



The impact of modified walking exercise incorporating intensity variations on increasing aerobic endurance

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Abstract: The aim of this study was to determine the effect of modified forms of exercise on increasing VO_{2Max} in college students. In particular, this study focused on assessing the effectiveness of interval training modifications, particularly in the form of walking exercises, in increasing VO_{2Max} in college students. This study followed a quantitative approach, using an experimental one-group pre-test and post-test design. Cooper's test is used as a research instrument in this study. The study was undertaken with participants from the Department of Sports Development, Faculty of Sports Science, Universitas Negeri Yogyakarta, Indonesia. The findings of this study can be used as a reference for implementing a modified form of interval training, especially using walking patterns, to increase VO_{2Max} in college students. Data analysis technique using Paired Sample t Test. The treatment group that underwent walking exercise experienced a significant increase in VO_{2Max} , although the level of significance varied. In particular, the walking treatment group showed a significant increase with a significance value of 0.000.

Keywords: training, modification, intensity, aerobics, endurance

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INTRODUCTION

Physical activity is proven to reduce mortality and prevent diseases such as cancer. Compared to just being a good habit, today physical activity is better known as medicine. By doing physical activity, namely sports, it has been shown to reduce tumor growth by up to 60% (Wang et al., 2021). In accordance to a study by the World Health Organization (WHO), 150 minutes of moderate-intensity physical activity or exercise per week can assist to reduce the risk of common chronic diseases such as breast cancer, type 2 diabetes and stroke, and can boost the immune system. (Hojman et al., 2017).

Aerobic exercise is a type of physical activity. Aerobic exercise is recommended because it can combat the health threats that arise from various diseases. The essence of aerobic exercise is to improve the function of blood oxygen from the heart to active muscles. Aerobic activity is activity that involves moving blood to the working large and small muscles. The virtue of aerobic exercise is the improvement of heart health. Thus, aerobic exercise has been shown to reduce the loss of strength, mobility, balance, and endurance caused by a lack of physical activity in performing daily tasks (Bai et al., 2022). Aerobic exercise in adults, middle-aged, and elderly can improve health, reduce mortality, and reduce susceptibility to several chronic diseases (Smith et al., 2020).

Cycling, dancing, hiking, jogging/running long distances, swimming, and walking are some examples of aerobic activities. Walking is one of the activities that can be done because it has many health benefits and improves quality of life and can reduce the risk of injury and stress (Id & Wadsworth, 2019). Walking is one of the simplest and most accessible forms of physical activity, known for its safety and cost-effectiveness. The advantages of walking closely parallel those of structured exercise. Additionally, accumulating 10,000 steps through walking has been substantiated to contribute positively to cardiovascular well-being (Siswantoyo, 2022). Another benefit of walking is that it can reduce resting



heart rate, increase postural stability, increase subjective perception of fatigue, reduce anxiety levels, and improve mental health in general (Pavl, 2022). Another study reported the benefits of trained walking, namely increased physical fitness, functional fitness, balance, strength, and walking speed (Andrea et al., 2019). Walking is the healthiest type of exercise because it is the most natural and has a simple range of motion and is easy for many people to do. Outdoor walking is assumed to be a light physical activity and has a positive impact on the body. This is in line with several other research studies which found neuromuscular modifications depending on the walking training used (Battaglia et al., 2020). The discussion shows that there are many studies that have proven that there are beneficial effects of exercise on cognitive growth and social behavior.

However, it is estimated that by 2030 degenerative diseases will cause 80% of all diseases in the world (Lorenzo, 2021). According to the Global Burden of Disease, behavioral factors such as poor nutrition, reduced fruit and vegetable intake, high body mass index (BMI 25.0 kg/m²), smoking, high alcohol consumption, and low levels of physical activity are the main determinants of chronic degenerative diseases (Benziger et al., 2016). These are associated with poor diet and physical frailty during the COVID-19 pandemic. It has been found based on surveys that the elderly lose the desire to maintain a healthy diet and about 10% of the elderly have physical weakness (Yokoro et al., 2023). So for the elderly will be very limited to do daily physical activities, easy to get sick and can die even before reaching their age (Renzo et al., 2023). In another study revealed that 87% of the majority of children spend up to two hours every day watching TV, playing computer games or using the internet passively which makes children lazy to do physical activity (Oja, 2022). Recent statistics show that engagement in physical activity has not increased globally over the past 20 years, with 27% of adults and 81% of adolescents not reaching guidelines for aerobic exercise (Guthold et al., 2020). Further research to provide solutions to this crucial problem needs to be conducted.

