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CORRELATIONS BETWEEN PHYSICAL ACTIVITY AND RUFFIER INDICES IN ROMANIAN UNIVERSITY STUDENTS

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ABSTRACT. Introduction: Physical inactivity was prevalent in 31% of adults older than 15 years in 2008 and it is the fourth leading risk factor for global mortality. The purpose of this study was to establish the correlations between the self-reported Physical Activity Index (PAI) and the Ruffier Index in the case of students from Cluj-Napoca, Romania. **Materials and methods:** Four hundred students, enrolled at the "Babeş-Bolyai" University of Cluj-Napoca, voluntarily participated in this research. Anthropometric measures (weight, height and waist circumference) were carried out. Body Mass Index (BMI) was calculated. All subjects self-evaluated their current physical activity level (Physical Activity Index), performed a Ruffier test and an abdominal strength test. **Results:** Mean age of subjects was 20.56 ± 4.58 years, mean weight was 62.51 ± 12.74 kg, mean height was 167.94 ± 12.41 cm, mean Ruffier Index was 11.28 ± 4.76, mean Physical Activity Index was 39.19 ± 25.98, mean BMI was 21.91 ± 3.56 kg/m^2, and the mean number of performed sit ups was 22.26 ± 9.55. A statistically significant negative relation between the Ruffier Index and the Physical Activity Index was found (r = -0.28, p < 0.001). **Conclusions: S**elf-reported levels of physical activity were highly predictive of cardio-respiratory fitness. A positive result of this research was the fact that the participants were not overweight. An alarming outcome was the poor level of their physical fitness. Further investigations are needed in order to see if this situation is valid at national level.

Keywords: *physical activity, Ruffier test, indices, correlations, students*

REZUMAT. ***Corelaţii între indicele de activitate fizică şi indicele Ruffier în cazul studenţilor români.*** **Introducere:** Inactivitatea fizică a fost prevalentă în cazul a 31% dintre adulţii cu vârste peste 15 ani în anul 2008 şi este al patrulea factor de risc al mortalităţii la nivel mondial. Scopul acestui studiu a fost acela de a stabili corelaţiile dintre indicele de activitate fizică şi indicele

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Ruffier în cazul studenţilor din Cluj-Napoca, România. **Materiale şi metode:** Patru sute de studenţi ai Universităţii „Babeş-Bolyai" din Cluj-Napoca au participat voluntar la această cercetare. Au fost efectuate măsurători antropometrice (greutate, înălţime şi circumferinţa taliei). S-a calculat Indicele de Masă Corporală (IMC). Toţii subiecţii şi-au autoapreciat nivelul de activitate fizică (Indicele de Activitate Fizică - IAF), au efectuat un test Ruffier şi unul pentru evaluarea forţei abdominale. **Rezultate:** Vârsta medie a subiecţilor a fost 20.56 ± 4.58 de ani, greutatea medie a fost 62.51 ± 12.74 kg, înălţimea medie a fost 167.94 ± 12.41 cm, indicele Ruffier mediu a fost 11.28 ± 4.76, IAF mediu a fost 39.19 ± 25.98, IMC mediu a fost 21.91 ± 3.56 kg/m^2 şi numărul mediu de abdomene efectuate a fost 22.26 ± 9.55. Între indicele Ruffier şi IAF există o corelaţie negativă semnificativă statistic (r = -0.28, p < 0.001). **Concluzii:** Nivelurile de activitate fizică autodeclarate au prognozat corect nivelurile de pregătire fizică ale participanţilor. Un rezultat pozitiv al cercetării a fost acela că subiecţii nu au fost obezi. Este alarmant, însă, faptul că nivelul lor de pregătire fizică a fost foarte scăzut. Ar trebui efectuate investigaţii ulterioare pentru a vedea dacă această situaţie este valabilă la nivel naţional.

Cuvinte cheie: *activitate fizică, testul Ruffier, indici, corelaţii, studenţi*

Introduction

Physical inactivity causes annually the death of approximately 3.2 million people worldwide. As the fourth leading risk factor for mortality, physical inactivity was prevalent in 31% of adults older than 15 years in 2008 (WHO, 2011). Over the course of time, physical activity has been proved to be negatively related to weight gain or obesity, coronary heart disease (CHD), type 2 diabetes mellitus, Alzheimer's disease and, respectively, dementia (Reiner et al., 2013). In school-aged children and youth, aerobic exercise has positive effects on blood pressure, on the metabolic syndrome, on Body Mass Index (BMI), total fat, and/or abdominal fat, on bone mineral density, and on depression (Janssen & LeBlanc, 2010).

