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Effect of Volleyball Small Side Games on Body Mass Index and Physiological Conditions on Pre Pubertal Children

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Abstract

This study aims to determine effect *volleyball small side games* (SSG) on body mass index (BMI) and physiological conditions in prepubescent children. The method used *The Randomized Pretest-Posttest Group Design* with a sample of 20 subjects. Research subjects determined based on inclusion and exclusion criteria and divided into experimental and control groups. Experimental group was given SSG volleyball intervention and control group without treatment. BMI measured by the formula BMI and Blood taken 24 hours before the exercise intervention and 24 hours after the intervention. To determine the physiological condition of the subject, the variables used were blood glucose and hemoglobin. SSG volleyball was carried out for 8 weeks with 3x intervention in 1 week. The results of BMI and serum data were analyzed with SPSS 25 with paired sample t-test and independent t-test. The results of this study from an independent t-test between the experimental group and the control group showed a variable value of BMI with *a p-value* of 0.016 (P<0.05),blood glucose p-value of 0.000 (P<0.05) and a hemoglobin p-value 0.007 (P<0.05). Results this study can be concluded a significant influence of volleyball SSG intervention on changes body mass index and physiological conditions of prepubertal children.
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Keywords: SSG*;BMI;physiological conditions;*

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INTRODUCTION

Sports is one of the activities that can support individual growth and development. Exercise can be done from an early age to the elderly, just adjust the intensity of exercise according to the age of the individual. By exercising which can support growth and development psychomotor, physical, physiological, and physical health (Anggriawan, 2015), khususnya pada anak yang sedang tahap pertumbuhan. But in fact, based on SSGI 2023, obesity in children increases at the age of 5-12 years where 10.8% are in the obese category and 9.2% are in the obesity category, it can be said that 1 in 5 children is in the obese category (Kemenkes RI., 2023). And based on the 2023 Indonesian Health survey, it is predicted that in children aged 5-14 years, there is a tendency to increase DM (Diabetes Mellitus) by 1.7%, and in 2030 it is predicted that DM in children will increase by 4.4%. In addition to DM, based on

data 4 out of 10 children aged 5-12 years were declared stunted, this increased from 2017 which was only 3 out of 10 children aged 5-12 years who were declared stunted (Indonesia, 2017). Meanwhile, stunting in children tends to settle in adulthood. The increase in DM and stunting in prepubescent children is approximately 56% due to lack of physical activity/sports (Efendi, 2021). So that this becomes a problem in the field of health and sports.

Increase in obesity and DM disease and stunting in children aged 10-12 years can be prevented by exercise. Exercise is able to improve health and increase bone density, reduce fat levels and increase the sensitivity of the body's immune system (Maulana et al., 2020). Therefore, exercising can reduce the risk of DM and stunting in children, this is because of the ideal weight and increased insulin sensitivity (Krismawati et al., 2018). A child who has an ideal BMR/BMI and low levels fat reduces the risk of DM and other diseases because it reminds the child's system and physical health. One of the most popular sports that can prevent the risk of disease in children is volleyball. Volleyball have characteristics of being easy to modify, fun and can be adjusted to the targeted intensity. In children aged 10-12 years, volleyball must be done with light-moderate intensity so that children can get comfort and a sense of pleasure when playing volleyball.

Volleyball with the right intensity in children can be a good stimulator in supporting children's health and physical fitness. Several previous studies have explained that using the pretest-posttest design method with volleyball modification treatment or by using the small side games (SSG) method of volleyball can significantly improve the physical fitness of 12-year-old school children, with 72% of students entering the very good category (Wijayanto, Zulki, 2012). More research by (Showab & Djawa, 2019) By modifying volleyball significantly increased the sense of excitement in volleyball learning with a result of 68.7%. Other previous research (Sujarwo et al., 2021) With the research and development method in 252 schools, it was determined that using the mini volleyball learning material model could significantly affect the character values of discipline, cooperation, and hard work with a t value of -11,700 and a significance value of 0.000. Strengthened by other research by (Stojanović et al., 2020) small side games volley ball method, students in the experimental group had significantly better results (<0.05) than the control group in terms of decreasing body fat tissue, as well as increasing muscle tissue. Based on the results of previous research, it is explained that volleyball has a positive impact on increasing children's growth and development factors. Previous research with 20 subjects aged 10-12 years with a volleyball modification intervention significantly increased IGF-1 levels between the experimental group and the control group so that IGF-1 can play a role in supporting the growth and development of children (Krisnawati

