DOI 10.26773/smj.240202

SportMont

ORIGINAL SCIENTIFIC PAPER

Differences in the Quality of Life Relative to the Level of Cardiorespiratory Capacity of Primary School Students

Leona D. Roca[1], Marko B. Badrić[1], Vladimir R. Živanović[2]

[1]University of Zagreb, Faculty of Teacher Education, Zagreb, Croatia, [2]University of Belgrade, Faculty of Education, Belgrade, Serbia

Abstract

As cardiorespiratory capacity is an important factor of an overall quality of life and a significant indicator of physical fitness, its development should begin from early childhood. The goal of the research is to determine the differences in the quality of life and cardiorespiratory abilities of primary education students. A total of 651 fourth-grade primary school students from the Republic of Croatia participated in the research. The average age of the subjects was 10.38±0.50 years, and the sample was divided in two subsamples according to gender, 316 girls (10.30±0.47 years) and 335 boys (10.34±0.49 years). Body height was measured with a portable altimeter, while body mass, body mass index – BMI, percentage of fat, level of obesity, and muscle mass were measured with a two-frequency body composition analyser (TANITA DC-360P). Waist circumference and hip circumference were measured with a centimeter tape, while the ratio of the waist and hip circumference (WHR index) was calculated based on their ratio. Cardiorespiratory capacity was assessed with a multi-stage 20m-running test (20MSRT Shuttle run test). For assessing the qualty of life, the researchers used a Croatian version of the KIDSCREEN-10 Questionnaire. The research results show a high mean value of the overall life quality assessment (4.33). The identification of individual differences between the researched groups demonstrated that students with a high level of cardiorespiratory capacity rate their quality of life significantly higher than students with a low or moderate cardiorespiratory capacity. According to the results, 41.01% of students have an unsatisfactory level of cardiorespiratory ability. There are statistically significant differences in morphological characteristics and cardiorespiraory capacity among the groups classified according to their level of cardiorespiratory capacity. Children with a higher level of cardiorespiratory capacity report a better quality of life and have better indeces of physical nutrition. Physical exercises used to boost the development of the cardiorespiratory capacity of children indirectly impact the prevention of obesity and can diminish other factors of cardiovascular risk.

Keywords: *KIDSCREEN 10, quality of life, maximum oxygen uptake, 20 m Shuttle run test, students*

Introduction

Health-related quality of life is a measure of impact of health or illness on everyday functions. It is greatly influenced by concerns, conditions, and aspirations of individuals, as well as the self-perceived health and well-being (Haraldstad et al., 2019). The World Health Organisation defined the health-related quality of life as a multidimensional and integrative construct consisting of physical, psychological, and social well-being and functioning (WHOQOL, 1993). Children's quality of life is as important as investing in the future of our society because children constitute an important social group and deserve a safe and healthy environment in which they grow up (Roca, 2023). It is necessary to raise awareness among young people regarding the importance and impact of doing physical activities and basic endurance sports, such as swimming and water polo (Marković & Milošević, 2023), useful for improving cardiorespiratory capacity. Children's quality of life has been conceptualised and studied for several decades, but

Correspondence:

Vladimir. R. Živanović
University of Belgrade, Faculty of Education, Department of Physical Education Methodology, Kraljice Natalije 43, 11000 Belgrade, Serbia
E-mail: vladimir.zivanovic@uf.bg.ac.rs

with different approaches. Three main approaches include the health-related quality of life (HRQOL), social indicators, and subjective well-being (Wallander & Koot, 2016). Common aspects of the quality of life include personal health (physical, mental, and spiritual), educational status, work environment, social status, wealth, sense of security, freedom, autonomy in decision-making, social belonging, and their physical environment (Ilić, Popović, Marković, Nemec, & Milosević, 2020; Teoli & Bhardwaj, 2023). Determinants of health quality include socio-demographic, environmental, and nutritional characteristics such as factors of nutrition and lifestyle (Pano et al., 2020). Physical exercise as a public health tool is based on its influence on physical health, including a positive influence on the prevention and control of diabetes type 2. There is an increasing interest in its impact on other aspects of health, such as mental and social health, and on the quality of life and an overall well-being (Heimer & Sporiš, 2016). The health-related quality of life encompasses the aspects of the overall quality of life that clearly impact physical and mental health. Nowadays, measuring the quality of life has become an important outcome in the evaluation of health interventions and treatments from clinical and epidemiological perspectives (Ravens-Sieberer et al., 2006).

