

## RELATIONSHIP OF CARDIORESPIRATORY FITNESS AND PHYSICAL ACTIVITY LEVEL OF PUPILS

Ivana Nikolić, Snježana Mraković, Srna Jenko Miholić

University of Zagreb, Faculty of Teacher Education, Croatia

### Abstract

The aim of this study was to determine predictive values of body mass index, motor abilities, level of physical activity (PA) and sedentary behavior on cardiorespiratory fitness of pupils. The sample consisted of fourth grade pupils (N=74) of the city elementary school aged 10 to 11 years. The predictor set of variables consisted of body mass index, two motor tests for the assessment of agility and repetitive strength as also daily time spent in sedentary activities and high, medium and low intensities calculated on the basis of the Youth Physical Activity Questionnaire (YPAQ). The criterion variable was the result in 3 min running test. The relationship was calculated by the regression analysis. The results of this sample show a high percentage of physically active children, 60 (81%) who meet the WHO recommendations of  $\geq 60$  min/day of moderate to vigorous PA. The highest partial effect on cardiorespiratory fitness shows test for the assessment of coordination, agility and explosive strength (BETA=-.507;  $p=.000$ ) and body mass index (BETA=-.306;  $p=.000$ ), followed by high-intensity PA (BETA=.184;  $p=.004$ ), moderate (BETA=.132;  $p=.037$ ), and the negative impact of sedentary activities (BETA=-.136;  $p=.026$ ). The obtained results and the characteristics of this sample indicate that organized PA in school have an important role in promoting and increasing of a daily high to moderate intensity physical activity.

**Key words:** *physical activity, cardiorespiratory fitness, pupils*

### Introduction

Physical activity (PA) is associated with many health benefits in school-aged children and young people. Despite recommendations of the World Health Organization (WHO) that children and youngsters spend at least 60 min/day in some of the moderate intensity PA, the results show that the level of moderate and vigorous PA decrease by about the ninth year of age (Dalene et al., 2018), and from 9-12 years (Corder et al., 2015) vigorous PA decrease faster. Cardiorespiratory fitness (CRF) is an important indicator of health and can be improved by regular PA, that has a strong influence on health in childhood and adolescence.

Studies show that low level of CRF is a strong predictor for clustering of cardiovascular disease risk factors in children (Anderson et al., 2007), while adequate level of CRF contributes to improving and maintaining health status and is used as a prevention of obesity and related health conditions.

Previous research shows that intensification of PA level is necessary, because vigorous PA (Parikh & Stratton, 2011) and hard PA ( $\geq 9$  METs) (Denton et al., 2013) are more strongly associated with CRF in children compared to lower intensities, such as moderate.

The aim of this study was to determine predictive values of body mass index, motor abilities, level of physical activity and sedentary behavior on cardiorespiratory fitness of pupils.

### Methods

The sample of subjects consisted of 74 pupils (41 male and 33 female) of the First elementary school in Čakovec. With the prior consent of the parents, 4th grade pupils aged 10 to 11 years participated in the study.

The sample of variables for the assessment of physical fitness consisted of two anthropometric measures (body height and body weight), based on which the body mass index (BMI) was calculated, two standard motor tests for the assessment of coordination, agility and explosive strength - carrying over by running (COR) and repetitive strength - sit-up (MSU). Cardiorespiratory fitness was assessed by a 3-minute running test (F3).

A youth physical activity questionnaire (YPAQ) was used to assess PA and screen sedentary time in children. The questionnaire estimates physical activities in the last 7 days, and includes organized PA, PA in school, PA in leisure time and sedentary activities, and makes a list of physical activities energy consumption for the youngsters in which they most frequently participate (Ridley, Ainsworth & Olds, 2008). According to Ainsworth et al. (2000) activities were characterized