& Agyanur, 2023). Therefore, by adopting the pattern of small side games, volleyball will have a positive effect on children who are in the stage of growth and development.

Volleyball modification or can also be called Small side games volleyball has similarities with the real competitive volleyball situation in terms of structure and intensity of player movements (Batiurat et al., 2023). Difference between the original volleyball and SSG lies in the difference in the size of the court, reducing the number of players, reducing the weight of the ball. However, there are similarities that make the game of volleyball closer to the competitive demands of the game and also contribute to engaging the stimulation that the muscles prefer, so it is important to perform certain movements during the match. Modifying volleyball in a child who is in the growth stage provides a simulation of the movement pattern of a volleyball match to the child in such an environment that they have to move actively under the pressure and intensity given. The purpose of modifying volleyball is to adopt faster techniques, and manipulation of certain games or movements to achieve higher abilities / *performance* or maintain the intensity of the given sport, so that it becomes a good stimulus in helping the child's growth and development patterns (Hidayat Taufiq & Kurniawan Deddy, 2015). Modifying volleyball with SSG model is much more intense and exciting, which fully meets the needs of the child in the development of physical, motor and social activities.

The purpose of this study was to determine effect of *small side games* of volleyball for 8 weeks on changes in body parameters, mass index, and physiological conditions before and after treatment.

METHOD

Experimental research uses the *Quasi Experimental* method with a Randomized Pretest-Posttest Group Design *research design*. The research sample was taken using the formula technique by Higgins and Kleinbaum (1985), with the results of 20 subjects. Group division based on *Matched Subject Design* which is a popular technique in experimental research based on inclusion, exclusion and *dropout* criteria or called research subject criteria (Wardana et al., 2020).

Study is based on parental consent for each participant, because the subjects in this study are still children and in the growth stage. This research protects children's privacy by allowing anonymity and is designed in accordance with the clinical research recommendations of the World Medical Association Declaration (Kurihara et al., 2024) The subject criteria in this study include:

No	Inclusion Criteria	Exclusion Criteria	Kriteria Drop Out
1	Age Criteria 11-12 years old	Age <10 & 13> years old	At the time of the study intervention there were physical signs of pain (pale face, dizziness, nausea).
2	Male Gender	High or low blood pressure (<60 bpm & 100>bpm)	HR at the time of the study intervention >157.5 bpm
3	Normal blood pressure (60-90 bpm).		
4	Willing to sign the willingness to be the subject (*informed consent*) carried out by parents/guardians.		

Based on the inclusion, exclusion and dropout criteria above, the subjects will be divided into 2 groups, namely the experimental group and the control group. The experimental group was given a volleyball modification program for 8 weeks with 3x interventions per week, and the control group was not given treatment. The volleyball modification program can be seen in the following table:

	Weeks 1 & 2	Weeks 3 & 4	Weeks 5 & 6	Minggu 7 & 8
Field size	3x3 m	4x4 m	3x3 m	4x4 m
Number of Players	6 (3v3)	8 (4v4)	6 (3v3)	8 (4v4)
Counting System	10 score	15 score	10 score	15 score
Touch Frequency	5	4	5	4
Ball Weight	Light Ball 160 grams	Light Ball 180 grams	Bola Ringan 160 gram	Bola Ringan 180 gram
High Net	1,5	1,8	1,5	1,8

Anthropometric measurements of samples to measure height (TB) using a stadiometer (cm), to measure body weight (BB) using a scale of seca (kg) and after that it is calculated with the BMI formula

For the measurement of physiological conditions, the researcher checked the child's blood glucose and hemoglobin. Blood collection for pretest is carried out approximately 24 hours before the intervention begins and *posttest* collection is carried out 24. Blood collection must be done between 07.00-08.00 WIB, and subjects are not allowed to consume food 12 years before. Blood was processed by faal laboratory staff and IGF-1 levels were analyzed using an ELISA kit (Catalog No: E-EL-H0177; Lot No.: 3E MSDS 4VI; *Elabscience*, China) with the unit of concentration ng/mL.

