-health behaviours requires health-oriented attitudes at all stages of ontogenesis, with particular emphasis on children and adolescents. Healthy behaviours, as behavioural determinants of health, are shaped in the process of socialisation as a result of the impact of norms and patterns functioning in a given environment. In this context, school health education (at all of its stages) is important, in which teachers of all specialisations, including physical education teachers, are involved. School health education aims to shape healthy attitudes in children and adolescents, along with positive attitudes towards behavioural determinants of health that affect the proper development of children and adolescents.

The effectiveness of teachers' work in the field of health education depends, *inter alia*, on their individual attitudes towards behavioural determinants of health. The importance of teachers' pro-health behaviours for shaping students' lifestyles has been confirmed, among others, in American, Chilean and Chinese studies (Rossiter, Glanville, Taylor, Blum, 2007; Findholt, Izumi, Shannon, Nguyen, 2016; Montenegro, Salinas, Parra, Lera, Vio, 2014; Chang, Liao, Chen, Niu, Hsieh, 2017). A health-conscious teacher is a more credible health educator, as indicated by the teachers themselves (Schee, Gard, 2014; Moynihan, Paakkari, Välimaa, Jourdan, Mannix-McNamara, 2015). Despite the key role of a healthy lifestyle in raising health potential, in numerous studies the prevalence of anti-health behaviours has been shown in the lifestyle of various population groups, including academic youth with a teaching educational profile (Deasy, Coughlan, Pironom, Jourdan, Mcnamara, 2015; Kosiba, Gacek, Bogacz-Walancik, Wojtowicz, 2016a; Monhollen, Summers, Sabin, Rutherford, 2016; Yahia, Wang, Rapley, Dey, 2016).

The implementation of health education by teachers has been recorded in the core-curriculum documents of many countries. In Poland, the role of a teacher in school health education has been included in the core-curriculum of general education (Journal of Laws 2017, Item 356) and in the educational standards preparing to perform the profession of a teacher (Journal of Laws of 2019, Item 1450). Also in Spain, in the decrees of autonomous communities, tasks related to shaping attitudes and behaviours conducive to health were included as objectives of general education (Decreto 97/2015 from 3rd March).

Pro-health behaviours are determined by a wide spectrum of socioeconomic, cultural and personality-related factors (Remick, Polivy, Pliner, 2009). Among the psychological features important for the development of health culture, personal resources occupy an important place, including those related to a generalised sense of self-efficacy (Juczyński, 2012). Sense of self-efficacy, as a belief in the ability to achieve intended goals, is conducive to exercising control over behavioural factors conditioning holistically defined health (Juczyński, 2012). To date, research on the determinants of different areas of lifestyle among physical education students and of other teaching specialisations has concerned satisfaction with life (Kosiba, Gacek, Wojtowicz, Bogacz-Walancik, 2016b) and readiness for change (Kosiba, Gacek, Wojtowicz, 2019a).

The premise for undertaking the presented research was the assumption that health-related behaviours are a key determinant of health, and the personal resources of the subject play an important role in shaping them. The aim of the study was to assess the level of pro-health behaviours (according to the IZZ) together with the relationship between generalised sense of self-efficacy and the relationship to the intensity of pro-health behaviours, then to analyse the moderating importance of the country of origin in Polish and Spanish physical education students in relation to the examined correlations.

Materials and Methods

The study was conducted in 2017–2019 among 499 physical education students aged 18 to 35 (21.65 ± 2.42) of second and third year B.A. degree studies. Research included 219 Polish students (University of Physical Education in Krakow, $n = 135$, and the University of Physical Education in Wroclaw, $n = 84$) as well as 280 Spanish students (University of Murcia, Faculty of Sport Sciences, $n = 127$, and the University of Granada, Faculty of Sport Sciences, $n = 153$).

In the research, a diagnostic survey and two standardised research tools were used: the Inventory of Health Behaviours (IZZ) by Z. Juczyński, and the Generalised Self-Efficacy Scale (GSES) by R. Schwarzer, M. Jerusalem and Z. Juczyński (Juczyński, 2012). Based on the Inventory of Health Behaviours (IZZ), 4 categories of health behaviours (proper eating habits, preventive behaviours, pro-health practices, and positive mental attitude) and the general index of pro-health behaviours were assessed (Juczyński, 2012). To measure the sense of self-efficacy, the standardised Generalised Self-Efficacy Scale (GSES) by R. Schwarzer, M. Jerusalem and Z. Juczyński (Juczyński, 2012) was used. The GSES scale, containing 10 statements, is constructed in such a way that the higher the test result (within the range of 10–40 points), the higher the sense of generalised self-efficacy. Research was carried out in accordance with the principles of the 1964 Declaration of Helsinki after obtaining the subjects' informed consent to participate in the study.

The IBM SPSS 21 program and J.T. Newsom's macro were used for statistical calculations. Basic statistics of the studied variables were calculated (means and standard deviations). Pearson's correlation coefficient analysis was used to determine the relationships between variables, while moderation analysis with simple comparisons (simple slopes) was used to determine differences in the relationships between sense of self-efficacy and students' pro-health behaviours. The Student's *t*-test was applied to determine differences in the level of self-efficacy between students from Poland and Spain. The significance level of $\alpha = 0.05$ was adopted.

Results

Among the categories of pro-health behaviours included in the Inventory of Health Behaviours (IZZ), the physical education students obtained the highest average results in the category of positive mental attitude (22.26). The value for pro-health practices was 20.10 and proper eating habits was 19.85, while the value for preventive behaviours was 18.97 (Table 1).

Table 1. Level of pro-health behaviours among Polish and Spanish physical education students (descriptive statistics)

IZZ categories	N	Minimum	Maximum	Mean	Standard deviation
Positive mental attitude (PMA)	499	10.0	30.0	22.26	3.62
Preventative behaviours (PB)	499	6.0	30.0	18.97	4.05
Proper eating habits (PEH)	499	6.0	30.0	19.85	5.01
Pro-health practices (PHP)	499	7.0	29.0	20.10	3.64
IZZ total	499	15.0	113.0	50.27	29.14

In the analysis, no statistically significant difference in the level of self-efficacy was shown between the students from Poland and Spain ($t = -1.50$; $df = 497$; $p = 0.134$).

The conducted analysis on the relationship between the generalised sense of self-efficacy and pro-health behaviours for the entire group of students showed that along with the increase in generalised sense of self-efficacy, the level of positive mental attitude and preventive behaviour of the studied physical education students increased (Table 2).

Table 2. Sense of generalised self-efficacy and pro-health behaviours among Polish and Spanish physical education students (Pearson's correlation coefficient)

		PMA	PB	PEH	PHP	IZZ total
GSES	R	0.10 [*]	0.160 ^{**}	0.070	0.020	0.030
	p	0.024	<0.001	0.143	0.595	0.501
	N	499	499	499	499	499

^{*}p < 0.05; ^{**}p < 0.001.

Analysis was also conducted on how the relationship between the generalised sense of self-efficacy and the level of pro-health behaviours changes depended on the country of origin of the physical education students (Table 3). It has been shown that the country of origin may be considered as a moderator of the relationship of self-efficacy with the overall indicator of pro-health practices. Among the physical education students from Spain, the higher the level of generalised sense of self-efficacy, the higher the general level of pro-health behaviours, while among the students from Poland this relationship was negative, i.e. along with the increase in self-efficacy, the general level of pro-health behaviours decreased (Figure 1).

Table 3. Moderation analysis – moderating variable: country; independent variable: GSES

Ind. var.	Moderator	Dep. var.	B	SE	T	P	Interaction
GSES	Country	Positive mental attitude	-0.04	0.07	-0.59	0.552	$\beta_P = 0.12$ ($p = 0.080$) $\beta_S = 0.07$ ($p = 0.229$)
		Preventative behaviours	0.09	0.07	1.35	0.176	$\beta_P = 0.09$ ($p = 0.217$) $\beta_S = 0.21$ ($p < 0.001$)
		Proper eating habits	-0.02	0.07	-0.34	0.734	$\beta_P = 0.09$ ($p = 0.209$) $\beta_S = 0.06$ ($p = 0.317$)
		Pro-health practices	0.09	0.07	1.38	0.168	$\beta_P = -0.07$ ($p = 0.335$) $\beta_S = 0.06$ ($p = 0.318$)
		IZZ Total	0.16	0.07	2.27	0.024	$\beta_P = -0.10$ ($p = 0.158$) $\beta_S = 0.11$ ($p = 0.065$)

Key: β – standardised coefficient Beta; SE – standard error; p – significance; P – Poland; S – Spain.

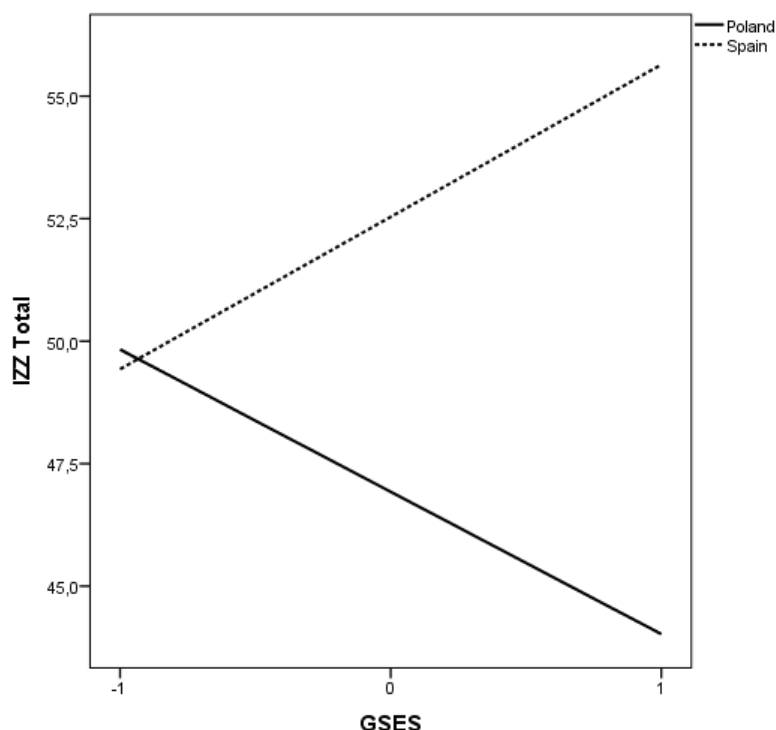


Figure 1. Correlation between sense of self-efficacy and total level of pro-health practices depending on physical education students' home county (Poland vs. Spain)

Discussion

In the discussed research, some statistically significant relationships were demonstrated between the generalised sense of self-efficacy and the health behaviours. The moderating influence of the students' home country was also statistically significant. The Polish and Spanish physical education students, in among four categories of health-promoting behaviours (positive mental attitude, proper eating habits, preventive behaviours and pro-health practices), obtained the highest results in terms of positive mental attitude (positive thinking, caring for proper relations with others, avoiding negative emotions and mental strain), and so-called pro-health practices (adequate sleep and rest, recreational physical activity, and limiting stimulants). They implemented proper eating habits to a slightly lesser extent, and preventive behaviours also a bit less (compliance with medical recommendations, regular medical check-ups). The demonstrated high level of health-promoting behaviours in the domain of positive mental attitude and the so-called pro-health practices (including recreational physical activity) among physical education students may be associated with the educational profile of the studied group of academic youth oriented toward increased physical activity, which is an important factor contributing to the optimisation of mental state. Relatively high results in the so-called pro-health practices domain (including, but not limited to, physical activity) correspond, at the same time, to trends described in other studies, confirming a higher level of physical activity of physical education students compared to students with a different educational

profile (Fagaras, Radu, Vanvu, 2015; Bednarek, Pomykała, Bigosińska, Szyguła, 2016; Yager, Gray, Curry, McLean, 2017; Kosiba, Gacek, Wojtowicz, Majer, 2019b). In another study, Spanish physical education students were also characterised by a more healthy lifestyle and more favourable body composition as well as blood lipid profile than students of other university specialisations, which is related to the educational profile focused on promoting an active and healthy lifestyle (Grima, Blay, 2016).

