Original Article

doi: 10.16926/par.2023.11.10

Physical fitness of students in Indonesian during the COVID-19 period: Physical activity, body mass index, and socioeconomic status

Wilda Welis ABCDE, **Yendrizal** ABCDE, **Darni** ABCDE, **Deby Tri Mario** ABCD

Faculty of Sport Science, Universitas Negeri Padang, Indonesia

Authors' Contribution: A – Study Design, B – Data Collection, C – Statistical Analysis, D – Manuscript Preparation, E – Funds Collection

Abstract

The coronavirus disease (COVID-19) pandemic has caused the physical education learning process to switch to online methods. Conditions such as this do not result in optimal Physical Activity (PA) (sports activity) carried out by students, which has an impact on their Physical Fitness (PF). With regard to PF, Body Mass Index (BMI) and socioeconomic status (SES) during the COVID-19 period also need to be investigated. Therefore, this study aimed to analyze the effects of PA, BMI, and SES on students' PF during the COVID-19 period. A total of 69 junior high school students were sampled, consisting of male (n=34) and female (n=35). PA data were collected using the Global Physical Activity Questionnaire (GPAQ), BMI using anthropometric data, SES using a questionnaire (education level and parental income for one month), and PF using an Indonesian physical fitness test for the age group of 13-15 years. The data were then analyzed using descriptive statistics and regression analyses. The results showed that PA, BMI, and SES affected students' PF ($P<0.05$), with a simultaneous effect of 67.60%. The effects of PA is 41.50%, BMI is 32.60%, and SES is 38.70%. Of these three factors, PA is the dominant factor affecting PF without neglecting other factors (BMI and SES). In conclusion, regular PA, balanced nutritional intake, and good SES have an impact on students' PF. This research is expected to be useful for school principals, teachers (especially physical education teachers), parents, and students to evaluate the importance of these factors for the survival of quality children. Future studies should also consider other factors related to students' PF.

Keywords: physical fitness, physical activity, body mass index, socioeconomic status, junior high school

Author for correspondence: Wilda Welis, email: wildawelis@fik.unp.ac.id

Recevied: 24.11.2022; Accepted: 12.12.2022; Published online: 4.01.2023

Cite this article as: Welis W, Yendrizal, Darni, Mario DT. Physical fitness of students in Indonesian during the COVID-19 period: Physical activity, body mass index, and socioeconomic status. Phys Act Rev 2023; 11(1): 77-87. doi: 10.16926/par.2023.11.10

INTRODUCTION

The COVID-19 pandemic has become an important problem in the education sector [1]. Learning activities that are usually carried out face-to-face have shifted to online-based learning which is increasing rapidly world wide [2], including in Indonesia. Previous studies have analyzed the factors that support online learning [3-5], and student satisfaction in online-based learning [6,7]. Learning like this can cause a decrease in students' motivation to learn in schools, because students only focus in front of the monitor and depend on smartphones. In addition, the limited PA carried out by students will have an impact on their PF[8,9],especially in physical education.

PA is often associated with PF [10]. This is due to the benefits of PA, such as calorie expenditure, weight loss, reducing stress, social interaction, reducing the risk of poor health, and improving self-image [11,12]. Despite these benefits, a large proportion of children and youthworld widefail to actively engage in PA [13-15]. Globally, only 20% of adolescents meet this recommendation [14]. The total amount of PA carried out by adolescents is insufficient [16], leading to a sedentary lifestyle [17]. The World Health Organization recommends that children and adolescents aged 5-17 years engage in moderate to vigorous PA every day for 60 minutes [18]. Thus, PF can be obtained from regular PA, especially for the purpose of physical education, which promotes PA in the learning process.

Then, PA is also often recommended to prevent obesity during childhood and adolescence.It is frequently determined that nutrition-related health issues, such as diabetes, obesity, and cardiovascular disease, significantly affect one's health [19]. Obesity can be caused by the excessive intake of food from fat sources. If food intake from fat and carbohydrate sources is not accompanied by PA, there is an imbalance in the energy used [20]. The national basic health research survey shows that data on malnutrition in Indonesia is quite large, with more than 1/4 of the population of adolescents aged 13-15 years experiencing stunting (about 26%), and 9% being underweight (thin) [21]. Among adolescents aged 16-18 years, 27% were stunted and 8% were underweight, while 2013 data showed that the prevalence of anemia in adolescents aged 13-18 years was 12.4% for boys and 22.7% for girls [22]. The main factor related to being overweight among teenagers was lack of PA. Teenagers who regularly engage in physical activities make it possible for them to avoid being overweight compared to those who are less active, and spend a lot of time watching television and playing gadgets. A qualitative-quantitative study on nutritional intake and PA conducted by UNICEF in 2017, reported that PA at school is minimal, and no more than 90 minutes a week. The food diversity of Indonesian youth is poor, or only 25% consume sources of iron and micronutrients, such asanimal and vegetable sources [22].