Existing scientific evidence regarding the association between a reduced risk of premature death and regular physical activity is incontrovertible (Warburton, Whitney Nicol & Bredin, 2006). Although it is known that physical activity lowers the risk of mortality, it still remains to be determined the role of its components (intensity, duration, frequency) on preventing CHD, hypertension, obesity, diabetes, and other chronic diseases. Citing different studies, Kokkinos & Myers (2010) conclude that exercise intensity and duration are both associated, in an inverse mode, to the risk of coronary events. Other authors (Warburton et

al., 2006) emphasize the fact that there seems to be a linear relation between the volume and the intensity of the performed physical activity and the health status of those who engage in it.

The general physical condition of one person is defined by that person's cardio-respiratory fitness. An indicator of the cardio-respiratory fitness is the speed of recovery of the cardiac frequency after exercising (Nsenga Leunkeu, Shephard & Ahmaidi, 2014). In France, the interest of the scientific community regarding the heart recovery curves during the first decades of the 20th century led Jean-Edouard Ruffier to develop the Ruffier test. Nsenga Leunkeu et al. (2014) compared the scores obtained by twelve healthy men who performed the Ruffier test with the results obtained by the same subjects after performing a 20 meter shuttle run. The Ruffier test indices and the 20 meter shuttle run indices were moderately correlated. Nevertheless, the scores obtained with the recovery test (Ruffier test) did not correspond to the ranking of the participants based on the 20 meter shuttle run results (Nsenga Leunkeu et al., 2014).

The purpose of this study was to establish the correlations between the self-reported Physical Activity Index (PAI) and the Ruffier Index in the case of students from Cluj-Napoca, Romania.

Materials and methods

Participants

Four hundred students, enrolled at the "Babeş-Bolyai" University of Cluj-Napoca, voluntarily participated in this research. The research protocol was explained to them and they agreed to sign a written informed consent.

Table 1. Physical Activity Index – self evaluation of the score

	Score	Activity
Intensity		
	5	Sustained heavy breathing and perspiration
	4	Intermittent heavy breathing and perspiration, as in tennis
	3	Moderately heavy, as in cycling and other recreational sports
	2	Moderate, as in volleyball, softball
	1	Light, as in fishing
Duration		
	4	Over 30 minutes
	3	20 to 30 minutes
	2	10 to 20 minutes
	1	Less than 10 minutes

Frequency		
	5	6 to 7 times per week
	4	3 to 5 times per week
	3	1 to 2 times per week
	2	A few times per month
	1	Less than once a month

Procedures

Anthropometric measures (weight, height and waist circumference) were performed on all 400 subjects. The Body Mass Index (BMI) was calculated for each participant according to the formula: weight / height^2 [kg/m^2].

Table 2. Physical Activity Index – evaluation of the physical activity level

Evaluation of Activity Score		
Score	**Evaluation**	**Activity Category**
81 to 100	Very active lifestyle	High
60 to 80	Active and healthy	Very good
40 to 59	Acceptable but could be better	Fair
20 to 39	Not good enough	Poor
Under 20	Sedentary	Very poor

All subjects self-evaluated their current physical activity by selecting a score for each of the three components (intensity, duration, frequency) (Table 1). The total score was calculated with the following equation: Intensity x Duration x Frequency, and it was categorized as shown in Table 2.

Table 3. Ruffier Index – classification

Classification	Ruffier Index
Endurance athletes	< 0
Excellent or Good Aerobic fitness	0.1 - 5
Average fitness	5.1 - 10
Poor fitness	10.1 - 15
Very poor or medical issues	> 15.1

Each subject performed a Ruffier test as described by Monod, Vandewalle & Flandrois (2007), cited by Nsenga Leunkeu et al. (2014). Participants performed 30 squats in 45 seconds, with a given pace. Their feet were placed

shoulder width apart, flat on the floor, and their back was kept straight. Heart rates were recorded before starting the test, after 3 minutes of seated rest (P_0), immediately after performing the squats (P_1), and after 1 minute of seated rest (P_2). The Ruffier index was calculated with the formula: Ruffier Index = [(P_0 + P_1 + P_2) – 200] / 10. The classification was made according to Table 3 (Nsenga Leunkeu et al., 2014).