The obtained results also correspond to the tendencies described in other groups of Polish students of teaching specialisations, including physical education, in which it was shown that the students from the University of Physical Education (AWF Kraków), similarly to the students of other specialisations, obtained the highest results in the area of positive mental attitude and less in the category of preventive behaviours (Kosiba et al., 2019b). Similar trends were also described among students of Poznań universities and the Holy Cross University in Kielce, who showed the highest intensity of behaviours associated with positive mental attitude, and less regarding preventive and rational eating behaviours (Rasińska, 2012; Palacz, 2014). Similarly, students of Lublin Medical University mostly applied so-called pro-health practices, and to a lesser degree – preventive behaviours (Kropornicka et al., 2015). The lower level of healthy behaviours in terms of proper eating habits corresponds to the results of other studies among students with different educational profiles, which confirm the prevalence of numerous eating irregularities, in particular: irregular eating and low consumption of products with high nutritional density (vegetables, fruits, whole grain product, cereals, milk and its products). Nutritional irregularities have also been described both among Polish (Myszkowska-Ryciak, Kraśniewska, Harton, Gajewska, 2011; Rasińska, 2012; Misiarz Malczyk, Zoloteńka-Synowiec, Rydelek, Sobota, 2013; Szczodrowska, Krysiak, 2013; Grygiel-Górniak et. al., 2016), as well as in Chinese, Brazilian, Spanish and American students (Hu et al., 2016; Alvarenga Mdos, Lourenço, Philippi, Scagliusi, 2013; Navarro-Gonzalez, Periago-Caston, Vidana-Gaytan, Rodriguez-Tadeo, 2019; Yahia, Wang, Rapley, Dey, 2016). Insufficient vegetable consumption among students has also been confirmed in a systematic review of works from 2009–2018 (Rodrigues et al., 2019).

Regarding the future professional work of the physical education students surveyed, it can be assumed that students who present a higher level of pro-health behaviours would more effectively influence the development of pro-health attitudes in their students. This is suggested by the results of research in the USA which showed the importance of teachers' positive attitudes towards nutrition for the adoption of students' eating habits (Findholt et al., 2016; Rossiter et al., 2007). In this context, it seems extremely important to take actions conducive to rationalising food choices and other aspects of the lifestyle in physical education students, who, in their future work will be involved in the implementation of health education among children and youth.

In the authors' research, statistically significant positive correlations have been shown between the generalised sense of self-efficacy and the intensity of positive mental attitudes and preventive behaviours among Polish and Spanish physical education students. The found regularities are explained in the characteristics of the analysed dimension of personality and refer to the results of studies by other authors. Higher levels of healthy behaviours in terms of positive mental attitude and preventive behaviours among students with a high sense of self-efficacy may be associated with their belief in the possibility of achieving specific goals, such as health, by exercising control over health determinants, holistically defined as striving for psychophysiological balance. As well as being a friendly environment, a healthy lifestyle denotes a genetic capability and the availability of medical care, a basic determinant of health (WHO, 2004; Gray, 2017). In another study on Polish university students, a positive impact has been demonstrated regarding positively correlated psychological traits, including a sense of self-efficacy, coherence,

and optimism on students' pro-health behaviours (Posadzki, Stockl, Musonda, Tsouroufli, 2010). In a Turkish study, a relationship has also been found between locating a sense of health control and a sense of health-related efficacy, as well as student pro-health behaviours (Açıkgöz Çepni, Kitiş, 2017). The predictive importance of a generalised sense of self-efficacy on the scale of pro-health behaviours has also been confirmed among Japanese and Chinese students (Sato, 2017; Xu et al., 2017). In M. Lipowski's research (2012), a positive correlation between the level of optimism and the level of efficacy and some health behaviours of women practicing sports was found. The predictive importance of a generalised sense of self-efficacy on the level of physical activity has been confirmed among Chinese, Malaysian, British, South Korean and Australian high-school students (Chung-Yan, 2014; Ler, Wee, Ling, 2017; Blake, Stanulewicz, McGill, 2017; Lee, Park, Lee, Kim, Park, 2018; Plotnikoff, Costigan, Karunamuni, Lubans, 2013). Unlike the results obtained in this study which did not show a correlation between the level of self-efficacy and the intensity of proper eating habits among physical education students, other studies have shown a larger scale of rational dietary choices with a high level of effectiveness. Such trends have been described, among others, for people practicing sport, including juniors training football, Polish American football players, athletes practicing individual disciplines (Gacek, Frączek, 2013; Gacek, 2015; Gacek, 2019) and women recreationally undertaking fitness (Gacek, 2017), as well as professional soldiers (Gacek, 2018). Different trends in this area may result from the limited number of diagnostic questions regarding diet in the Inventory of Health Behaviours by Z. Juczyński (2012), who themselves suggest the need for further in-depth research.

The modern holistic concept of health emphasizes the key importance of a healthy lifestyle, not only for strengthening health potential, but also for improving quality of life. In studies among students of teaching faculties, it has been shown that adolescents with a greater intensity of healthy behaviours (in terms of positive mental attitude, daily pro-health practices, proper eating habits, and preventive behaviours) were also characterised by a higher level of life satisfaction (Kosiba, Gacek, Bogacz-Walancik, Wojtowicz, 2017).

Referring to the results indicating positive relationships between a generalised sense of self-efficacy and health-promoting behaviours, it should be pointed out that strengthening one's own efficacy, including through psychological techniques, may promote a healthy lifestyle and in consequence strengthening the health, which has been confirmed by British authors (Ashford, Edmunds, French, 2010).

The results obtained in this study on the moderating impact of the home country (Poland vs. Spain) in relation to the studied dependencies (sense of efficacy vs. the level of pro-health behaviours), showed that the country of origin can be considered a moderator of the self-efficacy relationship with the general indicator of health-oriented behaviours, but only among the physical education students from Spain, where the higher the intensity of the generalised sense of self-efficacy, the higher the overall level of health-promoting behaviours. This was different from the students from Poland, in whom the overall level of health behaviours decreased as the sense of self-efficacy increased. Assuming that personality is an intercultural trait, the relationships between pro-health behaviours and personality traits in different cultures could be the same. There are no publications in literature on the moderating importance of the country of origin in relation to the studied dependency of efficacy vs. pro-health behaviours. There are systematic reviews regarding the determinants of physical activity, but they did not clearly identify the moderators of the relationship between personality and physical activity (Wilson, Dishman, 2015). Perhaps the special emphasis on health education from an early age in Spain (written in the decrees of individual autonomous communities) positively moderates the relationship between the generalised sense of self-efficacy and the intensity of health-promoting behaviours. In other studies aiming to compare the health behaviours of Polish and Spanish

physical education students (Gdańsk vs. Murcia), the differences between some aspects of lifestyle was confirmed, where Spanish students showed a higher level of physical activity and consumed more seafood and dairy products, less often reaching for sweetened sodas and alcoholic beverages or tobacco. In turn, Polish students consumed more vegetables and liquids. Regardless of the students' country of origin, it has been suggested to rationalise student lifestyle in a way that promotes early prevention of chronic diseases, such as obesity and diabetes (Lopez-Sanchez et al., 2019). These lifestyle differences can originate in different cultures, traditions and climatic factors (Northern vs. Southern Europe), and also from the implementation of effective health policies (Lopez-Sanchez et al., 2019). The cited authors also indicate the need for repeating research in various regions of Poland and Spain, something which was attempted in this study.

Further research on the psychological determinants of health behaviours among physical education students should consider a broader spectrum of the group (also other years and levels of study) and a larger number of analysed variables.

Conclusion

1. Polish and Spanish physical education students, among the pro-health behaviours included in the IZZ, obtained the highest scores in the category of positive mental attitude, lower in terms of pro-health practices and proper eating habits, and less again in the domain of preventive behaviours.

2. Statistically significant relationships between the level of the generalised sense of self-efficacy and the intensity of certain categories of pro-health behaviours (positive mental attitude and preventive behaviours) have been demonstrated among Polish and Spanish physical education students.

3. Among Polish and Spanish physical education students, the moderating influence of their home country on the relationships between the generalised sense of self-efficacy and the general indicator of pro-health behaviours have been demonstrated, with an increase in the scale of pro-health behaviours along with the intensification of the generalised sense of self-efficacy among the Spanish students and a reduction in the Polish students.

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MORPHOLOGICAL CHARACTERISTICS, ASSESSMENT OF HYPERMOBILITY AND PAIN THRESHOLD OF RUGBY PLAYERS

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Abstract Body build is an important factor in achieving success in sport. One sport that is less investigated, in terms of player morphological characteristics, is rugby 7s. Rugby 7s with 7 players in a team was derived from the classical Rugby Union with 15 players. A team of rugby 7s consists of scrum and offensive formations. As a contact sport, rugby carries the risk of numerous injuries for its players. The aim of the study was the morphological characterization and assessment of body composition, hypermobility and pain threshold of rugby players, taking into account their tasks and position on the pitch during the game. The research carried out in Kaskada Szczecin team showed that the scrum players obtained considerably higher statistically significant values of body weight, BMI, fat content percentage as well as chest depth than the offensive players, who obtained statistically significantly higher values of muscle tissue percentage. The examined rugby players had a high pain threshold, however, no statistically significant differences between both rugby formations were found in the assessment of the pain threshold. The occurrence of hypermobility in the studied group of rugby players was determined at only 3.8%. Identification of potential factors such as pain threshold or hypermobility can provide additional information for trainers and physiotherapists, helping to minimize the risk of injury.

Key words rugby 7s, morphological characteristics, hypermobility, pain threshold, algometry

Introduction

Body build is an important factor in achieving success in sport. Knowledge of appropriate morphological features, body proportions, which vary for each sport, facilitates the process of selection and recruitment. Issues related to athletic build have been discussed in numerous research works and scientific studies, including both representatives of individual sports and team games (Pietraszewska, 1998; Pietraszewska, Stachoń, Burdukiewicz, Andrzejewska, Sieroń, 2016; Krakowiak, Cabrić, Sokołowska, Lewandowski, 2008; Krakowiak, Lewandowski,

Sokołowska, Čabrić, 2017). One of the less investigated sports, in terms of player morphological characteristics, is rugby 7s. This sport is derived from the classical Rugby Union that originated from football sports in the 19th century in the British Isles. The oldest written rules of the game were created in 1845 in the city of Rugby located in central England, which gave the name to the entire sport. Today, rugby associations exist in 170 countries, of which 117 are members of World Rugby. Matches are played with an oval ball.