The majority of research has also examined how SES affects PF, concentrating on the accessibility of recreational opportunities and PA in communities with low SES [23,24]. According to the study, communities with high SES are 4.5 times more likely to have recreational amenities than those with low SES [23]. According to estimates, people with low SES are less likely to engage in PA if there are fewer facilities available, which could have an impact on their physical health. However, this study focused on environmental demographics and facility availability. Very limited research has linkedSES to individual PF. Other studies have also addressed the differences in PA levels among different SES. The findings demonstrate that low SES groups of all ages tend to be more sedentary than high SES groups [25-27]. However, several of these studies have compared groups according to race. Moreover, no association wa found between SES and PF. In one study, the FITNESSGRAM battery of fitness tests was used to evaluate the PF of 1.314 female high school students [28]. The findings indicate that there are disparities in body composition, running, and PA across groups of high and low socioeconomic classes, and that overall lower SES groups had lower levels of PF [28]. However, no previous studies have been conducted using male samples.

This study aimed to evaluate the effects of PA, BMI, and SES on students' PF during the COVID-19 period. This research is very important, because PF is the basis for quality child survival. Therefore,some of these factors need to be analyzed and proven. This research is expected to be useful for school principals, teachers (especially physical education teachers), parents, and students to evaluate the importance of these factors for the survival of quality children.

MATERIAL AND METHODS

Study design

This research is associative quantitative, and aims to prove the relationship between two or more variables. The relationship used was causal, consisting of PA (X_1), BMI (X_2), and SES (X_3) as independent variables, and PF (Y) as the dependent variable.

Participant

A total of 69 junior high school students number 2 from 50 cities, West Sumatra, Indonesianwere used as research samples, recruited by proportional stratified random sampling. The sample is aged 13-15 years, male (n=34), and female (n=35). This research was conducted after obtaining research ethics approval from the Health Research Ethics Committee, Padang State University approval number: No.08.01/KEPK-UNP/II/2021.

Procedure and instruments

Physical activity

PA was measured using the GPAQ. The GPAQ was developed as a tool to evaluate and compare levels of PA on a local and international scale [29]. The GPAQ consists of 16 questions designed to estimate the level of PA, and consists of three important domains that students do during one week (work, travel, and leisure), and time spent sedentary behavior. The PA score was calculated as the total PA Metabolic Equivalent (MET) min/week.

$$\text{Total PA-MET min/week} = [(P2 \times P3 \times 8) + (P5 \times P6 \times 4) + (P8 \times P9 \times 4) + (P11 \times P12 \times 8) + (P14 \times P15 \times 4)].$$

P = Question number, 8 = high PA coefficient, 4 =moderate PA coefficient

The formula above is a calculation of the PA score based on the MET according to the analysis guide of the GPAQ questionnaire version 2. After obtaining the total PA value in MET min/week, it was categorized into three levels of PA: high, moderate, and low (Table 1).

Table 1. Classification of levels of physical activity

MET	Classification
MET ≥ 3000	High
3000 > MET ≥ 600	Moderate
600 < MET	Low

Body mass index

BMI was measured using anthropometry based on the participants' weight and height. After the results are obtained using the formula above, the classification is determined by looking at the calculation table based on the index of weight according to height in children aged 5-18 years [30] (Table 2).

$$\text{BMI} = \frac{\text{Body weight (kilograms)}}{\text{Height (meters)}^2}$$

Table 2. Classification of body mass index

Index	Classification	Threshold*
BMI by age for ages 5-18 years	Very thin	≤ (3 SD)
	Thin	(-3 SD) - (≤ 2 SD)
	Normal	(-2 SD) - (1 SD)
	Fat	(>1 SD) - (2 SD)
	Obesity	>(2 SD)

*Assessment based on the BMI table of the Indonesian Ministry of Health.

Socioeconomic status

The SES of the parents was obtained using a questionnaire, consisting of the level of education and income of the parents for 1 month. The categories for the parents'education level were as follows: no school was coded 1, elementary school was coded 2, junior high school was coded 3, senior high school was coded 4, and undergraduate/above was coded 5. The categories for parental income for one months are low income (≤ IDR 3.000.000) (code 1) and high income (≥ IDR 3.000.000) (code 2).

Physical fitness

PF was obtained from the "Indonesian physical fitness test" for the age group13-15 years. This test consists of several components: 50 meters run, pull-ups/elbow-bend hanging test, sit-ups, vertical jump, and middle distance running 800/1000 meters [31] (Tables 3 and 4). Then, each of the test items in Tables 3 and 4 was accumulated as a whole into the level of PF (Table 5).

Table 3. Physical fitness test items for male

50 meter run*	Pull ups*	Sit ups*	Verical jump*	1.000 meter run*	Score	Classification
≤ 6.7"	≥ 16	≥ 38	≥ 66	≤ 3'04"	5	Very good
6.8-7.6"	11-15	28-37	53-65	3'05-3'53"	4	Good
7.7"-8.7"	6-10	19-27	42-52	3'54-4'46"	3	Enough
8.8"-10.3"	2-5	8-18	31-41	4'47-6'04"	2	Less
≥ 10.4"	0-1	0-7	0-30	≥ 6'05"	1	Very less

*Unit run 50 m (seconds), pull up (repeat), sit up (repeat), vertical jump (cm), run 1000 m (minutes)

Table 4. Physical fitness test items for female

50 meter run*	Hang elbow bend*	Sit ups*	Verical jump*	800 meter run*	Score	Classification
≤ 7.7"	≥ 41"	≥ 28	≥ 50	≤ 3'06"	5	Very good
7.8-8.7"	22-40"	19-27	39-49	3'07-3'55"	4	Good
8.8"-9.9"	10-21"	8-18	30-38	3'56-4'58"	3	Enough
10.0"-11.9"	3-9"	3-8	21-29	4'59-6'40"	2	Less
≥ 12.0"	0-2"	0-2	0-20	≥ 6'01"	1	Very less

*Unit run 50 m (seconds), pull-ups (time), sit-ups (repeat), vertical jump (cm), run 800 m (minutes)

Table 5. Total assessment of physical fitness test items

Total value	Classification
22-25	Very good
18-21	Good
14-17	Enough
10-13	Less
5-9	Very less

Statistical analysis

Data were analyzed using descriptive statistics to determine the classification level of each research variable. Correlation and regression analyses were then used to prove the relationship between variables. All stages were analyzed using IBM SPSS version 24.