Cardiorespiratory ability is linked to the health-related quality of life (Mišigoj-Duraković et al., 2018). Different factors impact the maximum oxygen uptake (VO2max). Over time, a downward trend in aerobic ability can be expected. It is assumed that these trends reflect temporal changes in body composition (increasing obesity), rather than a true drop of cardiorespiratory function over time (Rowland, 2007). Maximum oxygen uptake (VO2 max) refers to the intensity of the aerobic process and indicates the maximum ability to transfer and use oxygen during exercising (Shete, Bute, & Deshmukh, 2014). Cardiorespiratory fitness in childhood considerably influences health in adulthood and offers a potential insight into the health status of the human population in the future (Ruiz et al., 2009). Cardiorespiratory fitness reflects an overall capacity of the physiological systems (cardiovascular, respiratory, metabolic, and neuromuscular) when performing a continued and dynamic physical exercise of large muscle groups at moderate to high intensity over long periods of time. The usefulness of the cardiorespiratory fitness is in the fact that it is one of the indicators of health index (Tomkinson, Lang, Blanchard, Léger & Tremblay, 2019). The American Heart Association states that cardiorespiratory fitness should be regularly assessed as the fifth clinical vital sign for predicting human health and lifespan, along with respiration, body temperature, pulse, and blood pressure (Ross et al., 2016). A higher value of cardiorespiratory fitness in childhood and adolescence is stronlgy linked to the current level of health, as well as to a great prediction for the future (Ortega et al., 2011). The research by Andersen et al. (2017) on a sample of 10-year-old Norwegian students found that improving the cardiorespiratory capacity greatly improves the quality of life of children. In the longitudinal study by Evaristo et al. (2019) it was concluded that the level of cardiorespiratory capacity decreased in children in two years, and therefore the quality of life decreased significantly. Basterfield, Burn, Galna, Karoblyte and Weston (2021), in a study on a sample of 432 subjects, found that additional physical activity of children during the day impacts the increase in cardiorespiratory capacity and the quality of their life. In addition, the existence of a significant connection between a high level of CRF and the quality of life of children and young people has been established in research (Marques, Mota, Gaspar, & de Matos, 2017; Pires-Júnior et al., 2018; Redondo-Tébar et al., 2019). Although there are studies that have addressed this topic, studies related to the population of children in Croatia are still lacking. Therefore, the goal of the research is to determine the differences in the quality of life and cardiorespiratory abilities of primary school students in Croatia.

Methods

Participants

A sample of 651 fourth-grade primary school students in Croatia was used in this research. The average age was 10.38±0.50 years, and the sample was divided into two subsamples according to gender, 316 girls (10.30±0.7 years) and 335 boys (10.34±0.9 years). The research was conducted in the second term of the school year 2021/2022. All participants were completely healthy at the time of the research. Students with confirmed health problems were not included in the implementation of the research and, in agreement with the teachers, they were not granted consent to participate in the research. Students who provided a signed parental consent to participate in the research were included in the study. In each class, the research was conducted for the duration of two school hours of physical education, while students who did not perform one measurement were also excluded from the further procedure. The research was conducted in line with ethical principles set in the Code of Ethics of the University of Zagreb, The Code of Ethics in the Research Involving Children (Ajduković & Keresteš, 2020) and the study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of the University of Zagreb, Faculty of Teacher Education (Reg. No.:251-17-22-1, date of approval January 1st, 2022).

Classification according to the Level of Cardiorespiratory Fitness

Table 1 shows the results of the frequency analysis of the participants classified according to the level of cardiorespiratory fitness. The classification was carried out in line with the international norms (Tomnkinson et al., 2017). The participants classified under 40 centils were placed in the category low level of cardiorespiratory ability. The participants in the range 40-60 centils were categorised in the group of an average level of cardiorespiratory ability, whereas the participants in the range of 60-100 centils were ranked in the category of the high level of

Table 1. Results of the number of participants relative to gender and level of cardiorespiratory capacity

	TOTAL		BOYS		GIRLS	
	No	**%**	**No**	**%**	**No**	**%**
Low level CRF	267	41.01	168	50.15	99	31.33
Average CRF	176	27.04	60	17.91	116	36.71
High level CRF	208	31.95	107	31.94	101	31.96

Note CRF- Cardiorespiratory fitness

cardiorespiratory ability. The results show that out of the total sample, 41.01% of participants have an unsatisfactory level of cardiorespiratory ability. From gender perspective, 50.15% of boys have a very low level of this ability, the result which is much worse compared to 31.33% of girls.