According to the FITT-VP concept, which stands for frequency, intensity, time, type, volume, and development, aerobic exercise tailored to individual needs is a form of physical activity. Personalized aerobic exercise rules to assess cardiorespiratory fitness, determine the maximal oxygen uptake rate (VO₂ max) at various exercise intensities and integrate and evaluate cardiovascular, skeletal muscle respiratory and neuromuscular responses to exercise. to maintain good effects, aerobic exercise is performed over a long period of time (Lo et al., 2021). Some of these literature studies show evidence that it is very important to do physical activity. Recognizing the need and importance of reducing the amount of inadequate physical exercise on a global scale, this study investigated the impact of modified walking exercise with intensity variation on improving aerobic endurance. According to the researchers, walking exercise can be an alternative to improve cardiorespiratory ability that can be effectively performed by all ages with minimal chance of injury.

A reciprocal relationship exists between physical activity and one's level of fitness, with a notable emphasis on the cardiorespiratory endurance aspect. Activities such as interval training, brisk walking, and weightlifting contribute to the enhancement of cardiovascular stamina. These exercises are straightforward and uncomplicated to perform. This investigation centers on evaluating the efficacy of modified interval training, particularly walking routines, in augmenting VO₂Max levels (Kusumaningtyas, 2021).

METHODS

This study uses a quantitative research approach, namely experimental. Experimental research is a methodological approach used to explore and understand the causal relationship between independent and dependent variables (Igwenagu, 2016). This study used a quasi-experimental design. The quasi-experimental design uses a control group to regulate outside factors that affect how the experiment is conducted but does not fully function (Thomas, L. 2023). The sample in this study were 40 students of Yogyakarta State University. In determining the groups in this study, the subjects were divided into groups with another non-random approach. Because researchers often have few control groups, therefore researchers investigate pre-formed groups and receive different treatments afterwards. The instrument used in this study was Kenneth Cooper's 12-minute running test. This test involves measuring the distance traveled by participants within 12 minutes. The coherence of the 12-minute test was judged to be accurate, but in subjects who had lower VO₂max values were undervalued, while subjects who had higher Vo₂max values were overvalued. The test-retest reliability coefficient of the 12-minute run

indicates that healthy adults aged between 18-35 years can be recognized. Furthermore, this study was conducted at the community sports park which is the integrated field of the Faculty of Sports Science, Yogyakarta State University in Indonesia. The treatment group in this study was the walking exercise group. Before proceeding with the research treatment, all research samples were pre-tested. After passing the pre-test, the research sample then followed the exercise program determined by the research team. After completing a series of exercise programs as part of the research treatment, a post-test was conducted to compare and analyze potential differences in the results obtained from the treatment given.

RESULTS AND DISCUSSION

This study procedure ensures that participants follow standard protocols for the Cooper test, enabling accurate and consistent data collection. Running results were recorded by measuring the distance traveled by each participant during the 12-minute run in meters. The data analysis technique used was quantitative descriptive statistics. To simplify the classification of study data and determine the cardiovascular endurance of the participants, standard norms were used. The distance achieved by each participant is compared with the table of relevant test norms, which is based on Cooper's age and gender group (Wahyoedi, 2001). This comparison allows determining the participants' cardiovascular endurance levels based on set norms. The results of the formula are then converted into Cooper's test tables, enabling the determination of test score norms.

Table 1. Research on KM Running Test

Age	Very good	Good	Average	Low	Very low
13-14	>2700 m	2400-2700 m	2200-2399 m	2100-2199 m	<2100 m
15-16	>2800 m	2500-2800 m	2300-2499 m	2200-2299 m	<2200 m
17-19	>3000 m	2700-3000 m	2500-2699 m	2300-2499 m	<2300 m
20-29	>2800 m	2400-2800 m	2200-2399 m	1600-2199 m	<1699 m
30-39	>2700 m	2300-2700 m	1900-2299 m	1500-1999 m	<1500 m
40-49	>2500 m	2100-2500 m	1700-2099 m	1400-1699 m	<1400 m
>50	>2400 m	2000-2400 m	1600-1999 m	1300-1599 m	<1300 m

The treatment in this study was carried out 16 times with a frequency of 4x per micro exercise. Here is an overview of the current threat distribution.