The aim of the game is to ground the ball inside the opponent's point area behind the goal line of the pitch. In rugby, players from one team can only pass the ball backwards. If a mistake is made and the ball is thrown forward or falls out of the player's hands, the referee calls for a characteristic element of this sport called a scrum formation. The spectacularity of this sport is primarily based on the possibility of stopping the player with the ball by knocking them to the ground in an action called a "tackle". Only players who have the ball can be stopped by having their shirts, legs, arms, grabbed or body blocked. It is only permitted to tackle a player when both the legs are on the pitch. It is also forbidden to strike, kick or tackle above the shoulder (Powała-Niedźwiecki, 1997).

Rugby 7s with 7 players in a team was derived from the classical Rugby Union with 15 players in a team. In 2016, Rugby 7s was added to the Summer Olympic Games programme. The Polish national team takes part in competitions organized by Rugby Europe.

The rugby rules regarding seven and fifteen player teams are mostly similar, with changes designed to adapt the game to fewer players on the pitch. The match of Rugby 7s requires a great deal of physical effort, and therefore comprises 2 halves of 7 minutes. Moreover, due to the shorter time, matches in this type of rugby are conducted in the form of tournaments. In Rugby 7s, the team that scored points starts the game, while in Rugby Union the team that lost these points begins. The formation of the scrum in rugby sevens includes 3 players, and 8 in Rugby Union.

In 2016, Rugby 7s was added to the Summer Olympic Games programme. The Polish national team takes part in competitions organized by Rugby Europe. A team of rugby 7s, the type of game practiced in Poland, has 7 players on the pitch. It consists of scrum and offensive formations. Scrums in Rugby 7s consist of 3 players: the right and left props of the scrum and a hooker. The props are usually the tallest and strongest players on the pitch, whose main task is to hold the scrum and lift up the jumping players. The hooker is the most important player in the formation, as he brings the scrum together, is responsible for coordinating it and playing a set-piece fragment of the game, starting the game from the lineout, scooping back the ball in the scrum, is active in the defensive game, and often tackles. Behind the formation of the scrum there are offensive players, namely: scrum-half, fly-half, centre player and wing player. The scrum-half throws the ball into the scrum, starts most of their team's actions, and is greatly responsible for the team's tactics. Tasks of a fly-half include finding and exploiting gaps in the defence of the opponent. They are the best kickers on the pitch, set the pace of the game, and kick the ball forward to the centres or forward. Centre players have important roles in attack and defence. In the case of the latter, they often interrupt the opponent's attack, while in offence, they get the ball, break the defensive lines, pass the ball on, and overtake defensive players. Wing players, who most often are responsible for scoring "tries", are the last line of defence for their team (<https://www.pzrugby.pl>).

Rugby is a sport that is becoming increasingly popular in Poland. As a contact sport, it carries the risk of numerous injuries between players (Trzepizur, Bielecki, Jędrusik-Pawłowska, Cieślík-Bielecka, 2016). Therefore, it is extremely important to look for potential factors that may reduce the risk of injury. The aim of the study was the morphological characterization and assessment of body composition, hypermobility and pain threshold of rugby players, taking into account their tasks and position on the pitch during the game

Materials and Methods

The research covered players practicing RUGBY in the Kaskada Szczecin team, who take part in the Polish Rugby 7s League and Polish Rugby 7s Cup. The team also trains players appointed to the Polish national team in Rugby 7s. A positive opinion of the Bioethics Committee No. 10/KB/VI/2018 of June 21, 2018, was obtained for the conducted research. The study was performed in compliance with the Declaration of Helsinki.

The surveyed players were of chronological age from 18 to 35 years, while their professional experience ranged from 2 to 11 years. The players were divided into 2 group-formations according to the tasks and positions they occupy on the pitch during the game (Żyła, Stachura, Różańska, 2014).

Group 1 are SCRUM players (*props, hooker*), who are responsible for creating the scrum formation, i.e. starting a set-piece of the game. Group 2 are OFFENSIVE players (*scrum-half, fly-half, centre and wing players*), whose task is to play the ball and move it into the opponent's goal area, i.e. to score a try.

Information on the chronological age and professional experience of each player was collected. Morphological features were measured in accordance with the principles adopted in Z. Drozdowski's anthropometry (1992): body height (BV), body weight, torso length (sst-sy), upper limb length (a-da), lower limb length (sy-B), shoulder width (a-a), chest width (thl-thl), chest depth (ths-xi), hip width (ic-ic), shoulder circumference, thigh circumference, chest circumference.

Body composition measurements of body fat percentage, skeletal muscle percentage, body mass index BMI and PPM were performed using an Omron BF 511 body composition analyser.

Moreover, joint hypermobility was also assessed using the Beighton scale (Beighton, Grahame, Bird, 2012), consisting of an analysis of the mobility of selected peripheral joints and the spine. For each activity performed the patient was assigned points on a scale of 0–1. Obtaining at least 4 points indicated joint hypermobility. Movement was assessed for the right and left sides of the body. During diagnostics carried out with this scale, the player performed the following tasks: passive dorsiflexion of the fifth MCP (metacarpophalangeal) joint $\geq 90^\circ$; the ability to bring the thumb to the forearm; elbow hyperextension $\geq 10^\circ$; knee joint hyperextension $\geq 10^\circ$; the ability to place the hands flat on the ground while bending forward and keeping the knees straight (Beighton et al., 2012).

In the study group, pressure pain threshold (PT) was assessed using a pressure algometer manufactured by Quirumed. Algometry is a quantitative method for the assessment of tenderness that is commonly used in clinical practice (Chesterton, Sim, Wright, Foster, 2007). PT is defined as the minimal amount of pressure where the pressure sensation first becomes painful (Vanderweeën, Oostendorp, Vaes, Duquet, 1996). The PPT of the participants was measured by gradually increasing the pressure exerted by the head of the algometer, which was placed at an angle of 90 degrees, with a speed of 100 g/s until the pressure sensation first became painful (the participants were instructed to say 'stop' when they felt a painful sensation). A mean for three measurements was then calculated and used for the main analysis. A 30-second rest between each measurement was allowed. PPT was measured: the 1st dorsal interossei of the left hand (PPT1) and the tibialis anterior muscle (PPT2).

Descriptive statistics were used for material analysis, and Student's T test was used to assess the significance of differences in the parameters studied, assuming significance at the level of $p < 0.05$.

Results

Descriptive characteristics (values of arithmetic means and standard deviations) of chronological age, training experience and the analysed morphological features, as well as body composition, for all the rugby players were broken down by formation and presented in Table 1. It also includes the results of the significance of differences (Student's T test) for $p < 0.05$ in the tested parameters in groups of players, taking into account their tasks and position on the pitch during the game. Statistically significantly higher values, such as body weight, chest depth, BMI index and fat percentage, were recorded for the scrum players as opposed to the offensive players, who obtained statistically significantly higher values for the percentage of muscle tissue.

Table 1. Descriptive characteristics of the analysed parameters of rugby players (in total and divided into formations) and the results of the test of significance of differences in the examined features between players of selected formations

	All players n = 26		1st formation – scrum n = 14		2nd formation – offense n = 12		Student's T test
	M	SD	M	SD	M	SD	
Age (years)	24.73	4.20	24.93	4.01	24.50	4.41	0.258
Training experience (years)	5.14	2.34	4.92	2.14	5.43	2.69	-0.529
Height (cm)	181.43	3.76	180.59	4.16	182.42	2.96	-1.307
Weight (kg)	90.27	10.22	95.30	8.71	84.40	8.59	3.205
sst-sy (cm)	55.66	3.60	55.15	3.86	56.25	3.17	-0.797
Sy (cm)	91.25	2.57	90.82	2.80	91.75	2.18	-0.950
a-da (cm)	80.99	3.45	80.48	3.36	81.58	3.46	-0.822
a-a (cm)	42.66	2.04	42.71	2.10	42.61	1.97	0.124
thl-thl (cm)	32.23	1.71	32.40	1.61	32.04	1.80	0.531
ths-xi (cm)	23.12	2.20	23.89	2.53	22.21	1.21	2.214
ic-ic (cm)	34.65	1.54	34.74	1.20	34.53	1.86	0.335
L arm circumference (cm)	33.56	3.07	33.59	3.24	33.53	2.85	0.051
L thigh circumference	60.64	7.91	62.54	9.27	58.43	5.14	1.427
Chest circumference (cm)	104.12	6.42	105.79	7.64	102.16	3.75	1.572
Abdominal circumference (cm)	89.03	9.59	90.74	11.29	87.04	6.56	1.039
BMI (kg/m ²)	26.37	3.44	28.10	3.11	24.35	2.62	3.341
Fat tissue (%)	20.82	6.00	23.91	5.53	17.23	4.27	3.471
Muscle tissue (%)	38.63	3.04	37.08	2.67	40.45	2.35	-3.424

Difference statistical significance for $p < 0.05$ in bold.

The results of Beighton's hypermobility assessment of rugby players in total, and taking into account the division into formations, are presented in Table 2. Accordingly, only one player had JHS, i.e. obtained at least 4 points.

Table 2. Beighton's results of hypermobility assessment of rugby players in total and taking into account the division into formations

Hypermobility	All players n = 26		1st formation – scrum n = 14	2nd formation – offense n = 12
	n	%	n	N
Occurrence of JHS	1	3.8	1	0
No JHS	25	96.2	13	12

The results of the assessment of the pain threshold of rugby players in total and taking into account the division into formations and the assessment of the significance of differences between selected formations are presented in Table 3. No statistically significant differences were found in the assessment of pain threshold on both the dorsal interossei of the left hand (PPT1) and the tibialis anterior muscle (PPT2) in the analysed groups of 2 rugby formations.

Table 3. Results of the assessment of player pain threshold and significance of differences

	All players n = 26		1st formation – scrum n = 14		2nd formation – offensive n = 12		Student's T test
	M	SD	M	SD	M	SD	
PPT 1 (N/s)	12.98	3.01	13.17	2.98	12.79	2.77	0.337
PPT 2 (N/s)	13.42	3.11	13.92	2.87	12.92	2.91	0.879

Statistical significance for $p < 0.05$.

Discussion

In rugby, as in other team sports, players have different motor tasks to perform during the game. Thus, their different specializations are also closely related to the varied body build of players playing in different positions. The most intense form of work in rugby is the contact itself, which should be very dynamic and short. There are also sprints and runs, which involve passing several players by means of feints or quick contact or knocking down an opponent. All these efforts are brief, but of very high intensity, which is why players must demonstrate the development of maximum power or strength in a short period of time and repeat these efforts repeatedly in short intervals. The scrum players during the match take part in the contact phase for 14% of the time, while the offensive players only for 1.3% of the game time. Offensive players focus mainly on speed and endurance, while scrum player training regards mainly strength preparation (Gasik, Stupnicki, 2013). The tests carried out in the Kaskada Szczecin team showed considerably higher statistically significant values of body weight, BMI, fat percentage as well as chest depth for the scrum players as opposed to the offensive players. Players in the 2nd formation obtained statistically significantly higher values for the percentage of muscle tissue. When examining players from three teams of the Polish Rugby Ekstraliga, D. Pietranis, J. Janowski and K. Karpowicz (2017) showed differences in body structure between the scrum and offence formation and found that in the case of similar body height, the scrum players are characterized by a much higher body weight than the offensive players, which was also confirmed by our research.