Anthropometric Characteristics

Anthropometrical measurements were carried out in line with the International Biological Program (IBP) (Weiner & Lourie, 1969). Body height was measured with altimeter (Seca® 213, Hamburg, Germany), while body mass, body mass index – BMI, and fatty tissue (%) were measured with a two-frequency body composition analyser (TANITA DC-360P). Waist and hip circumferences were measured with a centimeter tape, and the ratio of the hip and waist circumference (WHR index) was calculated on the basis of their ratio.

20 meters (20MSRT Shuttle run test)

Cardiorespiraotory capacity was assessed by a multi-stage 20m running test (20MSRT Shuttle run test) where the speed of running starts at 8.5 km/h−1 and increases by 0.5 km/h−1 every minute. Every stage lasts about 60 seconds, and the sound signal interval dictates the duration of each interval (Leger & Lambert, 1982). Maximum oxygen uptake (VO2max, mL/kg/min) was calculated by using an equation VO2max = 31.025 + 3.238 (S) 2 3.248 (A) + 0.1536 (A 3 S), where S = speed in kilometers per hour at the end of the test and A = age expressed in years (Leger et al., 1988). This equation is suitable for boys and girls age 8-19 using an online calculator (Wood, 2019).

Quality of life

The participants' quality of life was determined by using a questionnaire for children and adolescents of age 8-18 (The KIDSCREEN Group Europe, 2006). For assessing the subjective health and well-being of adolescents the Croatian version of the quality of life questionnaire The KIDSCREEN-10 was used, which is shorter version of the KIDSCREEN-52 (Lorger, 2011). The questionnaire evaluates dimensions of physical and mental well-being, autonomy and parental relationships, peer and social support, and school environment. It consists of 10 questions in which the participants mark their level of agreement with the content of individual statements on a Likert-type scale of five levels, resulting in an overall score. The metric characteristics of the KIDSCREEN-10 are at a satisfactory level. The values of Cronbach alpha are 0.82, and coefficient test-retest 0.70 as a satisfactory result of the internal consistency of the questionnaire (Ravens-Sieberer et al., 2010).

Statistical analyses

In data processing, basic descriptive parameters were calculated for all researched variables: arithmetic mean, standard deviation, median, skewness, kurtosis, and frequency analysis. The significance of the differences between the subsamples according to cardiorespiratory capacity and the quality of life was tested by the univariate analysis of variance ANOVA. The statistical significance of the differences in morphological characteristics, quality of life, and aerobic capacity relative to gender was tested by the univariate analysis of variance (ANOVA). For variables that have a statistically significant F value, the Scheffe post hoc test was used to determine the differences between the arithmetic means of the groups in the further analysis. The statistical significance of the differences was tested at the significance level of $p<0.05$. Data processing was performed with the program STATISTICA version 14.0.0.15., TIBCO Software Inc.

Results

The results in Table 2 show the descriptive parameters of all analysed variables. Due to the nature of the test on larger samples, asymmetry and skewness of the distributions were checked. The values are within the limits of -2 to +2 and with

Table 2. Descriptive indicators in morphological characteristics, cardiorespiratory capacity, and the quality of life of the fourth-grade boys and girls