A test for abdominal strength was carried out by all participants. The test consisted of executing sit ups, as fast as possible, in 30 seconds. Subjects were lying with their back on the floor, hands behind the head, knees bent, ankles immobilized by a partner. They elevated their trunk from the floor until they reached a vertical position.

Analyses

Means, standard deviations and standard errors were calculated for all data. Pearson's correlation coefficients were computed in order to investigate the relationships between parameters (age, weight, height, waist circumference, BMI, Physical Activity Index, Ruffier Index, sit ups). A crosstabulation analysis was performed for the Physical Activity Index and the Ruffier Index. The independent-samples t-test was used to investigate whether there are significant differences between males and females in the case of Ruffier Index, Physical Activity Index, sit ups, and BMI. A $p<0.05$ was considered statistically significant. The analyses were carried out in IBM SPSS, version 20.0.

Results

Mean age of subjects was 20.56 ± 4.58 years, mean weight was 62.51 ± 12.74 kg, mean height was 167.94 ± 12.41 cm, mean waist circumference was 73.06 ± 9.40 cm, mean Ruffier Index was 11.28 ± 4.76 (classified as *poor fitness* – see Table 3), mean Physical Activity Index was 39.19 ± 25.98 (evaluated as *not good enough* - see Table 2), mean BMI was 21.91 ± 3.56 kg/m^2 (evaluated as *low risk* of developing diseases related to obesity), and the mean number of performed sit ups was 22.26 ± 9.55.

As seen in Table 4, a statistically significant negative relation between the Ruffier Index and the Physical Activity Index was found (r = -0.28, p < 0.001). Subjects with high Ruffier scores have reported low levels of physical activity. Physical Activity Index has significant positive relations with BMI (r = 0.20, p < 0.001), with waist circumference (r = 0.29, p < 0.001), and with the performed number of sit ups (r = 0.23, p < 0.001) (Table 4).

Table 4. Correlations between six parameters

		BMI (kg/m²)	**Waist circum-ference (cm)**	**Sit ups**	**Physical Activity Index**	**Ruffier Index**	**Weight (kg)**
BMI (kg/m²)	Pearson Correlation	1					
	Sig. (2-tailed)						
	N	399					
Waist circum-ference (cm)	Pearson Correlation	0.769**	1				
	Sig. (2-tailed)	0.001					
	N	398	399				
Sit ups	Pearson Correlation	0.081	0.141**	1			
	Sig. (2-tailed)	0.108	0.005				
	N	398	398	399			
Physical Activity Index	Pearson Correlation	0.206**	0.299**	0.239**	1		
	Sig. (2-tailed)	0.001	0.001	0.001			
	N	395	395	395	396		
Ruffier Index	Pearson Correlation	-0.002	-0.115*	-0.187**	-0.289**	1	
	Sig. (2-tailed)	0.971	0.022	0.001	0.001		
	N	396	396	396	393	397	
Weight (kg)	Pearson Correlation	0.817**	0.861**	0.160**	0.348**	-0.100*	1
	Sig. (2-tailed)	0.001	0.001	0.001	0.001	0.046	
	N	399	399	399	396	397	400

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

A significant association was found between the five levels of self-reported physical activity (PAI) and the four levels of calculated recovery scores (Ruffier Index) ($\chi^2 = 53.15$, $df = 12$, $p = 0.001$) (Tables 5, 6).

Table5. Crosstabulation between Physical Activity and Ruffier Indices

			Ruffier Index				
			excellent	**average**	**poor**	**very poor**	**Total**
Physical Activity Index	81-100 high	Count	4	5	4	4	19
		% of Total	1.0%	1.3%	1.0%	1.0%	4.8%
	60-80 very good	Count	18	29	18	8	69
		% of Total	4.6%	7.4%	4.6%	2.0%	17.6%
	40-59 fair	Count	17	25	17	8	69
		% of Total	4.3%	6.4%	4.3%	2.0%	17.6%
	20-39 poor	Count	40	24	40	30	103
		% of Total	10.2%	6.1%	10.2%	7.6%	26.2%
	<20 very poor	Count	53	28	53	44	133
		% of Total	13.5%	7.1%	13.5%	11.2%	33.8%
Total		Count	56	132	132	94	393
		% of Total	14.2%	33.6%	33.6%	23.9%	100.0%

Table 6. Chi-square test (Physical Activity and Ruffier Indices)

	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	53.150[a]	12	0.001
Likelihood Ratio	53.514	12	0.001
Linear-by-Linear Association	37.183	1	0.001
N of Valid Cases	393		

a. 2 cells (10.0%) have expected count less than 5. The minimum expected count is 2.71.