RESULT

The data description aims to describe the characteristics of the test and measurement of each variable, so that the level/classification of the sample is known.

Table 6 shows that the average value of PA for male is 608.97 or is in the moderate classification, and for female is 514.29 or is in the low classification. The BMI for male is 0.97 or is in the normal

classification, and for female is 1.79 or is in the fat classification. Education level for parents of male 3.32 and female 3.00 or junior high school graduates. Parental income for male is 1.26 and female is 1.23 or is in the low classification. Then, PF for male is 13.41 and female is 9.51 or is in the less classification.

Figure 1 shows that the average score for males is superior to that of females, in terms of PA, BMI, SES, and PF. The results of the Kolmogorov-Smirnov normality test and inearity test also showed that each variable was normally and linearly distributed (P>0.05) (Table 7). Correlation and regression analyses were used to determine the interrelationships between these variables.

Table 8 shows that PA, BMI, and SES have a significant relationship withPF, either partially or simultaneously (P<0.05). The correlation between PA and PF was 0.644, regression significance was 47.53, and contribution was 41.50%. The correlation between BMI and PF was 0.571, regression significance was 32.40, and contribution was 32.60%. The correlation between SES and PF was 0.622, the regression significance was 45.27, and the contribution was 38.70%. Furthermore, the correlation of PA, BMI, and SES withPFwas 0.822, the regression significance was 45.17, and the simultaneous contribution was 67.60%.

Figure 2 shows that the graph plot forms a line pattern from the bottom left to the top right. Thus, each variable has a linear and significant relationship withPF ($Y = 17.79 + 0.644X_1$; $Y = 21.45 + 0.571X_2$; and $Y = 15.90 + 0.622X_3$). While simultaneously obtained the Regression model $Y = 3.53 + 0.396X_1 + 0.319X_2 + 0.355X_3$.

Table 6. Descriptive statistics

Gender	N	Variable	Min	Max	Ẋ	SD
Male	34	Physical activity	380.00	870.00	608.97	133.11
		Body mass index	0.10	2.31	0.97	0.51
		Level of education	1.00	5.00	3.32	1.07
		Income	1.00	2.00	1.26	0.45
		Physical fitness	12.00	17.00	13.41	1.46
Female	35	Physical activity	430.00	670.00	514.29	56.22
		Body mass index	0.34	2.52	1.79	0.58
		Level of education	1.00	5.00	3.00	1.08
		Income	1.00	2.00	1.23	0.43
		Physical fitness	5.00	11.00	9.51	1.63