The morphological characteristics and assessment of player body composition are an important element of selection and recruitment at the level of professional sport. However, in rugby, as well as other contact sports that carry the risk of numerous injuries, it is very important to identify as many factors as possible that determine the achievement of sports successes and can be helpful in minimizing the risk of injury.

The use of non-invasive testing methods for assessing player reactivity to stimuli – pain threshold or hypermobility can contribute to the optimization of the training process.

Pain is a specific sensation that plays a protective function, informing about the imminent damage. In the case of athletes, it indicates the limits of the physical capacity and is part of the sports experience (Pawlak, 2014). Differentiation in tolerance depending on the sport has been observed (Tajet-Foxell, Rose, 1995). In endurance sports, athletes show reduced pain sensitivity compared to strength sports (Assa, Geva, Zarkh, Defrin, 2019; Ceva,

Defrin, 2013). The studied rugby players had a high pain threshold; however, no statistically significant differences were found in an assessment of the pain threshold in groups of 2nd rugby formation. A higher pain threshold may help succeed in sport; however, it should be kept in mind that people with lower pain sensitivity are at risk of overload and injury (Neziri et al., 2011).

Joint hypermobility (JH) is a condition that causes joints to move beyond their normal range of motion. Joint hypermobility syndrome (JHS) refers to a situation where four or more joints can move beyond their physiological range (Reuter, Fichthorn, 2019; Skwiot, Śliwiński, Milanese, Śliwiński, 2019). The JHS clinical diagnosis uses the Beighton point system (Beighton et al., 2012). In the examined group of 26 rugby players, JHS was diagnosed in just 1 player. While hypermobility predisposes to selected sports such as ballet or dance, in the case of rugby players, it may also be the cause of an increased risk of injury to the musculoskeletal system. The occurrence of hypermobility is statistically significantly associated with the risk of musculoskeletal disorders. This correlation has been confirmed by many scientific reports (Reuter, Fichthorn, 2019; Scheper et al., 2013; Smith, Damodaran, Swaminathan, Campbell, Barnsley, 2005; Konopinski, Graham, Johnson, Jones, 2016; Decoster, Bernier, Lindsay, Vailas, 1999; Stewart, Burden, 2004). In the case of suspicion of the existence of hypermobility, it is important to correctly diagnose and modify the training program. The incidence of hypermobility in the population of people aged 20-30 is about 34% (Connelly, Hakim, Davenport, Simmonds, 2015; Russek, Errico, 2016). The occurrence of hypermobility in the examined rugby players was determined only at the level of 3.8%, which may indicate the correct selection for practicing this sport.

Conclusion

The complex interaction of identifiable factors determines the achievement of success in every sport. Learning as many of these factors as possible is very important for optimizing sport training, especially in sports such as rugby 7s, which are characterized by significant morphological diversity resulting from the motor tasks of players playing in different positions. Identification of potential factors such as pain threshold or hypermobility can provide additional information for trainers and physiotherapists, helping to minimize the risk of injury.

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SPORTS IN SCHOOLS IN THE PROVINCE OF VOLHYNIA IN THE YEARS 1921–1939

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Abstract The aim of this paper was presentation of sports in schools in the province of Volhynia in the years 1929–1939. Schools in Volhynia were diversified in terms of nationality. Apart from Polish schools, with Polish as a language of instruction and a subject, there were Polish schools with languages of national minorities inhabiting the Volhynia province, as well as Ukrainian, Czech, German, Russian, Yiddish, Hebrew, Yiddish-Hebrew and Utraquist schools.

In the years 1929–1939, there was rapid development of sports in schools in the province of Volhynia. This process was particularly visible in the second half of the 1920s and in the 1930s. School sport was particularly popular in secondary schools. Among sports, school children and adolescents practiced mainly athletics, sport games, shooting, water sports and winter sports. School Sports Circles and Clubs were organised. Sport competition was developed mainly at the local, district and provincial levels. In the 1930s, the representation of Volhynian (Lutsk) school district participated in national sports competitions. School sports contests between Kremenets Lyceum and "The Sulkowskis" Junior High School in Rydzyn, taking place in the years 1933–1938, were regarded as blue-ribbon school contests.

Apart from Kremenets, Dubno, Kovel, Luck and Równe were also regarded to be strong school sports centres in Volhynia.

Key words school sports, province of Volhynia, Kremenets Lyceum, sports competition

Introduction

The purpose of the paper is to present sports in schools in the province of Volhynia in the years 1921–1939. The national diversity of the inhabitants of the province of Volhynia force the adjustment of the system of education to such a situation. Apart from Polish schools, with Polish as a language of instruction and a subject, there were Polish schools with languages of national minorities inhabiting the Volhynia province, as well as Ukrainian, Czech, German, Russian, Yiddish, Hebrew, Yiddish-Hebrew and Utraquist schools (Archiwum Akt Nowych w Warszawie – AAN, Urząd Wojewódzki Wołyński – UWW, File Ref. 979/83, Report on the situation in Volhynia in September 1933 and 1934 together with the work plan for the Province of Volhynia, p. 43).

Ultraquist schools were introduced by the government act in 1924. They constituted the basic type of state school, whose message was “raising children of Polish and non-Polish nationality as good citizens” in mutual respect for their national identity (the Act of July 31, 1924, containing certain provisions on the organisation of schools; Journal of Laws 1924, No. 79, item 776, pp. 1212–1213).

In September 1934, there were 1,931 school facilities in the province of Volhynia, of which the vast majority – 1,745 – were state schools (AAN, UWW, Ref. No. 979/83, Report on the situation in Volhynia in September 1933 and 1934 together with the work plan of the province of Volhynia, p. 43). In the educational structure, majority of schools were public elementary schools (1,732) and private elementary schools (149). Majority of the teachers employed in those schools there were Poles (2,817), Ukrainians (472), Russians (100), Czechs (36) and Jews (23). In the school year 1933/1934, 362,108 children remained in school duty in the province of Volhynia, while 236,516 children attended schools (AAN, UWW, Ref. No. 979/83, Report on the situation in Volhynia in September 1933 and 1934 with a work plan for the province of Volhynia, p. 43; Kęsik, 2008). In 1938, 73.3% of pupils fulfilled their compulsory school attendance, and the number of elementary school pupils increased to 300,000. The effort to promote education was reflected in the decline in illiteracy. In the mid-1920s over 68% of the Volhynia population could not read and write, whereas in 1931 the percentage of illiterates fell to 47.8%. Against the background of the whole country, where this percentage was 23% at that time, it can be stated that it was a very backward area (Kęsik, 2008). The greatest cognitive significance on the subject is assigned to the works of Eligiusz Małołepszy, Teresa Drozdek-Małołepsza and Daniel Bakota (Małołepszy, Drozdek-Małołepsza, Bakota, 2017; Małołepszy, Drozdek-Małołepsza, 2019).

Sports competitions in schools at the local and provincial level

The first Interschool Sports Competition of general secondary schools was organised on May 23–24, 1925 in Rivne (*Wychowanie Fizyczne*, 1925, No. 3–4, p. 268). The competition took place on the sports field of the „Sokół” Gymnastic Society (TS). There were 18 male and 12 female teams registered for the competition. A total of 320 competitors participated in the event. The idea was to show the physical fitness of young people. The programme of the competition included team games as part of combined track and field events. A challenge award was prepared only for contestants competing in pentathlon (boys) and track and field triathlon (girls). The first place and the challenge award among boys were won by pupils of the gymnasium in Rivne. Among female teams, the first place and the trophy were won by female contestants from the gymnasium in Zdobuniv. The competition programme also included track and field tetrathlon for boys for two age groups – from 12 to 15 years old and from 15 to 18 years old. The team from Kovel won in the younger age group, and in the older age group the team from Volodymyr-Volynskyi won the contest. There was also tetrathlon for girls between 12 and 15 years old. Out of 5 competing teams the first place was won by the girls from Lutsk. As part of the sports festival, school teams of *Przysposobienie Wojskowe* (PW) competed. 10 teams took part in the shooting competitions, and 12 players competed in bayonet fencing. Shooting competition took place over a distance of 100 m to a target with 10 rings without backrest. The team of the Teacher Training Seminary from Lutsk won the competition. In bayonet fencing the students of the School of Commerce in Rivne – Generowicz and Wiśniewski – turned out to be the best. Three teams took part in the competition of the PW school corps. The Cadet Corps of the “Juliusz Słowacki” State Junior High School in Kovel distinguished themselves in the PW competition (*Księga pamiątkowa...*, 1926, p. 21).

The successive competition (inter-school) took place on June 18–20, 1926 in Lutsk. Primary school students were invited to participate. In order to popularise and increase the interest of the local community in physical activity, the authorities of the Volhynia District Board of Education planned to hold county competitions for schools functioning in the district before starting the district competitions. The programme of the competitions was the same during both district and county rivalry (*Dziennik Urzędowy Kuratorium Okręgu Szkolnego Wołyńskiego*, 1925, pp. 226–227). The purpose of organising the School Youth Day in Volhynia was to demonstrate physical fitness and military training. The programme of the competition, due to introduction of multi-combat events, took into account the collective effort of individual teams. Commune and district competitions were organised for pupils of rural elementary schools aged 10 to 15. District competitions were organised in all 10 districts of the province of Volhynia (*Wychowanie Fizyczne*, 1926, p. 255). The competition of elementary school teams was conducted in two groups. The contestants were divided according to their age: girls – 10–14 years old, boys – 13–15 years old. The competition of one of the groups concerned only their participation in the tetrathlon (*Dziennik Urzędowy Kuratorium Okręgu Szkolnego Wołyńskiego*, 1926, No. 7, pp. 188–189). The team was to consist of 20 people – 8 boys and 12 girls. The district could be represented by the maximum of two teams, assuming it would be one female team and one male team. The boys competed in tetrathlon, military pentathlon and track-and-field pentathlon. The team consisted of 20 participants, 8 in the first two competitions and 4 in the track-and-field pentathlon. The competitors were allowed to participate only in one group. The terms of the regulations had an impact on the participation in the competition of a wide group of young people, because a representation of a district could consist, in the group discussed above, of max. 40 contestants.