	TOTAL N=651	BOYS N=335	GIRLS N=316			
Variables	**M ± SD**	**M ± SD**	**M ± SD**	**Median**	**Skew**	**Kurt**
Body height (cm)	147.92 ± 7.23	147.50 ± 6.85	148.37 ± 7.58	147.60	0.24	0.17
Body mass (kg)	41.03 ± 9.93	41.62 ± 10.42	40.40 ± 9.36	39.50	0.89	0.77
Body fat (%)	19.21 ± 7.57	17.88 ± 7.28	20.63 ± 7.62*	18.20	0.55	-0.29
Body mass index (BMI)	18.57 ± 3.45	18.93 ± 3.67*	18.20 ± 3.15	17.90	0.95	0.68
Waist circumference (cm)	63.50 ± 8.88	65.33 ± 9.78*	61.57 ± 7.35	61.00	1.22	1.72
Hip circumference (cm)	80.34 ± 8.58	80.98 ± 8.97*	79.66 ± 8.10	79.00	0.58	0.07
Waist and hip ratio (WHR)	0.79 ± 0.05	0.80 ± 0.05*	0.77 ± 0.05	0.79	0.37	1.73
Health evaluation	4.30 ± 0.74	4.30 ± 0.76	4.30 ± 0.72	4.00	-0.80	0.08
Physical form	4.26 ± 0.84	4.33 ± 0.79*	4.18 ± 0.89	4.00	-1.16	1.31
Energy level	4.38 ± 0.75	4.38 ± 0.77	4.39 ± 0.72	5.00	-1.22	1.61
Total assessment of the quality of life	4.33 ± 0.48	4.34 ± 0.46	4.33 ± 0.50	4.40	-1.17	1,62
Maximum oxygen uptake VO2max (mL/kg/min)	45.16 ± 3.78	45.79 ± 4.33*	44.50 ± 2.95	44.60	0.76	0.20
Running distance-(m)	487.28 ± 280.19	542.33 ± 323.72*	428.92 ± 210.35	400.00	1.14	1.00

Note M=arithmetic mean; SD = standard deviation; Skewness =asymmetrical distribution; Kurtosis = tailedness of distribution; * significance at error level $p < 0.05$

the fulfilment of this criterion (Hair et al., 2010) the investigated variables were included in the parametric analysis. Differences relative to gender were determined by using the analysis of variance. Given the results of the total sample, it is evident that the students' average height is 147.92±7.23 centimetres and their average body weight is 41.03±9.93 kilograms. The result of the percentage of fat is 19.21%, while the values of the body mass index (BMI) are 18.57, which means that the participants are normally nourished. The analysis of the results of the morphological characteristics relative to gender shows that the differences between boys and girls can be identified in most variables. Girls have significantly higher results in fat percentage (20.63), while boys have significantly higher values of body mass index, waist and hip circumference and their ratio. No significant differences were observed in the variables that assess the quality of life, except in the dimension of physical form, where boys rate their form significantly higher than girls. In the field of cardiorespiratory fitness, boys have significantly higher results than girls in both measured variables.

According to the results of the analysis of variance (ANOVA), Table 3 clearly shows that there are statistically significant differences between the groups which are categorised by the level of the cardiorespiratory capacity. A post hoc analysis was carried out using the Scheffe test in the variables where statistical significance was confirmed by the analysis of variance. The results show that the participants belonging to the subsample with the low level of cardiorespiratory capacity have significantly poorer results in all variables. Similarly, significant differences were identified between the subsamples of average and high level of this capacity in variables assessing morphological characteristics and cardiorespiratory capacity. Moreover, a statistically significant difference was identified in the variable assessing the overall quality of life of primary school students. In the subsamples of average and low level of cardiorespiratory capacity, differences were found in all morphological characteristics and cardiorespiratory capacity.

Table 3. Results of ANOVA test and Scheffe post hoc test for determining the differences between the groups defined according to the level of cardiorespiratory capacity

	Low level CRF	Average level CRF	High level CRF	Anova	
Variables	M±SD n=267	M±SD n=176	M±SD n=208	**F-test**	**p-value**
Body height (cm)	148.31 ± 7.49	147.89 ± 7.42	147.45 ± 6.69	0.83	0.44
Body mass (kg)	44.02 ± 11.17	40.70 ± 9.16*c	37.47 ± 7.34 *a/b	27.67	0.00
Body fat (%)	21.78 ± 8.00	19.67 ± 7.00*c	15.53 ± 5.81*a/b	46.00	0.00
Body mass index (BMI)	19.81 ± 3.90	18.44 ± 2.99*c	17.10 ± 2.45*a/b	40.79	0.00
Waist circumference (cm)	66.76 ± 10.37	62.73 ± 7.74*c	59.97 ± 5.68*a/b	39.21	0.00
Hip circumference (cm)	83.31 ± 9.30	80.27 ± 7.62*c	76.59 ± 6.73*a/b	40.13	0.00
Waist and hip ratio (WHR)	0.80 ± 0.06	0.78 ± 0.05*c	0.78 ± 0.04*a	8.48	0.00
Health estimate	4.14 ± 0.78	4.38 ± 0.73*c	4.44 ± 0.66*a	11.11	0.00
Physical form	4.10 ± 0.90	4.24 ± 0.87	4.47 ± 0.69*a/b	11.68	0.00
Energy level	4.26 ± 0.83	4.41 ± 0.69	4.52 ± 0.66*a	7.17	0.00
Total quality of life assessment	4.24 ± 0.51	4.32 ± 0.49	4.46 ± 0.39*a/b	12.16	0.00
Maximum oxygen uptake VO2max (mL/kg/min)	42.05 ± 1.61	44.74 ± 1.36*c	49.52 ± 2.85*a/b	794.10	0.00
Running distance -(m)	264.64 ± 89.17	441.59 ± 97.87*c	811.73 ± 238.17*a/b	740.43	0.00