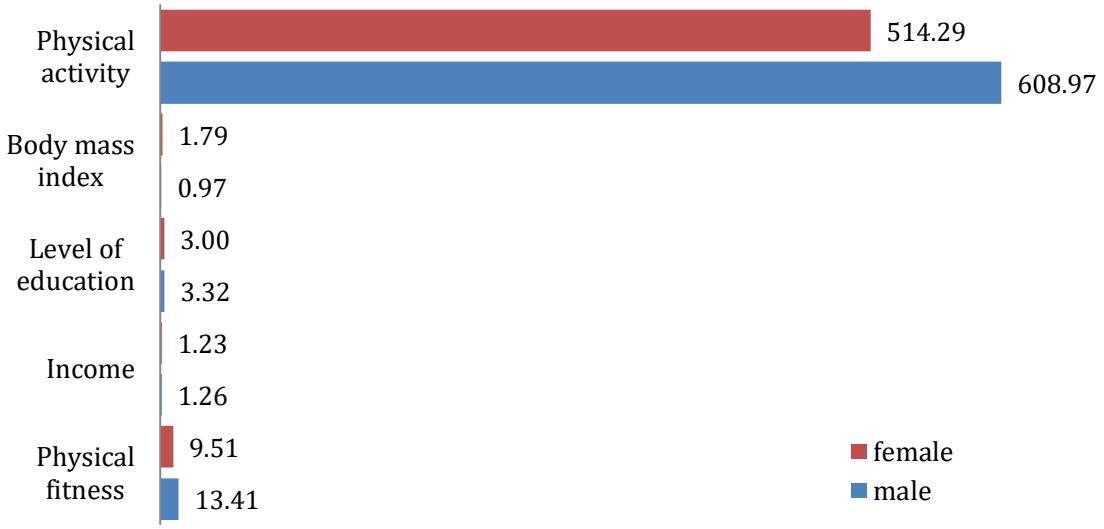


Figure 1. Differences in mean scores for male and female

Table 7. Test for normality and linearity

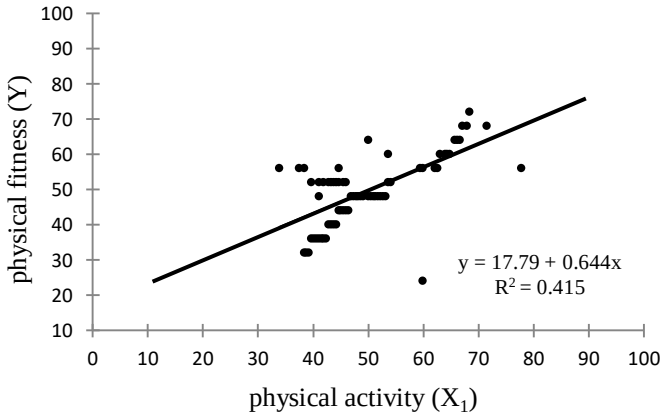
Variable	Normality test (p*)	Linierity test (p*)
Y-X_1	0.200	0.995
Y-X_2	0.169	0.450
Y-X_3	0.189	0.560

*Data are normally distributed and linear (P >0.05).

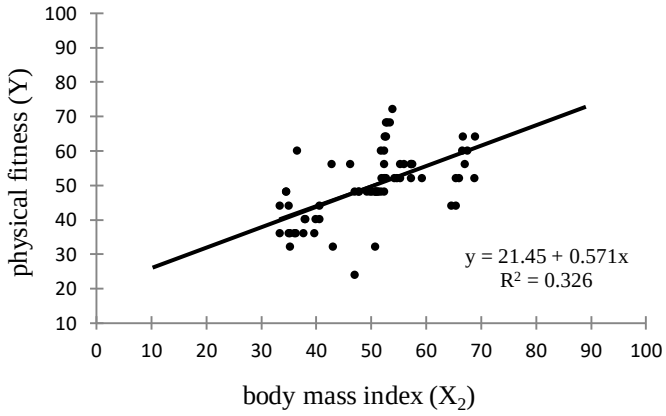
Table 8. Analysis of correlation and multiple regression

Variable	B*	R*	RSquare*	F*	p*	t*	p*
Physical activity	17.79	0.644	0.415	47.53	0.000	4.70	0.000
	0.644						
Body mass index	21.45	0.571	0.326	32.40	0.000	3.53	0.001
	0.571						
Sosioeconomic status	15.90	0.622	0.387	45.27	0.000	4.47	0.000
	0.622						
Simultaneous	3.53	0.822	0.676	45.17	0.000		
	0.396						
	0.319						
	0.355						

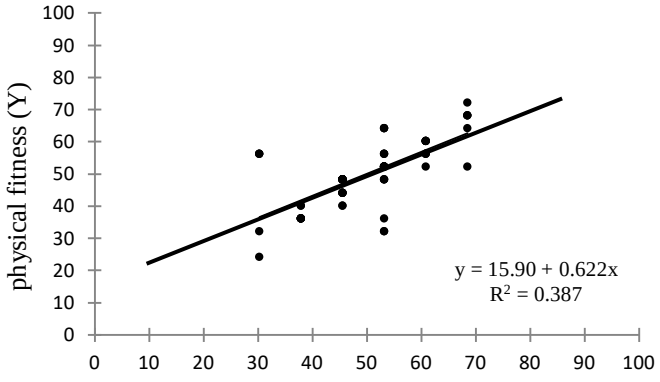
*Regression and correlation were significant (p<0.05); "B" is the regression model; "R" is the magnitude of the relationship; "RSquare" is the amount of contribution; "F" is the regression significance; "t" is the significance of the relationship.



(a)



(b)



(c)

Figure 2. (a) Linearity curve of physical activity with physical fitness, (b) body mass index with physical fitness, (c) socioeconomic status with physical fitness

DISCUSSION

This finding suggests, that PA, BMI, and SES on students' PF (simultaneous effect 67.60%). PA had an effect of 41.50%, BMIof 32.60%, and SES 38.70%. Of these three factors, PA is the dominant factor affectingPF, without ignoring other factors (BMI and SES). The results of this study are consistent with previous studies, reporting that PA is one of the most effective ways to improve PF [32]. Numerous physiological and psychological consequences, including cardiorespiratory fitness, have been positively correlated with moderatetostrenuous PA during adolescence. [33], metabolic diseases[34], and better mental health [35,36].The advantages of a physically active lifestyle in adolescence for both metabolism [37] and psycho-social behavior [38] have been well-documented in several research studies. Previous studies reported that, students who participated in carefully developed physical training programs experienced considerable changes in their physical development, fitness, cardiorespiratory system functionality, and body balance [39]. Students' PF indicators vary widely, necessitating routine customization of the training approach[40].Previous studies have also reported that games that involve PA can improve students' psychomotor, psychological, memory, and attention, and thus have an impact on their PF [41].

Schools through physical education are ideal for making students aware of fitness, which affects their physical and psychological well-being [42-45]. This opinion is consistent with earlier research showing that physical education benefits children's and teenagers' health [46,47] and physical and psychological well-being [42,48]. The results of previous studies show a significant difference between the percentage of adolescents who performPA on school days in physical education compared to non-class physical education school days. The percentage of students meeting PA targets on non-physical education class days (i.e., less than 50%) [43] is in line with other studies [43,49,50]. Thus, it is not surprising that students who have a good level of PA have an impact on good PF; therefore, they are more productive than students who have a low level of PA.