and scored according to metabolic equivalent intensity levels (METPA scores) as high-intensity PA (>6 METs), moderate intensity PA (3.0-6.0 METs), light intensity PA (1.6-3.0 METs) and sedentary activities (<1.6 MET). For example, the total time spent in moderate to high intensity activities (MVPA) in 7 days was calculated by summing all physical activities whose MET value was greater than 3 and the average values expressed in minutes per day. The questionnaire was translated into Croatian language, with some PA being replaced by culturally more appropriate activities for this region. Prior to the application of the questionnaire, a pilot study was carried out by random selection on the same sample of subjects (N=30) to determine the reliability of the questionnaire by test-retest method in a period of three weeks between the first and the final application. Reliability coefficients were ranged from 0.59 to 0.76 and illustrated acceptable reliability. The lowest coefficient ( $r_{tt}=0.59$ ) was obtained in the variable light activity (min/day) and the highest ( $r_{tt}=0.76$ ) in the variable vigorous activity (min/day). Children filled out the questionnaire in school together with the trained measurer. Basic descriptive statistic parameters were calculated. Regression analysis was used to determine the predictive value of BMI, motor abilities and level of PA on the criterion variable (F3). The obtained data were processed using the statistical data processing package «SPSS for Windows 17.0».

## Results and Discussion

Of the total sample of subjects (N=74), the majority are involved in organized sports activities, and only 7 (9.5%) are not involved. The majority, 31 of them (41%), are involved in football, basketball and volleyball. In dance activities are included 12 (16%) respondents, sports with racquet 7 (9%), martial arts 5 (6%) and individual sports such as gymnastics, athletics and swimming 12 (16%).

Table 1. Descriptive statistics of the variables

Variables	Min	Max	AM	SD	Skew	Kurt	KS-Z
BH (cm)	133.40	164.00	148.08	6.68	-.055	-.642	.701
BW (kg)	23.60	63.30	39.75	9.69	.829	.012	.253
BMI	12.80	30.30	18.15	3.80	1.184	.698	.042
COR (sec)	9.70	17.25	11.58	1.23	1.544	4.820	.480
MSU	14	38	22.39	3.63	.797	3.800	.459
F3	250	900	685.88	114.57	-.909	1.937	.563

Legend: BH-body height, BW-body weight, BMI-body mass index, COR- carrying over by running, MSU-sit-up, F3-3-minute running test

The average body mass index (BMI) is  $18.15 \pm 3.80$ , with a minimum score of 12.80, and maximum of 30.30. Higher values of asymmetry coefficients (Skew) in the variables BMI and carrying over by running (COR) indicate the grouping of subjects in the lower values zone with a few extremely high values.

Table 2. Descriptive statistisc of the physical activity

Variables	Min	Max	AS	SD	Skew	Kurt	KS-Z
VIGPA(min/day)	3.00	188.57	33.13	30.63	2.02	7.73	.071
MODPA(min/day)	4.00	195.71	72.61	45.54	.947	.025	.028
MVPA(min/day)	27.86	265.00	107.02	53.35	1.150	1.178	.071
LIGHPA (min/day)	2.14	192.86	43.98	40.07	1.446	2.215	.072
SST (min/day)	85.71	490.00	298.56	100.02	.020	-.739	.914

Legend: VIGPA-vigorous PA, MODPA-moderate PA, MVPA-moderate to vigorous PA, LIGHPA-light PA, SST-sedentary screen time

Table 2 shows that children spend daily in moderate to high/vigorous intensity PA (MVPA) from 27.86 min to 265 min ( $107 \pm 53.35$  min/day). Skew in the variables VIGPA, MODPA, MVPA indicates the grouping of subjects in the lower value zone with a few extremely high values. There is a high percentage of physically active children, 60 (81%) who meet the WHO recommendations of  $\geq 60$  min/day of moderate to vigorous PA, compared to the results (Inchley et al., 2016) of the PA of Croatian school children conducted in 2013./2014. year as part of the international HBSC project which shows that only 39% boys and 26% girls, aged 11 were in MVPA at least 60 min/day. One reason for this difference can be assumed to be the validity of the YPAQ questionnaire (McCrorie, Perez & Ellaway, 2016), which shows an average overestimation of MVPA for 25 min/day in relation to the direct method of measurement. Also, the characteristics of this sample show a high representation in organized leisure PA, as well as in school PA. Beside of the regular physical education classes, 50 children had extracurricular sports activities as part of their regular primary education, and 30 children attended

the universal sports school, twice a week for 45 min. Comparing the average values of time spent in MVPA to peers surveyed by the same questionnaire, respondents of this sample have higher values by 18 min (Raistenskis et al., 2015), by 7 min (Mc Crorie, Perez & Ellaway, 2016) and 32 minutes (Brooke et al., 2014). The high dispersion of results is in the sedentary activity variable and ranges from 85 to 490 min/day ( $298 \pm 100.02$  min/day). The respondents spent in sedentary activities average 5 hours/day and are similar to British peers (Klitsie et al., 2013), who spend 35 hours/week. Compared to Lithuanian peers who self-reported with the same questionnaire (Raistenskis et al., 2015), respondents in this sample spend 2.5 h more in sedentary activities per day.