The results of the data obtained were analyzed starting from descriptive statistics, normality tests, paired sample t-tests and independent t-test differential tests. This is to determine the effect of *volleyball small side games* intervention on BMI, hemoglobin and blood sugar, Furthermore, hormone levels were analyzed with SPSS 25 with a significance value ($P < 0.05$).

RESULTS

Results of Descriptive Analysis

Table 1. Descriptive Analysis of Body Mass Index and Physiological Conditions

No	Variable	Experimental Group					Control Group				
1.	**BMI**	**N**	**Pretest**		**Posttest**		**N**	**Pretest**		**Posttest**	
			Mean	Sd	Mean	Sd		Mean	Sd	Mean	Sd
	Weight (Kg)	10	37,1	10,6	36,5	8,83	10	36,3	7,57	40,1	8,30
	Height (cm)	10	135,8	12,6	136,6	10,9	10	135,1	9,94	135,5	9,81
	BMI (Kg/m^2)	10	19,73	3,10	19,2	2,08	10	19,70	2,18	21,61	1,90
2.	**Kondisi Fisiologis**										
	Blood glucosa (mg/dL)	10	99,60	8,20	93,90	4,60	10	97,0	3,74	104,3	5,31
	Hemoglobin (g/dL)	10	13,22	0,76	16,41	1,04	10	16,29	0,88	14,60	1,59

Keterangan :

BB = Weight (Kg)

TB = Height (cm)

BMI = Boddy Massa Index (kg/m^2)

Based on the results of the analysis, it can be seen that the mean or average values of BB, Tb and BMI in the pretest between groups and controls tend to be balanced. Furthermore, the mean values of BB Pretest and posttest of the control group tended to increase. Meanwhile, in the BB experimental group, it tends to be fixed. Furthermore, in the TB indicator, the control group and the experimental group tended to increase but little and did not have much effect. And on the BMI indicator, the experimental group between the pretest and the posttest tended to be fixed. Meanwhile, BMI in the control group increased the average BMI of children. Diagram of the results of the descriptive analysis of the body mass index and physiological conditions can be seen in figures 1, 2, and 3:

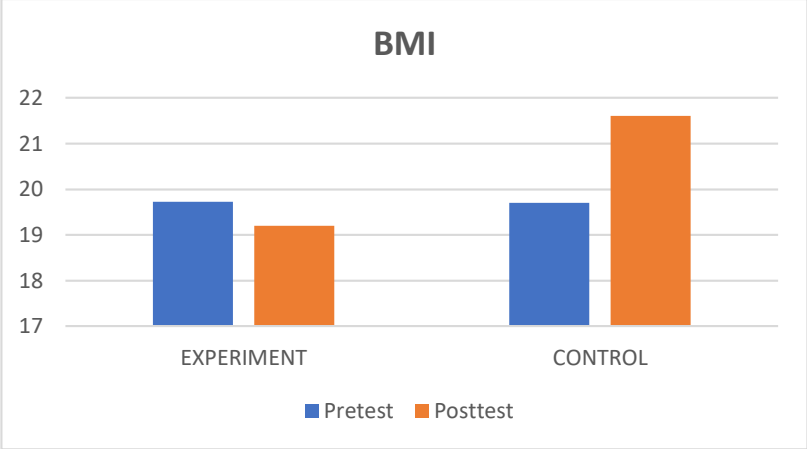

Figure 1. Diagram Analysis Descriptive BMI

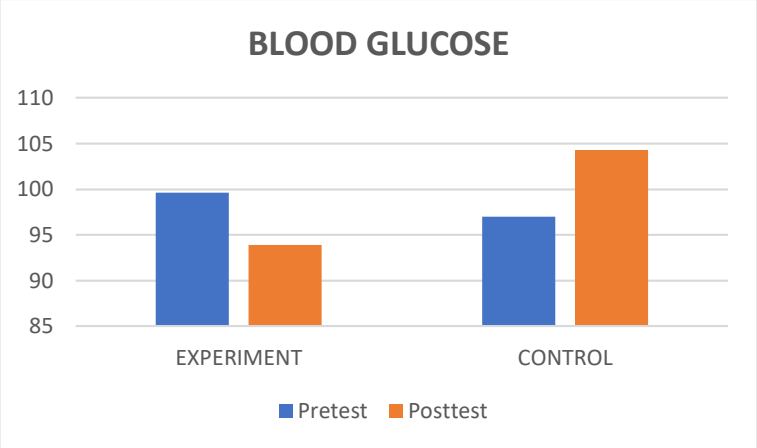

Figure 2. Diagram Analysis Descriptive Blood Glucose

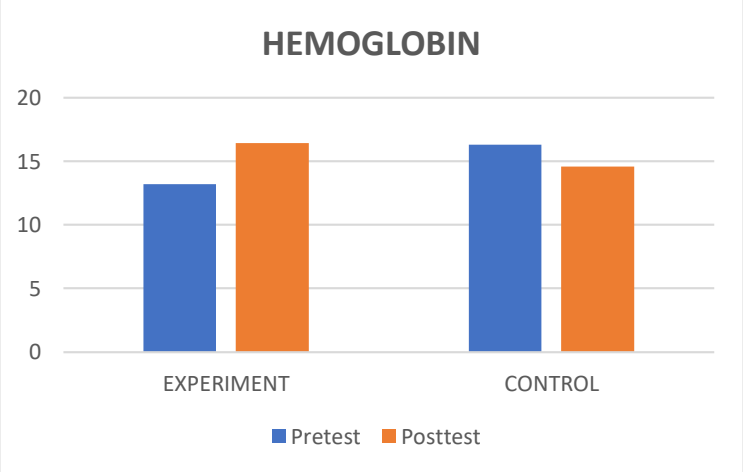

Figure 3. Diagram Analysis Descriptive Hemoglobin

Based on the results of the analysis, it can be seen that the mean/average blood sugar values of pretest children and posttest of the experimental group tend to be balanced. Furthermore, based on the average pretest and posttest scores, the blood sugar of the control group tended to increase. In the hemoglobin indicator, the hemoglobin level values of the

pretest and posttest control group tended to be fixed and in the control group pretest and posttest hemoglobin levels tended to decrease. After the descriptive analysis continued on the normality test, the paired test of the T-Test sample and the independent T-Test differential test.

Paired Sample T-Test Body Mass Index Group and Physiological Conditions Experiment and Control Group

The results of the Paired test of the T-test sample are used to find out whether there is a difference between the pretest and the posttest

Table 2 Paired Test of T-Test Samples of Experimental Group and Control Group

No.	Variabel	Experimental group		Control Group	
		Waktu Pelaksanaan	Signifikansi	Waktu Pelaksanaan	Sig.
1	BMI	Pretest - Posttest	0,391	Pretest - Posttest	0,006
2	Blood Glucose	Pretest – Posttest	0,43	Pretest – Posttest	0,003
3	Hemoglobin	Pretest - Posttest	0,000	Pretest - Posttest	0,006

Information:

BMI: Bodi Massa Index

Based on the results of the Paired test of the T-Test sample, in the BMI variable in the experimental group with a value of 0.391 (>0.05), it can be stated that there is no difference in BMI pretest and posttest in the experimental group. Meanwhile, in the control group, the significance value of BMI was 0.006 (<0.05), it could be stated that there was a significant difference in BMI pretest and posttest in the control group. Furthermore, in the blood sugar variable in the experimental group, the significance value was 0.43 (>0.05), this explained that there was no significant difference between the pretest and the posttest. And in the control group, the significance value of blood sugar was 0.003 (<0.05), the value could be stated to be a significant difference between the pretest and the posstest in the control group. In the hemoglobin level variable in the experimental group with a significance value of 0.000 (<0.05) and in the control group with a significance value of 0.006 (<0.05), it can be stated that there is a significant difference between the pretest and posttest in the experimental group and the control group on the hemoglobin variable. The data were then entered at the T-Test Independent Analysis Test stage, to find out if there was a difference in significance values between the experimental group and the control group

Independent T-Test

Results of the analysis of the independent T-test to find out if there is a significant difference in values between the experimental group and the control group can be seen in the following:

Table 4 Results of Independent Analysis of T-Test, Body Mass Index, and Physiological Conditions of Experimental and Control Groups

No.	Variabel	df	Sig.
1.	BMI	18	0,016
2.	Glukosa Darah	18	0,16
3.	Hemoglobin	18	0,007

Based on the results of the independent analysis of the T-Test on the BMI (Body Mass Index) variable, the value of sig. 0.000 (<0.05) can be stated that there is a significant difference in BMI between the control group and the experimental group due to the influence of small sided volleyball games. Furthermore, in the blood glucose variable, the value of sig. 0.16 (<0.05) can be stated that there is a significant difference in blood glucose levels between the control group and the experimental group. And in the hemoglobin level variable, the significance value of 0.07 (<0.05) can be stated that there is a significant difference in hemoglobin levels between the control group and the experimental group.

DISCUSSION

Effect of Small Sided Games on Body Mass Index (BMI)

Based on the results of the analysis of the independent T-Test table, the significance value between the groups with a value of sig. 0.000 (<0.05) can be stated that there is a significant difference in BMI between the control group and the experimental group due to the influence *of small sided volleyball games*. This is the same as previous research by (Nayıroğlu et al., 2022) with SSG and HIIT methods can significantly change body composition. The difference in BMI between the control group and the experimental group based on the results of descriptive analysis of BMI data tended to increase. Strengthened in the paired test table of t-test samples in the control group, the significance value (0.006<0.05) stated that there was a significant difference between pretest and posttest in the control group. This can be because the BMI of children at the age of 8-12 years tends to have a high BMI also at that age. BMI correlates with insulin and C-peptide resistance, at ages 8 and 12, most pronounced in boys (Huus et al., 2016). However, the average BMI is still in the normal category, but this can be a problem because in the Weight (BB) variable, the average value of the control group subjects increases. This can occur due to the child's inactive behavior, because they are not given treatment. This is the same as previous studies in which the control group that was not given treatment would increase body weight so that it could cause obesity (Risky et al., 2023). Therefore, the control group, if not given physical activity, can increase the risk of obesity and increase the risk of DM (Diabetes Mellitus), which will be dangerous because the child is still in the stage of growth and development.

Based on the results of the paired test of the t-test sample in the experimental group, there was also a significant difference between the pretest and posttest (0.391<0.05) which can be concluded that *small sided games* have a significant influence on the change of body mass index. However, this difference based on the results of descriptive analysis of BMI in the experimental group tends to decrease and is still in the normal BMI category. This happened because regular exercise activities in the experimental group had the effect of changing body mass index by decreasing fat and increasing muscle. This is in accordance with previous research that endurance training can affect BMI changes (Haskas et al., 2023). And on the research by (Krismawati et al., 2018) explained that there is a significant relationship between physical activity and BMI in children during growth and development. These changes can be influenced by pleasurable physical activity can be a stimulus in changing body composition, with light-moderate physical activity energy needed, so that if the energy from food is exhausted, the energy used comes from the body by breaking down fat, as well as protein (Krismawati et al., 2018). And physical activity/exercise carried out for 8 weeks has been adapted so that there are changes in fat and an increase in muscle fibers.