Previous studies have reported that a lack of PA is associated with overweight and obesity during childhood and adolescence [51]. Intense PA can help develop healthy musculoskeletal tissues and maintainideal body weight [52]. The results of this study are consistent with those of previous studies, reporting that a healthy lifestyle and balanced nutritional intake are important for avoiding various adverse health effects [53-56]. Lack of knowledge is one of the main causes of nutritional problems; therefore,it has a negative impact on students' health and fitness [57]. Another study also reported that students who eat nutritious food have an influence on exams at school; they show better behaviors, such as school attendance, and complete assignments given by the teacher carefully, compared to students who do not consume nutritious foods [58].

SES has an impact on PF. The findings of this study are consistent with those of earlier research, which showed that children from low socioeconomic homes frequently have issues with nutrition and

unhealthy behavior [59-61]. Families with sufficient financial conditions fulfill, their children's nutritionalneeds [62]. A poor diet is also linked to lower socioeconomic levels; minorities tend to skip breakfast and consume fewer fruits and vegetables [60,61]. The results of this study are in accordance with previous studies, which reported that SEShas a higher impact on student engagement in activities that are better compared to students who have a low SES [27]. According to another study, SES significantly affects people's physical health, but not their psychological health. The quality of one's lifestyle significantly improves one's mental and physical health. Additionally, the link between SES and health is mediated by lifestyle [63]. This study supports earlier studies that found that higher SES groups have better health outcomes than lower SES groups [64,65]. Numerous reports on SES and ways of life have focused on physical health [66]. In addition, higher income is associated with good nutritional status, housing conditions, medical services, etc [62]. Additionally, families with higher education levels typically have better health awareness and understanding of their health [67].

Based on dataobtained in the field, the level of PF is influenced by several factors, including PA, BMI, and SES. However, there are some limitations that need to be validated in future research. The sample used was junior high school students aged 13-15 years, so a wider sample size and diversity are needed. The factors used are still limited, namely PA, BMI, and SES; therefore, it is necessary to add other factors that affect PF. Then, the classification for the level of family income (SES) is divided into onlytwo classifications: low income and high income. This is because there is no definite reference for this classification, so we use 2 classifications (low and high income) which are guided by the “Regional Minimum Wage” (different for each region in Indonesian based on the research subject area). It is also important for future research on moderate income classifications, so that there are differences in each income classification.

CONCLUSION

Based on these findings, we conclude that physical activity, body mass index, and socioeconomic Based on these findings, we conclude that PA, BMI, and SES affect students' PF (simultaneous effect 67.60%). PA had an effect of 41.50%, BMI of 32.60%, and SES 38.70%. Of these three factors, PA is the dominant factor affecting PF, without ignoring other factors (BMI and SES). This means that regular PA, balanced nutritional intake, and good SES have an impact on students' PF. This research is expected to be useful for principals, teachers (especially physical education teachers), parents, and students to evaluate the importance of these factors for the survival of quality children. Future studies should include a larger sample size and other factors that influence PF.

Conflict of Interest

There are no possible conflicts of interest

REFERENCES

1. Jumareng H, Setiawan E, Patah IA, Aryani M, Asmuddin A, Gani RA. Online learning and platforms favored in physical education class during COVID-19 era: Exploring student perceptions. Int J Hum Mov Sport Sci 2021; 9(1): 11–18. doi: 10.13189/saj.2021.090102
2. Çiğdem H, Yıldırım, OG. Effects of students’ characteristics on online learning readiness : A vocational college example. Turkish Online J Distance Educ 2014; 15: 80–93. doi: 10.17718/tojde.69439
3. Bolliger DU, Halupa C. Online student perceptions of engagement, transactional distance, and outcomes. Distance Educ 2018; 39(3): 299–316. doi: 10.1080/01587919.2018.1476845
4. Shelton BE, Hung JL, Lowenthal PR. Predicting student success by modeling student interaction in asynchronous online courses. Distance Educ 2017; 38(1): 59–69. doi: 10.1080/01587919.2017 .1299562.
5. Yang D. Instructional strategies and course design for teaching statistics online: perspectives from online students. Int J STEM Educ 2017; 4(1): 1–15. doi: 10.1186/s40594-017-0096-x
6. Liaw SS, Huang HM. Perceived satisfaction, perceived usefulness and interactive learning environments as predictors to self-regulation in e-learning environments. Comput. Educ 2013; 60(1): 14–24. doi:

10.1016/j.compedu.2012.07.015
7. Weidlich J, Bastiaens TJ. Technology matters - The impact of transactional distance on satisfaction in online distance learning. Int Rev Res Open Distance Learn 2018; 19(3): 222–242. doi: 10.19173/irrodl .v19i3.3417
8. Al-Haliq M, Abu-Shihab E, Al-Kloub M, Harafsheh I. Testing the level of knowledge of physical fitness among the employees of hashemite university. Int J Hum Mov Sport 2021; 9(1): 156–162. doi: 10.13189 /saj.2021.090122
9. Abdullah MF, Pilus AM, Razak MRA, Bakar AYA, Nazarudin MN. The intrinsic and extrinsic motivation towards physical activity among Malaysian technical university (Utem) students. Int J Hum Mov Sport Sci 2021; 9(2): 375–382. doi: 10.13189/SAJ.2021.090227
10. Yendrizal Y. The effect of weight training using fast and slow repetition movement towards thigh muscle hypertrophy. Psshers 2020; 464: 935–937. doi: 10.2991/assehr.k.200824.207
11. Evans MB, Shanahan E, Leith S, Litvak N, Wilson AE. Living for today or tomorrow? Self-regulation amidst proximal or distal exercise outcomes. Appl Psychol Heal Well-Being 2019; 11(2): 304–327. doi: 10.1111
aphw.12160
12. Zelle DM, Klaassen G, Van Adrichem E, Bakker SJL, Corpeleijn E, Navis G. Physical inactivity: A risk factor and target for intervention in renal care. Nat Rev Nephrol 2017; 13(3): 152–168. doi: 10.1038/nrneph .2016.187
13. Kohl HW, Craig CL, Lambert EV, Inoue S, Alkandari JR, Leetongin G, Kahlmeier S, Andersen LB, Bauman AE, Blair SN, Brownson RC, Bull FC, Ekelund U, Goenka S, Guthold R, Hallal PC, Haskell WL, Heath GW, Katzmarzyk PT, Wells JC. The pandemic of physical inactivity: Global action for public health. Lancet 2012; 380: 294–305. doi: 10.1016/S0140-6736(12)60898-8
14. Hallal PC, Andersen LB, Bull FC, Guthold R, Haskell W, Ekelund U, Alkandari JR, Bauman AE, Blair SN, Brownson RC, Craig CL, Goenka S, Heath GW, Inoue S, Kahlmeier S, Katzmarzyk PT, Kohl HW, Lambert EV, Lee IM, Wells JC. Global physical activity levels: Surveillance progress, pitfalls, and prospects. Lancet 2012; 380: 247–257. doi: 10.1016/S0140-6736(12)60646-1
15. Tremblay MS, Gray CE, Akinroye K, Harrington DM, Katzmarzyk PT, Lambert EV, Liukkonen J, Maddison R, Ocansey RT, Onywera VO, Prista A, Reilly JJ, Martínez MDPR, Duenas OLS, Standage M, Tomkinson G. Physical activity of children: A global matrix of grades comparing 15 countries. J Phys Act Heal 2014 11: 113–125. doi: 10.1123/jpah.2014-0177
16. Guthold R, Stevens GA, Riley LM, Bull FC. Global trends in insufficient physical activity among adolescents: a pooled analysis of 298 population-based surveys with 1·6 million participants. Lancet Child Adolesc Heal 2020; 4(1): 23–35. doi: 10.1016/S2352-4642(19)30323-2
17. Varma VR, Dey D, Leroux A, Di J, Urbanek J, Xiao L, Zipunnikov V. Re-evaluating the effect of age on physical activity over the lifespan. Prev Med 2017; 101: 102–108. doi: 10.1016/j.ypmed.2017.05.030
18. World Health Organization. Global recommendations on physical activity for health. World Health Organization; 2010.
19. Vriendt TD, Matthys C, Verbeke W, Pynaert I, De Henauw S. Determinants of nutrition knowledge in young and middle-aged Belgian women and the association with their dietary behaviour. Appetite 2009; 52(3): 788–792. doi: 10.1016/j.appet.2009.02.014
20. Welis W, Darni D, Khairuddin K. Nutritional and motor ability status of elementary school student. Adv Soc Sci Educ Humanit Re 2020; 464: 410–412. doi: 10.2991/assehr.k.200824.098.
21. Riskesdas. Badan penelitian dan pengembangan kesehatan. Kementerian Republik Indonesia; 2018
22. United Nations Children's Fund. Strategi komunikasi perubahan sosial dan perilaku: Meningkatkan gizi remaja di Indonesia. UNICEF. Jakarta; 2021
23. Moore LV, Roux AVD, Evenson KR, McGinn AP, Brines SJ. Availability of recreational resources in minority and low socioeconomic status areas. Am J Prev Med 2008; 34(1): 16–22. doi: 10.1016/j.amepre.2007.09.021
24. Powell LM, Slater S, Chaloupka FJ, Harper D. Availability of physical activity-related facilities and neighborhood demographic and socioeconomic characteristics: A national study. Am J Public Health 2006; 96(9): 1676–1680. doi: 10.2105/AJPH.2005.065573
25. Fairclough SJ, Boddy LM, Hackett AF, Stratton G. Associations between children's socioeconomic status, weight status, and sex, with screen-based sedentary behaviours and sport participation. Int J Pediatr Obes 2009; 4(4): 299–305. doi: 10.3109/17477160902811215.
26. Felton GM, Dowda M, Ward DS, Dishman RK, Trost SG, Saunders R, Pate RR. Differences in physical activity between black and white girls living in rural and urban areas. J Sch Health 2002; 72(6): 250–255. doi: 10.1111/j.1746-1561.2002.tb07338.x