High school teams were reported for the entire programme. Everyone had to participate in free exercises. The competition programme included a cycling relay in which a team of 10 contestants had the right to take part; basketball games the final of which was to be played during county competitions, with the participation of two male and two female teams selected in qualification contests (*Dziennik Urzędowy Kuratorium Okręgu Szkolnego Wołyńskiego*, 1926, No. 4, p. 114). The transfer trophy in female contests was won by the pupils from the State Junior School in Kovel. Due to weather conditions, the track-and-field pentathlon for boys had to be cancelled (*Wychowanie Fizyczne*, 1926, No. 4, p. 256). The challenge award for boy teams remained in the possession of the State Junior High School in Rivne – the winner of the 1925 competition. A total of 474 students – 212 girls and 262 boys participated in the competition (Nowak, 1996). The District Sports Day of School Youth took place in 1927 on May 27–28, in Rivne. Apart from state schools, pupils from private schools participated in the competition, including Russian Private Junior High School. The number of participants from private schools was insignificant, because not all institutions had physical exercise classes (*Wychowanie Fizyczne*, 1927, No. 7–8, pp. 211). In total, the competition was attended by 471 competitors – 293 boys and 178 girls. The competition in combined track-and-field events was carried out in two groups of pupils – younger and older (over 15 years of age). Each team consisted of 4 players. The competitions for younger boys included team tetrathlon: high jump, long jump, 60 m run and small-calibre weapon shooting at the distance of 50 m. The older boys competed in the team pentathlon (long jump, pole vault, javelin throw, shot put and 4 × 100 m relay). Competitions for girls were held as part of a team track-and-field triathlon: high jump, 60 m run, balance beam exercises. Older girls competed in long jump, archery and 4 × 60 m relay race. In the tetrathlon for younger boys, the State Junior High School in Rivne, before the Junior High Schools in Dubno and Lutsk, turned out to be the best. The track-and-field competition for older boys was won by the team

of the State Junior High School in Lutsk ahead of the team of the Junior High School in Rivne. Third place was taken by pupils of the Junior High School in Ostroh. The competition in triathlon, among 11 teams of younger girls, was won by the State Junior High School in Kovel, the second place went to the Junior High School in Dubno, and the third – to the Junior High School in Rivne. Among the older girls (12 teams), the team from Kovel proved to be the best. The second place went to the team from the Junior High School in Rivne, the third place went to the Junior High School in Lutsk. The School Youth Sports Festival programme has been extended to include toxophily as an individual competition.

There were also other competitions held, such as cross-country race over a distance of 2,000 m, and a 5 × 1,000 m cycling relay race. The best team in the cross-country race was the High School in Kremenets (*Wychowanie Fizyczne*, 1927, No. 9–10, pp. 257). Team games included a basketball tournament in which 6 female and 10 male teams participated. The female group was won by the team from the Teacher Training Seminary from Ostroh; the male group tournament was won by the team of the State Junior High School in Rivne. The Challenge Award of the Board of Education for the best male team was won by the State Junior High School in Lutsk. The female team of the Junior High School in Kovel won the Challenge Award of the Board of Education of the Volhynia School District for the best female team once again (*Wychowanie Fizyczne*, 1927, No. 7–8, p. 212).

On the initiative of the Students' Sports Circle of the Kremenets Lyceum track-and-field competitions (track-and-field triathlon for girls, track-and-field triathlon for boys), and a tournament of sports games (*Wołyń*, 1933, No. 24, p. 10) were held. Inter-school competitions in track-and-field events were organised in Kremenets. The competition, held on May 5, 1932, included a 100 m run, shot put and high jump (*Życie Krzemienieckie*, 1932, No. 5, pp. 28–29). The competition was attended by teams from the K.L. Junior High School, K.L. Seminary, Local Government Junior High School as well as athletes from the 12th Podolian Cavalry Regiment, who participated out of competition. In high jump, the best result was achieved by Krasuski (157 cm), whereas Ivanov achieved the best result in shot put (13.30 m).

In 1935, in the primary school in Mlyniv (Dubno district), there were 3 kayak sections with 9 kayaks that were built by students in the school workshop as part of handicraft classes. The students were also making skis and toboggans. The initiator of the production of sports equipment by the pupils was the headmaster of the school Edward Nowak, Eng. About 140 pupils participated in canoeing lessons combined with swimming lessons. The location of the village on the Ikva River was conducive to the implementation of these activities (*Wołyń*, 1935, No. 27, p. 9).

Pupils participated in competitions organised on the occasion of putting sports facilities into use. On July 21, 1935, after a ceremonial opening of the rowing harbour and swimming area on the Ikva River in Dubno, pupils competed in canoeing and swimming competitions (*Wołyń*, 1935, No. 31, p. 9). On September 22, 1935, the junior high school crew took the third place in the canoe competition organised in Dubno by the kayaking section of the Maritime and Colonial League (*Wołyń*, 1935, No. 40, p. 8). In the rowing regatta held in Dubno on September 29, 1935, in the competition of two paddlers and the helmsman, the crew of the local State Junior High School won the first place. The main prize was a challenge cup funded by the Dubno Rowing Association (*Wołyń*, 1935, No. 42, p. 8).

School sport was also carried out in other institutions of secondary education in the province of Volhynia. In 1933, the Sports Club of the State Measuring and Road School in Kovel organised a cross-country skiing race at a distance of 8 km (*Wołyń*, 1933, No. 10, p. 7). The winner was Lubiak, the second place went to Lipnicki.

On February 23, 1933, the Committee on Physical Education at the Central Pedagogical Library in Rivne organised the 1st Interschool Team Skating Competition for the Schools of Rivne (*Wołyń*, 1933, No. 12, p. 6).

The competition program consisted of four skating competitions: races over a distance of 100 m and 200 m for girls, and races over a distance of 200 m and 400 m for boys. The competition gathered 130 participants and 1,500 spectators. Each team consisted of 4 people, competing individually. In the girls' skating race over a distance of 100 m, the first two places were taken by pupils of the State Junior High School, the third place was taken by pupils of the H. Sienkiewicz Primary School; in girls' skating race over a distance of 200 m the best were again the pupils of the State Junior High School. In boys' competitions in the skating race over a distance of 200 m the first place was taken by the pupils of the H. Sienkiewicz Primary School, while two next places were taken by representatives of the State Junior High School; the 400 m race was won by representatives of the Russian Junior High School, before the team from the Polish School of Economics (Polska Macierz Szkolna – PMS) and the State Junior High School.

As part of the winter sports action (1933/1934) in Kremenets, carried out by the Junior High School of the District Department, in cooperation with the School of Economics and Kremenets City Council, three sections were separated: skiing, tobogganing and skating (*Życie Krzemienieckie*, 1934, No. 2, pp. 53–54). The result of the campaign was, among others, the completion of a ski course for group leaders by two pupils. Under the guidance of physical education teachers, A. Hoffmanówna and H. Kobyliński, the Sports Club organised three ski courses. 28 boys, 16 girls and 10 students of the School of Economics participated in the courses. At the end of the courses competitions and ski trips were organised. Among the participants of the course for boys, 16 of them obtained the titles of group leaders.

On the initiative of the Municipal Committee of Physical Education and Military Training (MKWFIPW) in Lutsk, the Physical Education and Military Training Festival (WF and PW) has been organised annually to promote and develop physical activity in Lutsk and in the Lutsk district. In 1930 the Festival in Lutsk was held on June 7–9. The sports programme included sports competitions and shows of schoolchildren and a competition of clubs and sports associations. Pupils were to compete in sports games (palant – a Polish game similar to baseball, volleyball), in athletics and in shooting. Gymnastic shows were to be carried out by school students and the „Sokół” Gymnastic Society (TG) (Małolepszy et al., 2017).

Young people from schools in Kremenets performed very well during the Festival of Physical Education and Military Training on June 3, 1934, carried out on the sports field of the District Committee of Physical Education and Military Training (*Życie Krzemienieckie*, 1934, No. 6, pp. 269–270). The event was organised on the initiative of the Subject Committee on Physical Education, supervised by a school inspector, Bronisław Robak. Over 1,300 students took part in shows and competitions in physical education and sports, they represented: Kremenets Lyceum, primary schools, Orthodox Theological Seminary, Local Government Junior High and the School of Economics. The programme included: a gymnastic show, a demonstration lesson of physical education, relay runs, games and activities, sports games and a dance show.

The pupils obtained very good results during the Festival of Physical Education and Military Training held in Kovel on June 11, 1933 (*Wołyń*, 1933, No. 25, p. 9.). In the competition of games and fun, the winners were: in the volleyball competition of primary school girls – Primary School No. 1 in Kovel; in the volleyball in the competition of primary school boys – Primary School No. 3 in Kovel; in dodgeball – Primary School No. 4 in Kovel; women's volleyball, basketball, shooting and pentathlon – Junior High School Sports Club. A large number of competitions and disciplines carried out for school children deserves attention in the Kovel competition programme.

The sport competition of high school students in Volhynia should be considered interesting. On October 13, 1935, there was a match held in Kremenets between the students of the Kremenets Lyceum and the State Junior High School in Dubno (*Życie Krzemienieckie*, 1935, No. 10, p. 454; *Wołyń*, 1935, No. 44, p. 10). The students competed in sports games, track-and-field events and shooting. The competition was social in nature and aimed at comparing the physical fitness of the two educational institutions. Each team consisted of 15 players. Sports games and track-and-field competitions were dominated by students from Kremenets, among others they won girls' and boys' volleyball events, boys' basketball and hazena (Czech handball), as well as in track-and-field triathlon. In small-calibre shooting students from Dubno proved to be better.

Another competition with the participation of young people from schools in Volhynia took place in Kremenets on May 22–23, 1937 (*Życie Krzemienieckie*, 1937, No. 10–11, pp. 231–233). There were representations of the State Junior High School from Ostroh, the Local Government Junior High School from Kremenets, Pedagogium and the Junior High School of Kremenets Lyceum which participated in the competition of girls (each team consisted of 10 girls). Eight teams from schools from Bialokrynica, Kremenets, Dubno, Ostroh and Smyga entered the boys' competition. The competitions included athletics, sports games (hazena, basketball, volleyball), shooting (shooting with small-caliber weapons). The students from the Junior High School and Pedagogium of Kremenets Lyceum and the Junior High School in Dubno and Ostroh distinguished themselves in the competition.

Activities in the field of school sport were undertaken by the Polish Association of Physical Educators (PZWF) and the Interschool Commission of Physical Education (WF) in Lutsk. In the 1937/1938 reporting period, on the initiative of the above institutions, inter-school athletics competitions for high school youth were conducted three times and they were attended by over 70 students; inter-school gymnastics competitions were conducted three times with c. 60 students; ice hockey competitions were held twice; high school inter-school competitions in sports games in which 6 volleyball teams and 6 basketball teams took part were carried out four times; in consultation with the Regional PE Centre two swimming competition, with the participation of about 25 students, were held for a swimming badge, (*Wołyń*, 1938, No. 49, p. 5). In agreement with the Municipal Committee of Physical Education and Military Training (MKWF i PW) in Lutsk, the Interschool Festival of Physical Education and Military Training (WF i PW) was organised, attended by about 1,500 pupils from primary and secondary schools. The activity of the Polish Association of Physical Educators (PZWF) club in Lutsk should be assessed as extremely dynamic.

The Interschool Sports Youth Club in Kremenets Lyceum was the organiser of school sports competitions on September 25–26, 1937 (Małołepszy, Drozdek-Małołepsza, 2019). The competition was attended by 93 boys and 20 girls from the State Junior High School in Dubno, Orthodox Theological Seminary in Kremenets, Local Government Junior High School in Kremenets, High School, the School of Economics, Junior High School and Agricultural School of Kremenets Lyceum. They competed in track-and-field events and sports games. The best athlete of the competition was Kowalewski (Dubno), who won the 100 m race, long jump and high jump. In the competition of sports games, the schoolchildren from the Junior High School of Kremenets Lyceum won the girls' and boys' volleyball competition. Basketball competition was won by the youth of the Orthodox Theological Seminary. The Junior High School of Kremenets Lyceum won in the scoring of schools before the State Junior High School in Dubno. The event was well organised and attracted a wide audience.