Effect of Small Sided Games on Physiological Conditions

Based on the results of data analysis in physiological conditions, this study took 2 variables, namely blood sugar levels and hemoglobin levels of the subjects. Based on the independent results of the t-test on the blood glucose variable with a sig value of 0.16<0.05, it can be explained that there is a significant difference between the control group and the experimental group. This was reinforced in the analysis of descriptive data that the average value of blood glucose levels in the experimental group tended to decrease (99.6-93.9 mg/dL) and in the control group blood glucose levels increased (97.0-104.3 mg/dL) this was in accordance with previous research by (Sriyono et al., 2023) By comparing the walking experiment group and aerobic exercise and the control group with the results, there was a difference in significance of 0.000<0.05 on blood glucose in adolescents. In line with the research with (Huus et al., 2016) By providing a light-moderate intensity physical activity program to 107 children aged 8-12 years, there was a difference in blood glucose profiles in the activity group and the inactive group. These changes can be affected by physical activity or small side games and affect insulin resistance, which is known to be important in the development of the body in children. With increased insulin resistance, blood glucose can be controlled according to normal levels. Therefore, small sided volleyball games are good in controlling children's blood sugar during growth and development. However, based on the

descriptive analysis data in table 1, the blood glucose value of the control group increased (97,0-104,3 mg/dL)

Increased blood glucose levels in the control group because subjects were not given physical treatment/activity. So that they become inactive and lazy to move. This can cause insulin resistance to decrease and cause an increase in body fat mass and can make a child obese. With an average posttest result value of 104.03 mg/dL, this value is more than the normal blood glucose level of children under 12 years old (100 mg/dL).Although it is still not included in the DM (diabetes mellitus) value, it becomes a problem if it continues to be done, so that the risk of DM increases. In theory, increased blood glucose is due to β cell stress and causing overweight, rapid weight gain and low physical activity can contribute to stress or excess β cells, which leads to not only increased insulin secretion but also increased pancreatic autoantigen presentation which causes the child to tend to become more obese (Telford et al., 2012). Therefore, with physical activity with the appropriate intensity in children during the growth and development period, blood glucose can be maintained normally and if not doing activities can increase obesity and the risk of DM. Furthermore, physiological conditions based on hemoglobin levels.

Based on table 4, the sig value between the experimental group and the control group is 0.007<0.05, this value can be interpreted that there is a significant difference in the hemoglobin level value of the experimental group and the control group. This is the same as previous research with the medium-intensity volleyball physical activity method can increase hemoglobin levels by 21.3% and has an effect in increasing maximum aerobic capacity (Kusuma et al., 2020). And based on the results of table 3, the significance value of the pretest and posttest in the experimental group was 0.000<0.05 so that there was a significant difference in hemoglobin levels between before and after the test and based on the results of the analysis of the data on children's hemoglobin levels tended to increase (13.22-16.41g/dL). The data is the same as previous research by (Mir Balochi et al., 2019) With moderate-high intensity physical activity, there was a significant difference in hemoglobin levels between the control group and the experimental group with a value of 0.001<0.01. This increase can be influenced by the fact that when the subject treats small sided volleyball games, there is an increase in oxygen uptake capacity so that metabolically hemoglobin levels also increase. Because hemoglobin levels affect the maximum oxygen capacity uptake (Jadon & Kumar, 2023). In addition to the cardiorespiratory system, increased hemoglobin levels also have an effect on increasing iron secretion in the child's body. Therefore, it is important to provide activities with

small sided games to children in improving the physiological condition of children's hemoglobin levels and maintaining children's blood glucose in the normal range in the child's growth and development stage (Steiner et al., 2019).