27. Sallis JF, Zakarian JM, Hovell MF, Hofstetter R. Ethnic, socioeconomic, and sex differences in physical activity among adolescents. J Clin Epidemiol 1996; 49(2): 125–134
28. Fahlman MM, Hall HL, Lock R. Ethnic and socioeconomic comparisons of fitness, activity levels, and barriers to exercise in high school females. J Sch Health 2006; 76(1): 12–17. doi: 10.1111/j.1746-1561.2006.00061.x
29. Bull FC, Maslin TS, Armstrong T. Global physical activity questionnaire (GPAQ): Nine country reliability and validity study. J Phys Act Heal 2009; 6(6): 790–804. doi: 10.1123/jpah.6.6.790
30. Ministry of health of the Republic of Indonesian. Anthropometric standards for evaluating children's nutritional status. Directorate general of maternal and child health and nutrition development: Directorate of nutrition; 2011
31. Ministry of national education. Physical Fitness Level. Jakarta: Physical fitness and recreation center; 2010.
32. Lonsdale C, Rosenkranz RR, Peralta LR, Bennie A, Fahey P, Lubans DR. A systematic review and meta-analysis of interventions designed to increase moderate-to-vigorous physical activity in school physical education lessons. Prev Med 2013; 56(2): 152–161. doi: 10.1016/j.ypmed.2012.12.004
33. Gutin B, Yin Z, Humphries MC, Barbeau P. Relations of moderate and vigorous physical activity to fitness and fatness in adolescents. Am J Clin Nutr 2005; 81(4): 746–750. doi: 10.1093/ajcn/81.4.746
34. Ortega FB, Ruiz JR, Castillo MJ, Sjöström M. Physical fitness in childhood and adolescence: A powerful marker of health. Int J Obes 2008; 32(1): 1–11. doi: 10.1038/sj.ijo.0803774
35. Sabiston CM, O'Loughlin E, Brunet J, Chaiton M, Low NC, Barnett T, O'Loughlin J. Linking depression symptom trajectories in adolescence to physical activity and team sports participation in young adults. Prev Med 2013; 56(2): 95–98. doi: 10.1016/j.ypmed.2012.11.013
36. Biddle SJH, Asare M. Physical activity and mental health in children and adolescents: A review of reviews. Br J Sports Med 2011; 45(11): 886–895. doi: 10.1080/1750984X.2010.548528
37. Ekelund U, Tarp J, Steene-Johannessen J, Hansen BH, Jefferis B, Fagerland MW, Whincup P, Diaz KM, Hooker SP, Chernofsky A, Larson MG, Spartano N, Vasan RS, Dohrn I.M, Hagströmer M, Edwardson C, Yates T, Shiroma E, Anderssen SA, Lee IM. Dose-response associations between accelerometry measured physical activity and sedentary time and all cause mortality: Systematic review and harmonised meta-analysis. BMJ 2019; 366: 1–10. doi: 10.1136/bmj.l4570
38. De Rezende LFM, Lopes MR, Rey-Loṕez JP, Matsudo VKR, Luiz ODC. Sedentary behavior and health outcomes: An overview of systematic reviews. PLoS One 2014; 9(8): e105620–e105620. doi: 10.1371/journal.pone.0105620
39. Andrieieva O, Yarmak O, Kashuba V, Drozdovska S, Gineviciene V, Blagii O, Akimova-ternovska M. Efficiency of a combined fitness program for improving physical condition in young women. Teorìâ ta Metod Fìzičnogo Vihovannâ 2020; 20(4): 195–204. doi: 10.17309/tmfv.2020.4.01
40. Solohubova S, Lakhno O, Shyyan V, Shyyan O. The assesment of physical fitness and morphofunctional state of female first-year students in non-linguistic higher education institutions. Teorìâ ta Metod Fìzičnogo Vihovannâ 2020; 20(3): 157–164. doi: 10.17309/tmfv.2020.3.05
41. Kuznetsova L, Trachuk S, Semenenko V, Kholodova O, Podosinova L, Brychuk M, Varenyk O, Kedrych H. Effect of movement games on physical fitness of children with intellectual disabilities. Teorìâ ta Metod Fìzičnogo Vihovannâ 2022; 22(2): 158–165. doi: 10.17309/tmfv.2022.2.02
42. Raghuveer G, Hartz J, Lubans DR, Takken T, Wiltz JL, Mietus-Snyder M, Perak AM, Baker-Smith C, Pietris N, Edwards NM. Cardiorespiratory fitness in youth: an important marker of health: A scientific statement from the American heart association. Circulation 2020; 141: E101–E118. doi: 10.1161/CIR .0000000000000866
43. Sanz-Martín D, Ruiz-Tendero G, Fernández-García E. Contribution of physical education classes to daily physical activity levels of adolescents. Phys Act Rev 2021; 9(2): 18–26. doi: 10.16926/par.2021.09.18.
44. Olena Y, Galan Y, Nakonechnyi, Hakman A, Filak Y, Oleksandra B. Screening system of the physical condition of boys aged 15-17 years in the process of physical education. J Phys Educ Sport 2017; 17(3): 1017–1023. doi: 10.7752/jpes.2017.s3156
45. Galan Y, Iryna S, Zoriy Y, Briskin Y, Maryan. Designing an effective approach to sport for the integration in higher education institutions (the effects of yoga practice). J Phys Educ Sport 2017; 17(2): 509–518. doi: 10.7752/jpes.2017.s2077
46. Ardoy DN, Fernández-Rodríguez JM, Jiménez-Pavón D, Castillo R, Ruiz JR, Ortega FB. A physical education trial improves adolescents' cognitive performance and academic achievement: The EDUFIT study. Scand J Med Sci Sport 2014; 24(1): 1–10. doi: 10.1111/sms.12093
47. Singerland M, Oomen J, Borghouts L. Physical activity levels during dutch primary and secondary school physical education. Eur J Sport Sci 2011; 11(4): 249–257. doi: 10.1080/17461391.2010.506661