The Ruffier Index had a mean value of 12.05 ± 4.37 (classified as *poor fitness* – see Table 3) for female participants, and a mean value of 9.46 ± 5.2 (classified as *average fitness* – see Table 3) for male participants (Table 7). PAI had a mean value of 34.39 ± 22.76 (evaluated as *poor* - see Table 2) for females, and a value of 51.15 ± 29.35 (evaluated as *fair* - see Table 2) for males (Table 7).

Table 7. Descriptive statistics (Ruffier and PA Indices, Sit ups, BMI)

	Sex	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Ruffier Index	Female	279	12.0480	4.37011	0.26163
	Male	117	9.4585	5.20060	0.48080
Physical Activity Index	Female	280	34.39	22.757	1.360
	Male	115	51.15	29.348	2.737
Sit ups	Female	281	20.94	9.189	0.548
	Male	117	25.34	9.739	0.900
BMI (kg/m^2)	Female	282	21.440472	3.7178500	0.2213947
	Male	116	23.075164	2.8828848	0.2676691

Table 8. T-test for Ruffier and Physical Activity Indices, Sit ups and BMI

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
Ruffier Index	Equal variances assumed	8.830	0.003	5.078	394	0.001	2.58948
	Equal variances not assumed			4.731	187.992	0.001	2.58948
Physical Activity Index	Equal variances assumed	16.758	0.001	-6.088	393	0.001	-16.755
	Equal variances not assumed			-5.483	172.948	0.001	-16.755
Sit ups	Equal variances assumed	2.809	0.095	-4.274	396	0.001	-4.399
	Equal variances not assumed			-4.173	206.206	0.001	-4.399
BMI (kg/m^2)	Equal variances assumed	1.930	0.165	-4.239	396	0.001	-1.6346922
	Equal variances not assumed			-4.706	273.740	0.001	-1.6346922

The mean score of Ruffier Indices for female participants is significantly higher than the mean score of Ruffier Indices for male participants (t = 4.73, df = 187.99, p = 0.001) (Table 8). Because the variances for the two groups are significantly unequal (F = 8.83, $p < 0.05$), a t-test for unequal variances was used (Table 8). In the case of PAI, the same t-test for unequal variances was utilized (F = 16.76, $p < 0.05$) (Table 8). The mean PAI's score for females is significantly lower than the mean PAI's score for males (t = -5.48, df = 172.94, p = 0.001) (Table 8).

Mean scores of Ruffier Indices are presented in Figure 1 and Figure 2 presents the relations between Physical Activity and Ruffier Indices.

Discussion

In a study published in 2013, Asztalos et al. discussed the relations between subjective health and three other parameters (physical activity, waist circumference, and BMI) based on data obtained from 3208 Belgian adults. The short International Physical Activity Questionnaire (IPAQ) was used to assess physical activity. The authors reported that subjective health was strongly associated with physical activity and negatively associated with BMI (Asztalos et al., 2013).