Table 3. Regression analysis for cardiorespiratory fitness (F3)

R=0.88;R <sup>2</sup> =0.78;Adj.R=0,75 F(7.66)=33.69;p=0.00;SEE=56.34	B	SE	Beta	t	p
COR	-47.138	8.492	-.519	-5.725	.000
MSU	2.843	2.393	.090	1.317	.192
BMI	-9.214	2.290	-.306	-4.024	.000
VIGPA (min/day)	.687	.235	.184	3.010	.004
MODPA (min/day)	.332	.155	.132	2.133	.037
LIGHPA (min/day)	-.087	.189	-.030	-.462	.646
SST (min/day)	-.156	.061	-.136	-2.211	.026

Legend: COR-carrying over by running, MSU-sit-up, BMI-body mass index, VIGPA-vigorous PA, MODPA-moderate PA, MVPA-moderate to vigorous PA, LIGHPA-light PA, SST-sedentary screen time

According to the value of the coefficient of multiple correlation ( $R=0.88$ ), with a significance level of  $p=.00$  it can be established that there is a statistically significant correlation between the predictor and criterion variable CRF (Table 3). The value of the coefficient of determination shows that the set of predictors explained 78% of variance of the criterion variable, i.e. mostly according to corrected coefficient of determination, 75% of the criterion variance CRF. The highest partial influence ( $BETA=-.507$ ;  $p=.000$ ) is indicated by the test COR and BMI ( $BETA=-.306$ ;  $p=.000$ ). The predictive value of the PA variables on CRF showed the highest partial impact of high-intensity VIGPA ( $BETA=.184$ ;  $p=.004$ ), followed by moderate MODPA ( $BETA=.132$ ;  $p=.037$ ), and a negative impact of sedentary SST ( $BETA=-.136$ ;  $p=.026$ ) activities. Variables MSU and time spent in LIGHPA were not significantly related with the criterion variable. A negative correlation between BMI and CRF has been identified by other authors on a sample of peers (Hussey et al., 2007), showing that normal weight children have lower BMI and greater aerobic capacity in higher intensity activities than children who have higher BMI and lower aerobic capacity. Similar results are reported by Bonney et al. (2018) according to which overweight and obese children have reduced cardiorespiratory capacity compared to peers with normal weight. The negative correlation of BMI with aerobic capacity in a sample of subjects of the same age is cited by Gontarev and Ruzdi (2014) and Ceshia et al. (2016). Positive correlations between time spent in higher intensity PA and CRF are in accordance to research on children of similar age. Denton et al. (2013) found that for boys, vigorous and hard intensity PA ( $\geq 9$  METs) were significantly correlated to CRF. Gutin et al. (2005) in their research reports that adolescents who engaged in relatively large amounts of vigorous PA tended to have a better CRF and smaller, but significant proportion moderate PA of the variance in CRF. The importance of high intensity PA on CRF level (Ruiz et al., 2006) is shown in children who engaged  $>40$  min of vigorous PA/day had higher CRF than did those who accumulated  $<18$  min of vigorous PA/day. The correlation between variable light intensity PA and CRF is in accordance with studies (Aires et al., 2010; Yang et al., 2019) who found that light PA (1.5–2.9 METs) was not significant when associated with CRF. The negative significant correlation of sedentary activities with CRF indicates that children who spend more time in daily sedentary activities have significantly lower CRF. The results are not congruent with the study by Denton et al., (2013) in which no significant correlation was obtained.

## Conclusion

The results of this observational study may be useful in understanding the correlations between CRF and PA of different intensities in early school age children. Although the assessment of PA was performed by the indirect questionnaire method, the majority of subjects in this sample met the recommendation of daily PA, and the results confirm the previous understanding of the importance of intensifying high and moderate PA intensity in improving CRF. The lack of research is a small and convenient sample of a city school, so the obtained results cannot be generalized. However, the results and the characteristics of this sample also indicate that organized PA at school have an important role in promoting and increasing daily moderate to high intensity physical activity.

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