48. Alnedral A, Zonifa G, Yendrizal. A volleyball skills test instrument for advanced-level students. J Phys Educ Sport 2020; 20(3): 2213–2219. doi: 10.7752/jpes.2020.s3297
49. Kalman M, Inchley J, Sigmundova D, Iannotti RJ, Tynjälä JA, Hamrik Z, Haug E, Bucksch J. Secular trends in moderate-to-vigorous physical activity in 32 countries from 2002 to 2010: A cross-national perspective. Eur J Public Health 2015; 25(2): 37–40. doi: 10.1093/eurpub/ckv024
50. López Sánchez G. F, González Víllora S, Díaz Suárez A. Level of habitual physical activity in children and adolescents from the Region of Murcia (Spain). Springerplus 2016; 5(1): 4–9. doi: 10.1186/s40064-016-2033-8
51. Goyal JP, Kumar N, Parmar I, Shah VB, Patel B. Determinants of overweight and obesity in affluent adolescent in Surat city, South Gujarat region, India. Indian J Community Med 2011; 36(4): 296–300, doi: 10.4103/0970-0218.91418
52. Latt TS, Ko K, Aye TT, Thidar A, Khin E. A summary of the Myanmar clinical practice guidelines for the management of obesity. J Asean Fed Endocr Soc 2011; 26
53. Edwards JSA, Hartwell HL, Brown L. Changes in food neophobia and dietary habits of international students. J Hum Nutr Diet 2010;. 23(3): 301–311. doi: 10.1111/j.1365-277X.2010.01066.x
54. Welis W. The quality of nutrient intake of table tennis athlete. J Phys Conf Ser 2017; 755(1): 8–13
55. Mario DT, Komaini A, Welis W, Sepdanius E, Syafrianto D. High-protein foods in weight training as an alternative for muscle hypertrophy: Soy milk, egg whites, and tofu. J Phys Educ Sport 2022; 22(9): 2254–2264. doi: 10.7752/jpes.2022.09287
56. Mario DT, Komaini A, Welis W, Rifki MS, Alnedral A, Ihsan N, Syafrianto D, Zulbahri Z, Ilham I, Okilanda A, Alimuddin A. Slow-motion in weight training: How does it affect muscle hypertrophy in untrained young men?. J Phys Educ Sport 2022; 22(10): 2465–2471. doi: 10.7752/jpes.2022.10314
57. ul Haq I, Mariyam Z, Li M, Huang X, Jiang P, Zeb F, Wu X, Feng Q, Zhou M. A comparative study of nutritional status, knowledge attitude and practices (KAP) and dietary intake between international and Chinese students in Nanjing, China. Int J Environ Res Public Health 2018;. 15(9): 1–11. doi: 10.3390 /ijerph15091910
58. Prangthip P, Soe YM, Signar JF. Literature review: nutritional factors influencing academic achievement in school age children. Int J Adolesc Med Health 2021; 33(2): 1–9. doi: 10.1515/ijamh-2018-0142
59. Beets MW, Pitetti KH. One-mile run/walk and body mass index of an ethnically diverse sample of youth. Med Sci Sport Exerc 2004; 36(10): 1796–1803. doi: 10.1249/01.MSS.0000142309.29139.22
60. Delva J, Johnston LD, O'Malley PM. The epidemiology of overweight and related lifestyle behaviors. Racial/ethnic and socioeconomic status differences among american youth. Am J Prev Med 2007; 33(4): 178–186. doi: 10.1016/j.amepre.2007.07.008
61. Delva J, O'Malley PM, Johnston LD. Racial/ethnic and socioeconomic status differences in overweight and health-related behaviors among american students: National trends 1986-2003. J Adolesc Heal 2006; 39(4): 536–545. doi: 10.1016/j.jadohealth.2006.02.013
62. Komaini A. Fundamental motor skills of kindergarten students (a survey study of the influence of financial condition, playing activity, and nutritional status). IOP Conf Ser Mater Sci Eng Pap 2017. doi: 10.1088/1742-6596/755/1/011001
63. Wang J, Geng L. Effects of socioeconomic status on physical and psychological health: Lifestyle as a mediator. Int J Environ Res Public Health 2019; 16(2): 1–9. doi: 10.3390/ijerph16020281
64. Harper S, Lynch J. Trends in socioeconomic inequalities in adult health behaviors among U.S. States, 1990-2004. Public Health Rep 2007; 122(2): 177–189. doi: 10.1177/003335490712200207
65. Mackenbach JP, Stirbu I, Roskam AJR, Schaap MM, Menvielle G, Leinsalu M, Kunst AE. Socioeconomic inequalities in health in 22 european countries. N Engl J Med 2008; 358(23): 2468–2481. doi: 10.1056 /nejmsa0707519
66. Rohrer JE, Pierce R, Blackburn C. Lifestyle and mental health. Prev Med 2005; 40(4): 438–443. doi: 10.1016/j.ypmed.2004.07.003
67. Adler NE, Boyce T, Chesney MA, Cohen S, Folkman S, Kahn RL, Syme L. Socioeconomic status and health. Am Psychol 1994; 49(1): 15–24. doi: 10.1016/B978-0-08-097086-8.14043-7