Kremenets was the centre where the interschool competitions in winter sports were most often held. On February 16, 1936, skiing competitions took place in Kremenets, with the participation of students from Kremenets schools (*Życie Krzemienieckie*, 1936, No. 2, p. 76; *Wołyń*, 1936, No. 9, p. 11). The organiser of the event

was the District Commander of the Military Training (PW) and the local Committee of Physical Education Teachers. The competition began with a parade of students through the streets of Kremenets. Over 100 students participated in the competition, which proved the popularity of winter disciplines in the Kremenets school environment. Cross-country skiing was organised at various distances depending on age. Students from the School of Economics, Krzemieniec Junior High School and Lyceum and the Agricultural School stood out in the competition.

The ice hockey tournament of school teams and Kremenets Sports Club (KKS) took place in Kremenets in 1938 (*Wołyń*, 1938, No. 11, p. 8). The first place was taken by the team of hockey players from the State Junior High School in Dubno, who defeated the teams of Kremenets Interschool Sports Club and the Orthodox Theological Seminary. A year later (1939), an ice hockey tournament was held at Kremenets Lyceum ice rink, with the same teams: the State Junior High School in Dubno, KKS (Kremenets Sports Club), the Theological Seminary in Kremenets and the Kremenets High School Sports Club (KS) (*Wołyń*, 1939, No. 8, p. 6). The tournament was played according to the cup system. Hockey players of the High School Sports Club (KS) won. The match was a promotion of ice hockey among schoolchildren as well as adults.

The biggest school youth event in winter sports were the School Youth Winter Games (Małolepszy, Drozdek-Małolepsza, 2019). The competition, held in Kremenets from January 31 to February 2, 1937, and it was attended by 347 students from 24 high schools from the province of Volhynia. The competition programme consisted of the following disciplines: ice hockey, figure skating, skiing and tobogganing. Figure skating involved individual and pair rides; skiing – girls' races over the distances of 4 km and 6 km, boys' races – over distances of 7 km and 9 km; tobogganing: 300 m downhill toboggan ride (Małolepszy, Drozdek-Małolepsza, 2019). The Junior High School of Kremenets Lyceum won in the overall competition scores in the category of boys and girls. Other educational institutions also stood out in the competition: e.g. the State Junior High School from Dubno, the Local Government Junior High School from Kremenets and the State Junior High School from Zdolbuniv. The ice hockey tournament was won by students of the State Measuring and Road School from Kovel, ahead of Kremenets Junior High School and Kovel Junior High School. 8 teams competed in the ice hockey tournament. The sporting level of the competition was quite high.

Sports competition in education at inter-province and national level

An interesting form of sports competition was the competition between "The Sulkowskis" Junior High School in Rydzyna (the province Poznań) and Kremenets Lyceum. The initiative of conducting inter-school competitions was raised by the management of "The Sulkowskis" Junior High School in Rydzyna (Małolepszy, Drozdek-Małolepsza, 2019). It was specified in the competition regulations that the competition would be held annually in both cities for a change. 15-person teams could participate in the competition. Members of the teams had to have the National Sports Badge as evidence of all-embracing physical development. The results of competition in individual sports events were evaluated collectively, adding up the points obtained by the participant in a given section of the competition.

The editors of the *Życie Krzemienieckie* magazine pointed to the motives of the initiators of sport competition of two school centres:

(...) willingness to instil traditional inter-university competitions in Poland, (...) the desire to establish contact between two organizationally similar borderland school facilities by bringing the youth of the eastern and western borders closer together, and giving them the opportunity to look at the world as different as the western

provinces of Poland are for the inhabitants of the eastern borderlands *and vice versa*" (*Życie Krzemienieckie*, 1935, No. 4, pp. 171–172).

There were six editions of the competition. The first competition took place on May 13–14, 1933 in Kremenets, then the students from Greater Poland won (85:10). The last edition was held in 1938 in Rydzyna. Young people competed in track-and-field competitions, in sports games and shooting with military and small-calibre weapons. In all editions, the students from the Junior High School in Rydzyna won in the overall score (Małołepszy, Drozdek-Małołepsza, 2019). After the fifth edition of the competition the editors of *Życie Krzemienieckie* wrote: „the growing ties of mutual friendship bind both groups of competitors, the atmosphere in which the competition takes place is getting nicer, the fight of players is becoming more and more gallant” (*Życie Krzemienieckie*, 1937, No. 10–11, p. 234).

Representation of Lutsk (school district) participated in the School Youth Nationwide Sports Competition in Vilnius (Zaborniak, 2013). The first winter nationwide competition was organised on January 12–13, 1935 in Vilnius. The sport competition was attended by students representing 7 districts: Warsaw, Kraków, Lublin, Lviv, Lutsk, Poznań and Vilnius. Young people competed in ice hockey, figure skating and skiing. The team from Lutsk defended the colours of Volhynia in ice hockey competitions. The team consisted of, among others, students from the State Junior High School in Kovel and schools in Rivne (*Przegląd Sportowy*, 1935, No. 5, p. 5; *Wołyń*, 1936, No. 10, p. 10). The team from Lutsk defeated the representation of Warsaw, drew with the teams of Poznań and Lviv, lost their match with the team of Kraków. In the overall scoring of the hockey tournament the team from Volhynia won the third place and was recognised as the tournament's greatest revelation.

Summary

In the years 1921–1939 there was a development of sport in education in the Volhynia province. This process was particularly evident in the second half of the 1920s and in the 1930s. School sport was especially popular in secondary education. Among sports, school children and adolescents practiced mainly track-and-field events, sport games, shooting, water sports and winter sports. School Sports Circles and Clubs were organised at schools. District and Municipal Committees of Physical Education and Military Training played an important role in the development of school sport. Students participated in competitions organised by committees, intended mainly for schoolchildren.

Sport competition developed mainly at the local, district and province levels. In the 1930s, the representation of the Volhynia (Lutsk) school district participated in nationwide competitions. The elite school competition was a sport competition between Kremenets Lyceum and “The Sułkowskis” Junior High School in Rydzyna. Kremenets was the strongest school sport centre in Volhynia. In addition to Kremenets, strong school sports centres in Volhynia include Dubno, Kovel, Lutsk and Rivne.

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SELF-ESTEEM OF PHYSICAL EDUCATION STUDENTS WITHIN DIDACTIC AND EDUCATIONAL SKILLS DEPENDING ON THE MODE OF STUDY AGAINST EVALUATION BY PLACEMENT SUPERVISORS

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Abstract Introduction. In addition to knowledge and aptitude, practical skills are necessary to competently pursue every profession. For students, teaching practice is the first opportunity to confront knowledge and skills acquired at university with school reality. **The goal** of this study was the self-esteem of didactic and educational skills among full-time and extramural Physical Education students of Kazimierz Wielki University in Bydgoszcz participating in teaching practice as well as the comparison of their self-esteem with the assessment of teachers – placement supervisors. **Material and Methods.** A total of 625 Physical Education students of Kazimierz Wielki University in Bydgoszcz and the same number of placement supervisors were involved in the study. The diagnostic survey method was carried out to collect the data. The questionnaire technique was used. **Results.** Based on the conducted research, the following conclusions were formulated: the majority of full-time and extramural students assessed their didactic and educational skills as good or very good, both full-time and extramural students were very well prepared for teaching practice in Physical Education, and the assessments of teaching practice supervisors, in principle, were higher than the self-esteem expressed by student teachers ($p = 0.0000$ for the Z test).

Key words student's self-esteem, teaching practice

Introduction

From 1953 onwards, with the introduction of teaching apprenticeships as a compulsory form of study to the university's curriculum, higher education schools were required to properly prepare students for this practice. In addition to knowledge and aptitude, practical skills are necessary to competently pursue every profession. For students, teaching placement is the first opportunity to confront knowledge and skills acquired at university with

school reality. In this way, young teachers can verify knowledge, skills and attitudes while taking practical action and working with children in educational establishments.

The basis for building study programs are appropriately constructed learning outcomes defined in the following three areas: knowledge (understood as a set of related facts, principles, theories, and experiences acquired by the learner), skills (the ability to use knowledge as well as trained skills to perform tasks and solve problems), social aptitude (the ability to carry out the assigned tasks autonomously and responsibly, readiness for lifelong learning, communication skills, ability to interact with others as a team member and leader alike. The aptitude refers to what the student has achieved, and not only to the teaching content or to how one has acquired knowledge and skills) (Kennedy, 2007).

Among numerous qualities, predispositions and skills a good teacher should possess, proper self-esteem deserves special attention. Self-esteem is a complex and multi-faceted concept. It can be understood as a global positive or negative attitude towards oneself, and therefore it constitutes one of the subjective elements of the concept of "I" based on self-perception (Anastasi, Urbina, 1999). Correct self-assessment, deriving from self-esteem, allows achieving good educational results and better understanding of students.

The primary focus of this study was the self-esteem of the didactic and educational skills demonstrated by physical education students of Kazimierz Wielki University in Bydgoszcz and the assessment of these skills by placement supervisors. The following research questions were raised:

1. How do full-time and extramural students estimate their didactic and educational skills?
2. Is there a relationship between the mode of study and the degree of student preparation for conducting teaching practice?
3. How do placement supervisors assess the students' didactic and educational skills?

Material and Methods

A total of 625 physical education students of Kazimierz Wielki University in Bydgoszcz and the same number of placement supervisors were involved in the study. The diagnostic survey method was carried out to collect the data. The questionnaire technique was used. Two questionnaires were developed for the research. The first one was addressed to students whereas the second one to teachers – placement supervisors. The questionnaire for students included, among others, questions concerning the assessment of the preparation of lecturers, self-esteem of own teaching and educational skills, and the assessment of the usefulness of knowledge and skills acquired at university. Placement supervisors were asked to assess the students' teaching and educational skills, indicate the strengths and weaknesses of the teaching practice program and gaps in the students' pedagogical preparation. In both questionnaires, closed, open and semi-open questions were used. For the purposes of this research, from the surveys on the quality of education in the field of Physical Education, Kazimierz Wielki University in Bydgoszcz, in the context of the teaching practice implementation, we selected only the questions regarding the self-esteem of students and evaluation by placement supervisors. Statistical analyses were conducted with the program STATISTICA 12 (license for UKW). To verify the hypotheses, the Wilcoxon test was applied. The significance threshold was set at $\alpha = 0.05$. The results were considered statistically significant when the calculated probability p met the inequality $p < 0.05$. The questionnaires were completed by full-time and extramural students. The research was carried out in the academic years 2013/2014 and 2014/2015. Most of the respondents were male students (57.3%), people aged 21–22 (45.9%), and full-time students (66.4%). The figures are presented in Table 1.

Table 1. Comparison of the students involved in the research based on sex, age, year of study, mode of study, and the place of teaching practice

		N	Percent
Sex	female	267	42.7
	male	358	57.3
Age	up to 20 years of age	11	1.8
	21–22 years	287	45.9
	23–24 years	253	40.5
	25 years and older	74	11.8
Year of study	II	123	19.7
	III	339	54.2
	I MU (complementary master studies)	163	26.1
Mode of study	full-time	415	66.4
	extramural	210	33.6
Site of teaching practice	primary school	216	34.6
	junior secondary school	246	39.4
	upper-secondary school	163	26.1

Among teachers – placement supervisors, the largest group were male subjects (63.8%) and people between 41 and 55 years old. Most of the surveyed teachers had a master's degree (87.5%) and more than half of them were licensed teachers (63.2%). Figures are displayed in Table 2.