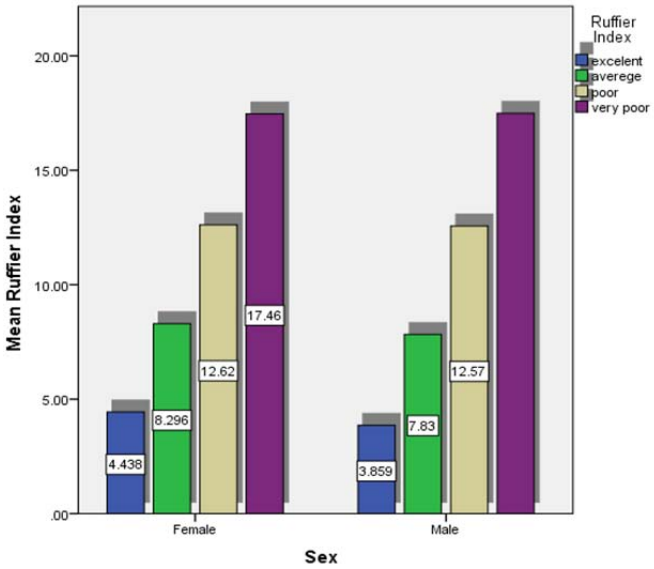

Fig. 1. Classification of Ruffier Indices

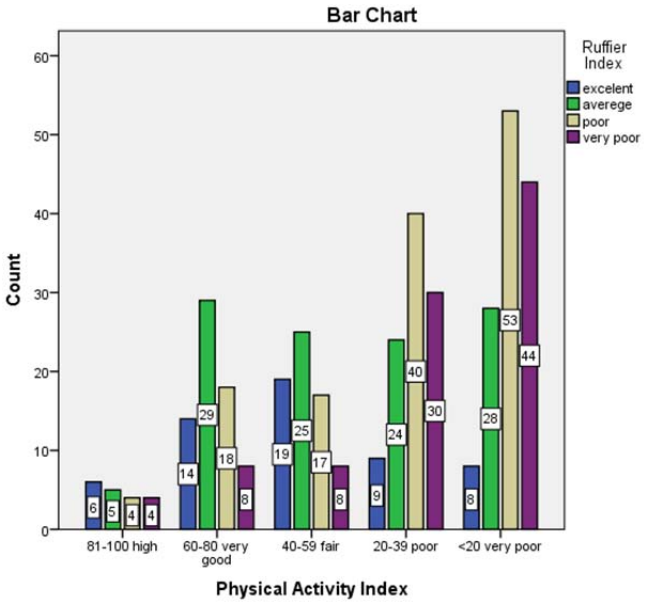

Fig. 2. Crosstabulation between Physical Activity and Ruffier Indices

In the same year, another group of researchers shared with the scientific community results regarding the relationship between the level of physical activity and markers of cardiovascular health in adolescents from Valencia, Spain (Morales-Suarez-Varela, Clemente-Bosch & Llopis-Gonzalez, 2013). 583 Valencian adolescents aged 12-18 years filled in a questionnaire developed to evaluate their physical activity level, participated in sessions of anthropometric (weight, height, waist circumference) measurements, have performed the 20 meter shuttle run test and manual dynamometry. Physical activity level was negatively related to BMI, waist circumference and weight in male adolescents, and positively related to aerobic capacity in both male and female adolescents (Morales-Suarez-Varela et al., 2013).

Self-reported physical activity levels and aerobic fitness status were assessed by Singleton, Fitzgerald & Neale (1994) in 384 healthy black and white adults aged 50-80 years. Physical Activity Index Questionnaire was used to evaluate physical activity levels and aerobic fitness was assessed using a Naughton protocol, with a treadmill (Singleton et al., 1994). Men were more physically active than females, white males and white females were more physically active than black males and black females, respectively. A significant positive relation was found between self-reported exercise levels and aerobic fitness in men. For women, fitness status could not be predicted by self-reported physical activity levels (Singleton et al., 1994).

Toriola & Monyeki (2012) investigated the status of health-related physical fitness, body composition and physical activity in 283 adolescents from South Africa (mean age of 14.90 ± 0.72 years, 111 boys and 172 girls). Eurofit protocol test was chosen to assess physical fitness and International Physical Activity Questionnaire (IPAQ) was administered to evaluate activity levels (Toriola & Monyeki, 2012). BMI was higher for girls than for boys, boys had better scores at Eurofit tests than girls. The conclusion of Toriola & Monyeki (2012) was that boys were more physically active and less overweight than girls.

The mean BMI of our subjects was 21.91 ± 3.56 kg/m^2, evaluated as *low risk* of developing diseases related to obesity. Females had significantly lower BMI than males. Neither males nor females were overweight. Mean Physical Activity Index was 39.19 ± 25.98, evaluated as *not good enough*. Females had significantly lower levels of self-reported physical activity than males. Mean Ruffier Index was 11.28 ± 4.76, classified as *poor fitness*. Females had significantly higher levels of Ruffier Indices than males. Men performed a significantly higher number of sit ups than women.

The findings of our study suggest that, among students aged 20.56 ± 4.58 years from "Babeș-Bolyai" University of Cluj-Napoca, self-reported physical activity was a very good predictor of cardio-respiratory fitness assessed with the

Ruffier test. These results were consistent with the findings of Morales-Suarez-Varela et al. (2013), in the case of adolescents, and partially consistent with the findings of Singleton et al. (1994), in the case of healthy older adults.

Conclusions

The main goal of this study was to investigate the correlations between the self-reported Physical Activity Index (PAI) and the Ruffier Index among students from Cluj-Napoca, Romania. According to the analyzed data, self-reported levels of physical activity were highly predictive of cardio-respiratory fitness. A positive result of this research was the fact that participants were not overweight. An alarming outcome was the poor level of their physical fitness. Further investigations are needed in order to see if this situation is valid at national level.

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