Note *statistical significance p<0.05; a=low level-high level; b= average level-high level; c= low level-average level; MEAN=arithmetic mean; SD = standard deviation; CRF- Cardiorespiratory fitness

Discussion

In line with the set goal of the research, the researchers determined the presence of the statistically significant difference between the subgroups categorised relative to the level of cardiorespiratory capacity and the quality of life of the primary school students. By determining individual differences between the researched groups, it becomes evident that students who have a high level of cardiorespiratory capacity rate their quality of life significantly higher than students who have a low or average level of cardiorespiratory capacity. No significant differences were found between the groups of students who have a low or average level of cardiorespiratory capacity. Significant correlations between cardiorespiratory ability and the quality of life were obtained in a study by Evaristo et al. (2019). Improving cardiorespiratory ability is useful for improving the quality of life of children (Andersen et al., 2017). Many research studies show that cardiorespiratory capacity is associated with a higher quality of life of children and adolescents (Gu, Chang, & Solmon, 2016; Marques, Mota, Gaspar, & de Matos, 2017; Pires-Júnior et al., 2018). A higher level of cardiorespiratory capacity contributes to the healthy quality of life, while age has the opposite effect, namely, the quality of life in terms of health decreases with age (Marković et al., 2022). There is very little research that examined the differences between groups categorised according to the level of cardiorespiratory capacity with quality of life, which makes any comparisons difficult. Morales et al. (2013) obtained similar results as in our research, given that it was determined that boys and girls who have a higher level of cardiorespiratory capacity also have better physical well-being results. In girls with a higher cardiorespiratory capacity, a significant difference in the overall level of the quality of life was found. Children with better results in the dimension of physical well-being have significantly better results of cardiorespiratory capacity compared to

those who reported a lower level of physical well-being which is an important segment of the quality of life (Pires-Júnior et al., 2018). A significant difference was found in body mass and body fat percentage. Students with an average level of cardiorespiratory capacity have a significantly lower body mass and fat percentage than students with a low level of cardiorespiratory capacity. Students with a high level of cardiorespiratory capacity have significantly lower body mass and body fat percentage than students with an average and low level. Students with a low level of cardiorespiratory capacity have significantly worse body mass index results compared to students with a higher level of aerobic capacity, while those with an average level have significantly lower body mass index results than students with a high level of cardiorespiratory capacity. Some research (Hermoso et al., 2019; Caamaño-Navarrete et al., 2021) found that children with normal physical nutrition have statistically better aerobic capacity results than those who belong to the obese or overweight groups. In the waist circumference and hip circumference variables, and their ratio, a statistically significant difference was found relative to the level of cardiorespiratory capacity. Students with a high level of cardiorespiratory capacity had significantly lower results in all three variables compared to students with average and low levels. Similar results were obtained in one research (Álvarez et al., 2020). A significant difference was also observed between students with an average and low levels, where students with an average level of cardiorespiratory capacity have significantly lower waist circumference, hip circumference, and waist-to-hip ratio results. In the research of Liu et al. (2022), it was found that children with better waist circumference achieved much better cardiorespiratory capacity results compared to those with worse waist circumference results. In our research, it was determined that boys have significantly better results in cardiorespiratory capacity than girls. The previous research showed that boys have significantly higher results than girls (Hamlin et al., 2014; Yang et al., 2019; Langer et al., 2020). In addition, our research confirmed a significant difference in the assessment of the physical form in favour of boys, but no difference was found in the overall assessment of the quality of life between the genders. Likewise, it was noted that boys have higher values of measures that assess body voluminousness and nutrition than girls. Boys have higher body mass index (BMI) values, but also waist and hip circumferences, which is very indicative for this age. A study (Živanović et al., 2018; Alvarez et al., 2020) showed that in both genders, the groups with a higher level of cardiorespiratory capacity had significantly lower values of waist circumference, waist and hip ratio, body mass index (BMI), and body fat percentage. The facts and conclusions of the previous research show that reducing obesity and increasing cardiorespiratory capacity contribute to a better quality of life. Children who have higher values of cardiorespiratory capacity report a better quality of life, but also have better indicators of physical nutrition. If young people continuously receive information about the importance of physical activity and proper nutrition, it is possible to encourage the development and maintenance of physical fitness and the adoption of a healthy lifestyle, thereby influencing the reduction of obesity as a dangerous health threat to the entire population.