CONCLUSION

Based on the results of data analysis and discussion in this study, conclusions can be drawn:

1. There was a significant effect between the small side volleyball game experimental group and the control group on the change in body BMI.
2. There was a significant influence between the small side volleyball game experimental group and the control group on blood glucose levels, but in the control group, the average value of children's blood glucose reached 104.3 mg/dL where the maximum limit of the normal category of blood glucose for children under 12 years old was 100 mg/dL
3. There was a significant influence between the small side volleyball game experimental group and the control group on hemoglobin levels in prepubescent children.

REFERENCES

Anggriawan, N. (2015). *Peran Fisiologi Olahraga Dalam Menunjang Prestasi*. *11*, 8–18.

Batiurat, W., Wandik, Y., & Putra, M. F. P. (2023). Modifikasi permainan bolavoli dalam pendidikan jasmani. *Multilateral : Jurnal Pendidikan Jasmani Dan Olahraga*, *22*(4), 272. https://doi.org/10.20527/multilateral.v22i4.16470

Efendi, V. P. W. A. (2021). Literature Review Hubungan Penggunaan Gawai Terhadap Aktivitas Fisik Remaja. *Jurnal Kesehatan Olahraga*, *9*, 17–26.

Haskas, Y., Wijaya, M. R. A., & Kadrianti, E. (2023). *Pengaruh Resistance Training Terhadap Body Mass Index (BMI) pada Penderita Diabetes Melitus Tipe 2*. *5*(1).

Hidayat Taufiq & Kurniawan Deddy. (2015). PENGARUH MODIFIKASI PERMAINAN BOLAVOLI TERHADAP KERJASAMA SISWA PADA PEMBELAJARAN PENDIDIKAN JASMANI, OLAHRAGA DAN KESEHATAN (Studi Pada Siswa Kelas X Boga 1 SMKN 3 Probolinggo). *Jurnal Pendidikan Olahraga Dan Kesehatan*, *03*(1), 20–24.

Huus, K., Åkerman, L., Raustorp, A., & Ludvigsson, J. (2016). Physical Activity, Blood Glucose and C-Peptide in Healthy School-Children, a Longitudinal Study. *PLOS ONE*, *11*(6), e0156401. https://doi.org/10.1371/journal.pone.0156401

Indonesia, P. K. (2017). *Profil Kesehatan Indonesia. Kementerian Kesehatan Republik Indonesia, Jakarta*.

Jadon, A., & Kumar, S. (2023). Effect of circuit training on hemoglobin of school students. *Sports Science & Health Advances*, *1*(1), 5–9. https://doi.org/10.60081/ssha.1.1.2023.5-9

Kemenkes RI. (2023). *Menteri Kesehatan Republik Indonesia Hasil Survei Status Gizi Indonesia (SSGI) 2022*. 1–7.

Krismawati, L. D. E., Andayani, N. L. N., & Wahyuni, N. (2018). Hubungan antara aktifitas fisik dengan Indeks MassaTubuh (IMT) pada remaja usia 16-18 tahun diSMA N 2 Denpasar. *Majalah Ilmiah Fisioterapi Indonesia*, 25–28.

Krisnawati, E., & Agyanur, S. (2023). Pengaruh modifikasi bola voli terhadap insuline-like growth factore 1 pada anak prapubertas. *Sriwijaya Journal of Sport*, *2*(2), 60–74. https://doi.org/10.55379/sjs.v2i2.667

Kurihara, C., Kerpel-Fronius, S., Becker, S., Chan, A., Nagaty, Y., Naseem, S., Schenk, J., Matsuyama, K., & Baroutsou, V. (2024). Declaration of Helsinki: ethical norm in pursuit of common global goals. *Frontiers in Medicine*, *11*(April). https://doi.org/10.3389/fmed.2024.1360653

Kusuma, M. N. H., Syafei, M., & Rilastiyo, D. (2020). Erratum: Pengaruh Status Gizi, Tingkat Aktivitas Fisik dan Kadar Hemoglobin Terhadap Kemampuan Daya Tahan Fisik. *JUARA : Jurnal Olahraga*, *5*(1), 121. https://doi.org/10.33222/juara.v5i1.933

Maulana, R., Rochmania, A., Pendidikan, J., Olahraga, K., Olahraga, F. I., & Surabaya, U. N. (2020). *Hubungan intensitas latihan dengan imunitas*. 20–35.