Table 2. Comparison of the teachers involved in the study based on sex, age, seniority, and education

		N	Percent
Sex	female	226	36.2
	male	399	63.8
Age	up to 30 years of age	34	5.4
	31–40 years	257	41.1
	41–55 years	317	50.7
	55 years and older	17	2.7
Seniority	up to 5 years	21	3.4
	6–10 years	105	16.8
	11–15 years	153	24.5
	16–20 years	126	20.2
	21–25 years	103	16.5
	25 years and more	117	18.7
Education	secondary	0	0.0
	higher vocational (BA)	6	1.0
	master's degree (other than PE)	68	10.9
	master's degree (PE)	547	87.5
Professional advancement degree	teacher trainee	3	0.5
	contract teacher	31	5.0
	appointed teacher	196	31.4
	licensed teacher	395	63.2

Results

The analysis of the students' self-esteem and evaluation within their didactic and educational skills were divided into the following parts:

4. Writing a lesson plan for Physical Education in functional terms.
5. The range of exercises.
6. The student's activities while conducting a PE lesson independently.

A six-mark scale was used for the assessment, where 0 means the lack of skills, 1 – very poor, 2 – poor, 3 – average, 4 – good, and 5 – very good.

Table 3 presents the self-esteem of students against the evaluation given by placement supervisors from the first part of the survey. Writing a lesson plan for Physical Education in functional terms was assessed. Over half of full-time students (57.6%) assessed their abilities to write a plan as good, and more than a third of them as very good (33.3%). Taking into account the type of discipline when writing a lesson plan, more than half of the students assessed their skills as good (56.4%), similarly to the so called "hard conditions" (49.4%), and the level of physical capabilities displayed by children (53.5%). About one third of the students participating in the study evaluated their skills of writing a lesson plan considering the above-mentioned conditions as very good. In all cases, the teachers' marks were higher than those given by full-time students. In addition to the percentage distribution, this is indicated by the average mark. With regard to writing a lesson plan regardless of the type of a didactic task, very good marks were given by 73.5% of placement supervisors. Taking into account the type of a discipline, it was 70.6%, the level of physical capabilities presented by children – 62.7%, and in hard conditions – 65.5%. In all cases, statistically significant differences were observed between the students' self-esteem and evaluation by placement supervisors ($p = 0.0000$ for the Z test). Placement supervisors rated the skills of writing a lesson plan significantly higher than the students.

Table 3. Full-time students' self-esteem against evaluation by placement supervisors on writing a lesson plan for Physical Education in functional terms

No. of question	Group	Mark (%)						Wilcoxon Test		Average mark
		lack of skills	very poor	poor	average	good	very good	Z	p	
P.1a	S	0.0	0.0	0.0	9.2	57.6	33.3	10.0	0.0000	4.11
	T	0.0	0.0	0.0	1.2	25.3	73.5			4.72
P.1b	S	0.0	0.0	0.5	12.1	56.4	31.1	10.1	0.0000	4.08
	T	0.0	0.0	0.0	1.7	27.7	70.6			4.69
P.1c	S	0.0	0.0	0.5	21.2	53.5	24.8	10.3	0.0000	3.97
	T	0.0	0.0	0.2	3.4	33.7	62.7			4.62
P.1d	S	0.0	0.0	2.7	21.0	49.4	27.0	9.9	0.0000	3.95
	T	0.0	0.2	1.0	4.1	29.2	65.5			4.62

Note: S – student; T – teacher; P.1a Writing a lesson plan for Physical Education regardless of the type of a didactic task; P.1b Writing a lesson plan for Physical Education regardless of the type of a discipline taught at university; P.1c Writing a lesson plan for Physical Education considering the different level of physical capabilities displayed by children of one class; P.1d Writing a lesson plan for Physical Education considering the so called "hard conditions" (lack of a school gym, lack of adequate sport equipment, etc.).

The second part of the survey was to assess the range of methodological exercises (Table 4). About a third of the students rated the range of methodological exercises: to perform different didactic tasks as very good (27.5%), to ensure the introduction and the main part A in a varied way (38.6%), to ensure the main part B and the

final part in a varied way (37.4%). The same aspects were evaluated by placement supervisors who rated the range of methodological exercises as very good in most full-time students (70.8%, 76.1% and 74.9%, respectively). In this part of the survey, significant differences were observed between the students' self-esteem and evaluation by placement supervisors also in all cases ($p = 0.0000$ for the Z test). Placement supervisors gave significantly higher marks for the range of methodological exercises than PE students.

Table 4. Full-time students' self-esteem against evaluation by supervisors concerning the range of methodological exercises

No. of question	Group	Mark (%)						Wilcoxon Test		Average mark
		lack of skills	very poor	poor	average	good	very good	Z	p	
P.2a	S	0.0	0.0	1.5	12.1	59.0	27.5	10.9	0.0000	4.16
	T	0.0	0.0	0.0	2.4	26.8	70.8			4.71
P.2b	S	0.0	0.0	0.5	11.6	49.4	38.6	9.6	0.0000	4.22
	T	0.0	0.0	0.0	2.2	21.7	76.1			4.74
P.2c	S	0.0	0.0	0.7	9.4	52.5	37.4	9.6	0.0000	4.21
	T	0.0	0.0	0.0	2.2	22.9	74.9			4.72

Note: S – student; T – teacher; P.2a The range of methodological exercises to perform different didactic tasks; P.2b The range of methodological exercises to ensure the introduction and the main part A in a varied way; P.2c The range of methodological exercises to ensure the main part B and the final part in a varied way.

In the last part of the questionnaire, self-esteem and evaluation covered the tasks while conducting a PE lesson independently. All data are included in Table 5. First, organizational activities (gathering, checking the attendance, distributing the equipment, etc.) were assessed. The average mark provided by full-time students was 4.53 and by teachers – 4.77. Almost half of the young people (47.2%) rated their skills of assigning particular exercises to pupils as very good. The average mark was 4.37, and the placement supervisors' average mark turned out to be higher again reaching 4.69. Teachers' marks were higher than the self-esteem of full-time students when it comes to the assessment of making use of the space for exercises (S-4.42; T-4.71), controlling the lesson time (S-4.22; T-4.59), maintaining classroom discipline (S-4.3; T-4.66) or developing motivation for active participation in the lesson (S-4.27; T-4.74). Demonstration of an exercise for every sports discipline taught at university was further evaluated. Almost half of the surveyed students (45.3%) evaluated their skills as very good as opposed to 82.2% of placement supervisors giving the same mark. One of the more important tasks during each Physical Education lesson includes correcting mistakes made by pupils. Such skills were rated as very good by 43.4% of students and by a significant proportion of teachers (63.4%). One-third of the students (31.6%) and more than half of the teachers (57.8%) evaluated the skills of resolving educational issues occurring during a lesson as very good. The last issues to be assessed in the study included co-educational groups, large number of groups of pupils doing exercises, as well as providing protection and security during exercises. Here, the average mark given by students was lower than the average mark provided by supervisors (S-4.13 T-4.58, S-4.07 T-4.58 and 4.38 T-4.76, respectively). Without exception, all Wilcoxon test results comparing students' self-esteem to evaluation expressed by their supervisors are statistically significant ($p = 0.0000$ for the Z test). The comparison of the percentage distributions and average marks clearly shows that evaluation given by placement supervisors was usually higher than the students' self-esteem.

Table 5. Full-time students' self-esteem against evaluation by supervisors concerning the student's activities while conducting a PE lesson independently

No. of question	Group	Mark (%)						Wilcoxon Test		Average mark
		lack of skills	very poor	poor	average	good	very good	Z	p	
P.3a	S	0.0	0.0	0.7	5.5	34.2	59.5	4.9	0.0000	4.53
	T	0.0	0.0	0.2	2.2	21.0	76.6			4.77
P.3b	S	0.0	0.5	0.2	8.7	43.4	47.2	6.6	0.0000	4.37
	T	0.0	0.0	0.5	2.9	24.3	72.3			4.69
P.3c	S	0.0	0.0	0.0	4.1	51.1	44.8	6.4	0.0000	4.42
	T	0.0	0.0	0.2	3.6	21.9	74.2			4.71
P.3d	S	0.0	0.2	2.7	12.5	45.1	39.5	7.1	0.0000	4.22
	T	0.0	0.0	0.7	3.9	33.3	62.2			4.59
P.3e	S	0.0	0.7	0.5	9.9	49.6	39.3	8.1	0.0000	4.30
	T	0.0	0.0	0.0	2.4	28.4	69.2			4.66
P.3f	S	0.2	0.0	0.7	13.3	52.5	33.3	10.0	0.0000	4.27
	T	0.0	0.0	0.0	2.4	22.2	75.4			4.74
P.3g	S	0.0	0.0	0.7	10.1	43.9	45.3	9.2	0.0000	4.40
	T	0.0	0.0	0.2	1.7	15.9	82.2			4.80
P.3h	S	0.0	0.0	0.7	9.9	46.0	43.4	5.9	0.0000	4.31
	T	0.0	0.0	0.5	1.9	34.2	63.4			4.62
P.3i	S	0.0	0.2	1.5	14.2	52.5	31.6	7.3	0.0000	4.16
	T	0.2	0.0	0.5	4.3	37.1	57.8			4.54
P.3j	S	0.5	0.2	1.9	14.5	48.2	34.7	7.9	0.0000	4.13
	T	1.9	0.0	0.2	2.9	25.8	69.2			4.58
P.3k	S	0.0	0.2	1.2	18.3	49.6	30.6	8.1	0.0000	4.07
	T	0.2	0.2	1.0	4.1	32.5	61.9			4.58
P.3l	S	0.2	0.0	0.5	8.7	45.5	45.1	8.1	0.0000	4.38
	T	0.0	0.0	0.2	1.9	20.5	77.4			4.76

Note: S – student; T – teacher, while conducting a PE lesson independently; P.3a organizational activities (gathering, checking the attendance, distributing the equipment, etc.); P.3b assigning particular exercises to pupils; P.3c making use of the space for exercises; P.3d controlling the lesson time; P.3e maintaining classroom discipline; P.3f developing motivation for active participation in the lesson; P.3g demonstration of an exercise for every sports discipline taught at university; P.3h correcting mistakes made by pupils; P.3i resolving educational issues occurring during a lesson; P.3j coeducational groups; P.3k large number of groups of pupils doing exercises; P.3l providing protection and security during exercises.

An analysis of self-esteem and assessment of didactic and educational skills was also conducted for extramural students. Table 6 presents the findings applying to writing a lesson plan in functional terms. Slightly more than half of the students assessed the ability of writing a lesson plan for Physical Education regardless of the type of a didactic task as good (54.3%), and almost a third as very good (29.5%). Like in the case of full-time students, placement supervisors' marks turned out to be more favorable. As much as 66.2% of placement supervisors rated this ability as very good. In terms of writing a lesson plan for Physical Education considering the type of a discipline taught at university, the number was 63.3%, the level of physical capabilities displayed by children – 58.1%, and in the case of hard conditions – 62.9%. In all cases, statistically significant differences were observed between the students' self-esteem and evaluation by placement supervisors ($p = 0.0000$ for the Z test). Supervisors evaluated the skills of writing a lesson plan significantly higher than the students.