The limitations of this research are found in measuring cardiorespiratory capacity which was carried out with a multi-stage 20 meter-running test (20MSRT Shuttle run test). Although this test is traditional in research involving children and has shown good metric characteristics, its assessment is based on field measurement and not on a direct measurement in the laboratory. Also, the limitation of this research may be the implementation of the 20-meter running test itself (20MSRT Shuttle run test) which is greatly influenced by motivation, giving rise to concerns that some results might be lower than the objective abilities of the research participants.

In the end, we can conclude that by raising the level of cardiorespiratory capacity in programmed and organised sports activities, it is possible to contribute to an increase in the quality of life of primary education students. This can certainly be an incentive to young people for a lifelong physical exercise, and cardiorespiratory capacity can be considered one of the factors influencing the quality of life from the aspect of health.

Acknowledgments
There are no acknowledgments.

Conflict of Interest
The author declares that there is no conflict of interest.

Received: 11 October 2023 | **Accepted:** 13 January 2024 | **Published:** 01 February 2024

References

Ajduković, M., & Keresteš, G. (2020). *Etički kodeks istraživanja s djecom (drugo revidirano izdanje) [Code of ethics for research with children (second revised edition)]*. Zagreb: Vijeće za djecu Republike Hrvatske.

Álvarez, C., Cadore, E., Gaya, A. R., Mello, J. B., Reuter, C. P., Delgado-Floody, P., & Ramírez-Vélez, R. (2020). Associations of cardiorespiratory fitness and obesity parameters with blood pressure: fitness and fatness in youth Latin-American ethnic minority. *Ethnicity and Health, 21*(1), 17. doi: 10.1080/13557858.2020.1840525.

Andersen, J. R., Natvig, G. K., Aadland, E., Moe, V. F., Kolotkin, R. L., Anderssen, S. A., & Resaland, G. K. (2017). Associations between health-related quality of life, cardiorespiratory fitness, muscle strength, physical activity and waist circumference in 10-year-old children: the ASK study. *Quality of Life Research, 26,* 3421-3428. doi: 10.1007/s11136-017-1634-1.

Caamaño-Navarrete, F., Latorre-Román, P. Á., Párraga-Montilla, J. A., Álvarez, C., & Delgado-Floody, P. (2021). Association between Creativity and Memory with Cardiorespiratory Fitness and Lifestyle among Chilean Schoolchildren. *Nutrients*, *13*(6), 1799. https://doi.org/10.3390/nu13061799

Evaristo, O. S., Moreira, C., Lopes, L., Abreu, S., Agostinis-Sobrinho, C., Oliveira-Santos, J., & Santos, R. (2019). Cardiorespiratory fitness and health-related quality of life in adolescents: A longitudinal analysis from the LabMed Physical Activity Study. *American Journal of Human Biology: The Official Journal of the Human Biology Council*, *31*(6), e23304. https://doi.org/10.1002/ajhb.23304

García-Hermoso, A., Correa-Bautista, J. E., Olloquequi, J., & Ramírez-Vélez, R. (2019). Health-related physical fitness and weight status in 13- to 15-year-old Latino adolescents. A pooled analysis. *Jornal de Pediatria*, *95*(4), 435–442. https://doi.org/10.1016/j.jped.2018.04.002

Gu, X., Chang, M., & Solmon, M. A. (2016). Physical activity, physical fitness, and health-related quality of life in school-aged children. *Journal of Teaching in Physical Education*, *35*(2), 117-122.

Ilić, R., Popović, J., Marković, V., Nemec, V., & Milosević, M. (2020). Work-related stress among primary healthcare workers. *Vojno Sanitetski Pregled*, *77*(11), 1184–1191.