Mir Balochi, R., Salesi, M., Chardah Cheric, M., Koushki Jahromi, M., & Sadeghipour, H. R. (2019). The Effect of One Session Exhaustive Exercise on Hepcidin, Iron, Ferritin and Hemoglobin of Female Athletes TT - تأثیر یک جلسه ورزش درمانده‌ساز بر هورمون هپسیدین، فریتین، آهن و هموگلوبین دختران ورزشکار. *JABS*, *9*(3), 1585–1595. http://jabs.fums.ac.ir/article-1-1933-en.html

Nayıroğlu, S., Yılmaz, A. K., Silva, A. F., Silva, R., Nobari, H., & Clemente, F. M. (2022). Effects of small-sided games and running-based high-intensity interval training on body composition and physical fitness in under-19 female soccer players. *BMC Sports Science, Medicine & Rehabilitation*, *14*(1), 119. https://doi.org/10.1186/s13102-022-00516-z

Risky, I., Program, S., Masyarakat, I. K., & Masyarakat, K. (2023). Literatur Review: Pengaruh Pola Makan Dan Kurangnya Aktivitas Fisik Terhadap Terjadinya Obesitas. *JK: Jurnal Kesehatan*, *1*(1), 170–176. https://jurnalkesehatan.joln.org/index.php/health/article/download/18/28/41

Showab, A., & Djawa, B. (2019). Pengaruh Modifikasi Permainan Bola Voli Terhadap Kegembiraan Belajar Siswa. *Jurnal Pendidikan Olahraga Dan Kesehatan2*, *07*(03), 307–312.

Sriyono, G. H., Hamim, N., & Narsih, U. (2023). Perbedaan Efektivitas Aktivitas Jogging dan Senam Aerobik Terhadap Kadar Gula Darah Sewaktu Pria Remaja. *Jurnal Health Sains*, *4*(1), 74–82. https://doi.org/10.46799/jhs.v4i1.817

Steiner, T., Maier, T., & Wehrlin, J. P. (2019). Effect of Endurance Training on Hemoglobin Mass and V-O 2max in Male Adolescent Athletes. *Medicine and Science in Sports and Exercise*, *51*(5), 912–919. https://doi.org/10.1249/MSS.0000000000001867

Stojanović, D., Branković, N., Stojanović, T., & Momčilović, Z. (2020). the Effects of Skill-Based Exercises and a Small-Sided Games Program on the Body Composition of Adolescents. *Facta Universitatis, Series: Physical Education and Sport*, *18*(1), 145. https://doi.org/10.22190/fupes191219001s

Sujarwo, Suharjana, Rachman, H. A., & Ardha, M. A. Al. (2021). The development of physical education learning models for mini-volleyball to habituate character values among elementary school students. *Sport Mont*, *19*(2), 29–33. https://doi.org/10.26773/smj.210605

Telford, R. D., Cunningham, R. B., Telford, R. M., Kerrigan, J., Hickman, P. E., Potter, J. M., & Abhayaratna, W. P. (2012). Effects of Changes in Adiposity and Physical Activity on Preadolescent Insulin Resistance: The Australian LOOK Longitudinal Study. *PLOS ONE*, *7*(10), e47438. https://doi.org/10.1371/journal.pone.0047438

Wardana, Z. S., Sari, G. M., & Tinduh, D. (2020). The Relation Between IGF-1 Levels and Fasting Blood Glucose in Obese Women. *STRADA Jurnal Ilmiah Kesehatan*, *9*(1), 140–146. https://doi.org/10.30994/sjik.v9i1.276

Wijayanto, Zulki, E. (2012). Pengaruh Pembelajaran Permainan Bola Besar Terhadap Tingkat Kesegaran Jasmani. *Journal Of Physical Education, Sport, Health and Recreations*, *1*(1), 6–10.