Table 6. Extramural students' self-esteem against evaluation by placement supervisors within writing a lesson plan for Physical Education in functional terms

No. of question	Group	Mark (%)						Wilcoxon Test		Average mark
		lack of skills	very poor	poor	average	good	very good	Z	p	
P.1a	S	0.0	0.0	0.0	16.2	54.3	29.5	7.51	0.0000	4.13
	T	0.0	0.0	0.0	1.0	32.9	66.2			4.65
P.1b	S	0.0	0.0	0.0	20.0	56.2	23.8	8.11	0.0000	4.04
	T	0.0	0.0	0.0	3.3	33.3	63.3			4.60
P.1c	S	0.0	0.0	1.4	29.1	49.1	20.5	8.49	0.0000	3.89
	T	0.0	0.0	0.5	3.3	38.1	58.1			4.54
P.1d	S	0.0	0.0	2.4	29.1	44.3	24.3	7.89	0.0000	3.90
	T	0.0	0.0	0.5	6.7	30.0	62.9			4.55

Note: S – student; T – teacher; P.1a Writing a lesson plan for Physical Education regardless of the type of a didactic task; P.1b Writing a lesson plan for Physical Education regardless of the type of a discipline taught at university; P.1c Writing a lesson plan for Physical Education considering the different level of physical capabilities displayed by children of one class; P.1d Writing a lesson plan for Physical Education considering the so called "hard conditions" (lack of a school gym, lack of adequate sport equipment, etc.).

The next part of the survey was intended to evaluate the range of methodological exercises (Table 7). About one-third of the extramural students assessed the range of methodological exercises as very good: to perform different didactic tasks (32.9%), to ensure the introduction and the main part A in a varied way (38.1%), to ensure the main part B and the final part in a varied way (34.8%). The same aspects were evaluated by placement supervisors who rated the range of methodological exercises as very good in the majority of full-time students (69.1%, 69.5%, and 70.0%, respectively). In this part of the survey, statistically significant differences were also observed in all cases between the students' self-esteem and assessment by teachers ($p = 0.0000$ for the Z test). Placement supervisors evaluated the range of methodological exercises significantly higher than the students.

Table 7. Extramural students' self-esteem against evaluation by placement supervisors concerning the range of methodological exercises

No. of question	Group	Mark (%)						Wilcoxon Test		Average mark
		lack of skills	very poor	poor	average	good	very good	Z	p	
P.2a	S	0.0	0.0	1.0	15.2	51.0	32.9	7.04	0.0000	4.16
	T	0.0	0.0	0.0	2.4	28.6	69.1			4.67
P.2b	S	0.0	0.0	1.4	15.7	44.8	38.1	6.33	0.0000	4.20
	T	0.0	0.0	0.0	4.8	25.7	69.5			4.65
P.2c	S	0.0	0.0	0.5	17.1	47.6	34.8	6.88	0.0000	4.17
	T	0.0	0.0	0.5	2.9	26.7	70.0			4.66

Note: S – student; T – teacher; P.2a The range of methodological exercises to perform different didactic tasks; P.2b The range of methodological exercises to ensure the introduction and the main part A in a varied way; P.2c The range of methodological exercises to ensure the main part B and the final part in a varied way.

Then, the results concerning self-esteem and evaluation of tasks while conducting a PE lesson independently were analyzed. All data are presented in Table 8. The evaluation scope covered organizational activities (gathering, checking the attendance, distributing the equipment, etc.), assigning particular exercises to pupils, making use of the space for exercises, controlling the lesson time, maintaining classroom discipline, developing motivation for active participation in the lesson, demonstration of an exercise for every sports discipline taught at university, correcting mistakes made by pupils, resolving educational issues arising during a lesson, co-educational groups, large number

of groups of pupils doing exercises, and providing protection and security during exercises. A very good mark in this regard was given by 25.7% to 60.0% of extramural students and from 52.4% to 73.8% of placement supervisors. In this part of the survey, statistically significant differences were also observed in all cases between the students' self-esteem and evaluation by teachers ($p = 0.0000$ for the Z test). Placement supervisors gave significantly higher marks to tasks performed by extramural students while conducting a PE lesson independently than the student's self-esteem.

Table 8. Extramural self-esteem against evaluation by placement supervisors concerning a teacher's tasks while conducting a PE lesson independently

No. of question	Group	Mark (%)						Wilcoxon test		Average mark
		lack of skills	very poor	poor	average	good	very good	Z	p	
P.3a	S	0.0	0.0	0.5	3.8	35.7	60.0	2.97	0.0030	4.55
	T	0.0	0.0	0.0	1.4	24.8	73.8			4.72
P.3b	S	0.0	0.0	1.4	9.1	44.8	44.8	4.53	0.0000	4.33
	T	0.0	0.0	0.0	1.9	34.8	63.3			4.61
P.3c	S	0.0	0.0	0.5	7.1	48.1	44.3	4.40	0.0000	4.36
	T	0.0	0.0	1.0	1.9	30.0	67.1			4.63
P.3d	S	0.0	0.0	1.9	17.1	41.0	40.0	4.71	0.0000	4.19
	T	0.0	0.0	0.5	4.3	37.1	58.1			4.53
P.3e	S	0.0	0.5	0.5	10.0	48.1	41.0	3.79	0.0002	4.29
	T	0.0	0.0	0.5	5.2	34.8	59.5			4.53
P.3f	S	0.0	0.0	1.0	9.5	55.2	34.3	6.47	0.0000	4.23
	T	0.0	0.0	0.0	1.4	29.1	69.5			4.68
P.3g	S	0.0	0.0	1.0	11.0	50.0	38.1	6.30	0.0000	4.25
	T	0.0	0.0	0.0	1.0	28.6	70.5			4.70
P.3h	S	0.0	0.0	0.5	14.8	51.4	33.3	4.77	0.0000	4.18
	T	0.0	0.0	0.0	6.7	35.2	58.1			4.51
P.3i	S	0.0	0.5	1.0	14.8	51.0	32.9	4.19	0.0000	4.15
	T	0.0	0.0	1.0	6.2	40.5	52.4			4.44
P.3j	S	0.0	0.5	1.9	18.6	47.6	31.4	6.07	0.0000	4.08
	T	0.0	0.0	0.5	3.8	38.6	57.1			4.52
P.3k	S	0.0	0.5	1.9	23.3	48.6	25.7	6.61	0.0000	3.97
	T	0.0	0.0	0.0	5.7	41.0	53.3			4.48
P.3l	S	0.0	0.5	1.4	3.8	51.9	42.4	5.27	0.0000	4.34
	T	0.0	0.0	0.0	2.9	25.7	71.4			4.69

Note: S – student; T – teacher, while conducting a PE lesson independently; P.3a organizational activities (gathering, checking the attendance, distributing the equipment, etc.); P.3b assigning particular exercises to pupils; P.3c making use of the space for exercises; P.3d controlling the lesson time; P.3e maintaining classroom discipline; P.3f developing motivation for active participation in the lesson; P.3g demonstration of an exercise for every sports discipline taught at university; P.3h correcting mistakes made by pupils; P.3i resolving educational issues occurring during a lesson; P.3j coeducational groups; P.3k large number of groups of pupils doing exercises; P.3l providing protection and security during exercises.

Discussion

Proper preparation for conducting teaching practice and adequate planning of the practice predispose students not only to pursue the teaching profession but also to resolve educational issues in future work with children and adolescents. Teaching placements have been the subject of seminars, conferences and symposia for a long time, e.g. "Model teaching placement program in educating future teachers", national scientific conference "Teaching

practice as an important link in the process of educating pre-school and early school teachers"; or theoretical and methodical conference "Professional placement – professional teachers. On enhancing the quality of teaching practice". In numerous scientific publications, much attention has been paid to teaching placements presenting both the objectives, scope and tasks of teaching practice as well as examples of practical solutions intended to improve teaching practice (Fabiś, Jachnik, Laurentowski, 1978; Kacperczak, 1978; Mańkowska, 1981; Kosińska, 2000; Kitowska, Placzek, Wójciak, 2003; Umiastowska, Makris, 2003; Janikowska-Siatka, 2006; Glapa, 2011).

In the relevant literature, student placements are presented as a form of teaching to:

- gain professional experience,
- build a professional network of contacts in the area of interest,
- recognize an industry and gather information,
- use theoretical knowledge to solve problems,
- develop professional competencies (Narayanan, Olk, Fukami, 2010; Templeton, Updyke, Bennett, 2012).

Self-assessment comprises an essential element of future PE teachers' interpersonal competencies. Adequate self-esteem is highly desirable in the teaching profession. A teacher who is sure about their skills has a great opportunity to build such an educational atmosphere that promotes personal development and establishing mutually satisfying contacts (Zubrzycka-Maciąg, 2007).

When participating in teaching practice, most full-time and extramural students rated their didactic and educational skills as good or very good. The mode of study was not significant in this case. Similar outcomes were obtained from the research carried out in 2012 at the Poznan University of Physical Education (Bronikowski, Kantanista, 2013). The aim of the research conducted AWF in Poznan was to determine the level of the students' preparation for taking part in teaching practice before placement commencement in the second year of studies. The surveyed students evaluated their preparation for work at school (during placements) as the lowest in the field of organizational competencies and the highest within educational skills.

Self-assessment of the physical education students' skills was also raised by the Wroclaw community (Koszczyk, Skarol, Wójcik, 2003). Preparation for work as a physical education teacher was highly evaluated by 92% of students after placement in primary school and by 94% of students conducting practice in junior high school.

Evaluation by placement supervisors turned out to be higher than assessment expressed by Kazimierz Wielki University students. These findings apply to both full-time and extramural students. The purpose of research conducted by S. Skibniewski (2011) was to find out the opinions of physical education teachers acting as placement managers about the competencies of physical education students graduating from the Józef Piłsudski University of Physical Education in Warsaw. The teachers involved in the study evaluated the students' moral and communication competencies as the highest, whereas the creative, IT and media competencies as the lowest. Own research does not confirm the findings of the study carried out by M. Sobieszczyk (2013). The analysis of the research showed that in the opinion of placement supervisors, the students' preparation within educational sphere was the worst. They pointed out that, regarding the students' assessment, emphasis should be placed not only on the level of theoretical knowledge, but above all on practical knowledge and the ability to establish a dialogue with pupils.

The conducted research proves the importance of further monitoring of physical education students' preparation for fulfilling the duties provided for in teaching practice programs. The conclusions drawn from such research prove invaluable when introducing changes in the mode of their preparation as well as within classes of physical education didactics or general didactics.

Conclusions

In this study examining self-esteem of full-time and part-time physical education students of the Kazimierz Wielki University in Bydgoszcz, participating in teaching practice, within didactic and educational skills and comparing this self-esteem with evaluation by teachers – placement supervisors, the authors came to the following conclusions:

- the majority of full-time and extramural students assessed their didactic and educational skills as good or very good,
- both full-time and extramural students were very well prepared for teaching practice Physical Education,
- the comparison of the percentage distributions and average marks clearly shows that evaluation given by placement supervisors was usually higher than the students' self-esteem.

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