Hair, J., Black, W. C., Babin, B. J. & Anderson, R. E. (2010). *Multivariate data analysis (7th ed.)*. Upper Saddle River, New Jersey: Pearson Educational International.

Hamlin, M. J., Fraser, M., Lizamore, C. A., Draper, N., Shearman, J. P., & Kimber, N. E. (2014). Measurement of cardiorespiratory fitness in children from two commonly used field tests after accounting for body fatness and maturity. *Journal of Human Kinetics*, *40*, 83–92. https://doi.org/10.2478/hukin-2014-0010

Haraldstad, K., Wahl, A., Andenæs, R., Andersen, J. R., Andersen, M. H., Beisland, E., Norekvål, T. M., … & LIVSFORSK network (2019). A systematic review of quality of life research in medicine and health sciences. *Quality of Life Research: An International Journal of Quality of*

Life Aspects of Treatment, Care and Rehabilitation, *28*(10), 2641–2650. https://doi.org/10.1007/s11136-019-02214-9

Heimer, S., & Sporiš, G. (2016). Kineziološki podražaji i ukupna tjelesna aktivnost u zaštiti zdravlja i prevenciji kroničnih nezaraznih bolesti [Kinesiological stimulants and overall physical activity in the protection of health and prevention of chronic non-communicable diseases]. U *I. Prskalo, i G. Sporiš (ur.), Kineziologija (str. 171-190).* Zagreb: Školska knjiga, Učiteljski fakultet Sveučilišta u Zagrebu, Kineziološki fakultet Sveučilišta u Zagrebu.

Langer, R. D., de Fatima Guimarães, R., Gonçalves, E. M., Guerra-Junior, G., & de Moraes, A. M. (2020). Phase Angle is determined by Body Composition and Cardiorespiratory Fitness in Adolescents. *International Journal of Sports Medicine*, *41*(9), 610–615. https://doi.org/10.1055/a-1152-4865

Léger, L. A., Mercier, D., Gadoury, C., & Lambert, J. (1988). The multistage 20 metre shuttle run test for aerobic fitness. *Journal of Sports Sciences*, *6*(2), 93–101. https://doi.org/10.1080/02640418808729800

Leger, L. A., & Lambert, J. (1982). A maximal multistage 20-m shuttle run test to predict VO2max. *European Journal of Applied Physiology, 49,* 1-12., 49, 1-12.

Lorger, M. (2011). *Sport i kvaliteta života mladih [Sport and quality of life of young people; Unpublished Doctoral dissertation].* Zagreb: Faculty of Kinesiology, University of Zagreb.

Marković, L., Trbojević Jocić, J., Horvatin, M., Pekas, D., & Trajković, N. (2022). Cardiorespiratory Fitness and Health-Related Quality of Life in Secondary School Children Aged 14 to 18 Years: A Cross-Sectional Study. *Healthcare (Basel, Switzerland)*, *10*(4), 660. https://doi.org/10.3390/healthcare10040660

Marković, V., & Milošević, M. (2023). The influence of technichal and tactical elements of water polo on victory and defeat in Champions League matches. *Journal of Physical Education and Sport, 23*(5), 1297-1305.

Marques, A., Mota, J., Gaspar, T., & de Matos, M. G. (2017). Associations between selfreported fitness and self-rated health, life-satisfaction and health-related quality of life among adolescents. *Journal of Exercise Science & Fitness, 15*(1), 8-11.

Morales, P. F., Sánchez-López, M., Moya-Martínez, P., García-Prieto, J. C., Martínez-Andrés, M., García, N. L., & Martínez-Vizcaíno, V. (2013). Health-related quality of life, obesity, and fitness in schoolchildren: the Cuenca study. *Quality of Life Research: An International Journal of the Quality of Life Aspects of Treatment, Care, and Rehabilitation*, *22*(7), 1515–1523. https://doi.org/10.1007/s11136-012-0282-8

Ortega, F. B., Artero, E. G., Ruiz, J. R., España-Romero, V., Jiménez-Pavón, D., Vicente-Rodriguez, G., … & HELENA study (2011). Physical fitness levels among European adolescents: the HELENA study. *British Journal of Sports Medicine*, *45*(1), 20–29. https://doi.org/10.1136/bjsm.2009.062679

Pano, O., Sayón-Orea, C., Gea, A., Bes-Rastrollo, M., Martínez-González, M. Á., & Martínez, J. A. (2020). Nutritional determinants of quality of life in a mediterranean cohort: The Sun Study. *International Journal of Environmental Research and Public Health*, *17*(11), 3897.

Pires-Júnior, R., Coledam, D., Greca, J., Arruda, G., Teixeira, M., & Oliveira, A. (2018). Physical fitness and health-related quality of life in Brazilian adolescents: a cross-sectional study. *Human Movement, 19*(2), 3-10. https://doi.org/10.5114/hm.2018.74055

Ravens-Sieberer, U., & The KIDSCREEN Group (2006). *The KIDSCREEN questionnaires Quality of life questionnaires for children and adolescents-Handbook*. Lengerich: Papst Science Publisher.

Ravens-Sieberer, U., Erhart, M., Rajmil, L., Herdman, M., Auquier, P., Bruil, J., & Czemy, L. (2010). Reliability, construct and criterion validity of the KIDSCREEN-10 score: a short measure for children and adolescents' wellbeing and health-related quality of life. *Quality of Life Research, 19*(10), 1487-1500.

Ravens-Sieberer, U., Erhart, M., Wille, N., Wetzel, R., Nickel, J., & Bullinger, M. (2006). Generic Health-related quality of life assessment in children and adolescents. *Pharmaco Economics, 24*(12), 1199–1220.

Roca, L., (2023). *Povezanost i razlike u pokazateljima aerobne sposobnosti i kvalitete života učenika primarnoga obrazovanja u makroregijama Republike Hrvatske [Associations and difference in indicators of aerobic capacity and quality of life of primary education students in macro-regions of the Republic of Croatia; Unpublished Doctoral dissertation].* Zagreb: Faculty of Teacher Education University of Zagreb.

Ross, R., Blair, S. N., Arena, R., Church, T. S., Després, J. P., Franklin, B. A., … & Stroke Council (2016). Importance of Assessing Cardiorespiratory Fitness in Clinical Practice: A Case for Fitness as a Clinical Vital Sign: A Scientific Statement From the American Heart Association. *Circulation, 134*(24), e653–e699. https://doi.org/10.1161/CIR.0000000000000461

Rowland T. W. (2007). Evolution of maximal oxygen uptake in children. *Medicine and Sport Science*, *50*, 200–209. https://doi.org/10.1159/000101392

Ruiz, J. R., Castro-Piñero, J., Artero, E. G., Ortega, F. B., Sjöström, M., Suni, J., & Castillo, M. J. (2009). Predictive validity of health-related fitness in youth: a systematic review. *British Journal of Sports Medicine*, *43*(12), 909–923. https://doi.org/10.1136/bjsm.2008.056499

Study protocol for the World Health Organization project to develop a Quality of Life assessment instrument (WHOQOL). (1993). *Quality of Life Research: An International Journal of Quality of Life Aspects of Treatment, Care and Rehabilitation*, *2*(2), 153–159.

Teoli, D., & Bhardwaj, A. (2023). Quality Of Life. In *StatPearls*. StatPearls Publishing.

Tomkinson, G. R., Lang, J. J., Tremblay, M. S., Dale, M., LeBlanc, A. G., & Léger, L. (2017). International normative 20 m shuttle run values from 1 142 026 children and youth representing 50 countries. *British Journal of Sports Medicine*, *51*(21), 1545–1554. https://doi.org/10.1136/bjsports-2016-095987

Wallander, J. L., & Koot, H. M. (2016). Quality of life in children: A critical examination of concepts, approaches, issues, and future directions. *Clinical Psychology Review*, *45*, 131–143. https://doi.org/10.1016/j.cpr.2015.11.007

Weiner, J. S. and Lourie, J. A. (1969). *Human Biology. A Guide to Field Methods*. IBP Handbook No. 9. Blackwell Scientific Publishers, Oxford.

Yang, X., Yin, X., Ji, L., Song, G., Wu, H., Li, Y., & Suzuki, A. (2019). Differences in Cardiorespiratory Fitness between Chinese and Japanese Children and Adolescents. *International Journal of Environmental Research and Public Health*, *16*(13), 2316. https://doi.org/10.3390/ijerph16132316

Živanović, V., Branković, D., & Pelemiš, V. (2018). Gender differences in children related to the body composition and movement coordination. *Croatian Journal of Education, 20*(1), 173-198. doi.org/10.15516/cje.v20i1.2604.