Table 2. Micro Training of Exercise Program

Care	Time
Micro I	20 minutes
Micro II	30 minutes
Micro III	40 minutes
Micro IV	50 minutes
Total	600 minutes

In detail, the following are the results of statistical analysis related to the description of the achievements of the treatment group I (street training). The interpretation of the results of processing the walking group treatment data can be shown in Table 3.

Table 3. The Research Sample

	Mean	N	St. Deviation	Standard of Mistake Meaning
Pre-test	1926.40	40	421.356	56.816
Post-test	2076.45	40	391.833	52.835

Table 3. The Normality Test Result

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pre-test	.056	55	.200*	.975	40	.300
Post-test	.092	55	.200*	.974	40	.276

The paired sample test table showed the value of Sig. (2-tail). The results of $p = 0.000$ or it can be concluded that the value of $p < 0.05$, it can be concluded that there is a significant difference in the average aerobic endurance (Cooper's test) before and after 4 weeks of walking training programs. The interval column or 95% confidence interval value, walking exercise for 4 weeks can provide a difference in the increase in aerobic endurance between -221.939 to -78.170.

Table 4. Research Result Data Analysis

		Pre_Test	Post_Test
N	Valid	40	40
	Missing	0	0
Meaningful		1945.13	2078.27
St. Mistake from Meaningful		51.339	52.817
Median		1900.00	2030.00
Mode		1900	1660a
St. Deviation		380.741	391.704
Difference		144963.632	153431.684
Reach		1495	1700
Minimum		1255	1370
Maximum		2750	3070
Total		106982	114305

In this study the treatment was carried out 16 times, with the frequency of exercise per week set at 4 times. Treatment involves walking as a form of exercise. This meant participants did the exercise walk 4 times per week for a total of 16 weeks. Treatment distribution was spread evenly throughout the study period to ensure regular and consistent participation in the walking exercise program.

Based on the statistical analysis of the Paired Sample Test table, the value of Sig. (2-tail). The results of $p = 0.000$ or it can be concluded that the value of $p < 0.05$, it can be concluded that there is a significant difference in the average aerobic endurance (Cooper's test) before and after the 4-week walking exercise program. Within 95% confidence. Interval column or 95% confidence interval value, walking exercise for 4 weeks can provide a difference in increasing aerobic endurance between -221.939 to -78.170. The result from this research showed that Treatment involves walking 16 weeks was very effective to Increasing the quality of health and functional physical fitness. The results of this analysis also show an increase in cardiovascular endurance and VO2Max which are important components in improving sports achievement and the quality of learning among students. Relevant to this, the objective of the experimental study entitled "The Effect of Variation of Endurance Exercise Intensity (Walking) on Increasing Aerobic Capacity in Yogyakarta State University Students" can be said to have succeeded in proving that there is an effect of varying the intensity of walking exercise on increasing students' aerobic capacity.

Based on previous research, people can manage cardiovascular disease and lower the risk of stroke by changing their lifestyle and making walking a regular activity. Other studies have shown that, depending on one's routine, increasing walking exercise can reduce the risk of stroke by up to 30% or more (An & Chuo, 2022). Previous research has shown that changes in body composition are associated with increases in walking activity itself and not due to dietary changes. Increasing walking activity is more effective in reducing body composition than modifying nutrition (Id & Wadsworth, 2019). Overall, aerobic exercise with walking has a significant positive impact in individual ability, even in individuals with mild to moderate walking impairment (Devasahayam et al., 2017). During a full-body workout at

a moderate-vigorous level, appreciable functional gains in fitness and outcomes related to walking were seen (Krause & Gregory, 2017).

Some other research in the UK, a similar study was conducted involving older adults who were reluctant to engage in vigorous activities such as running to play football. The results of the study demonstrated the established health benefits of playing football, highlighting the significance of exercise and social interaction for promoting healthy aging. Football, being a popular and adaptable activity, engages participants in immersive, physically demanding, and social exercises. The act of playing football requires a considerable amount of energy expenditure, resulting in a significant reduction in sugar levels, as evidenced by Reddy at Siswantoyo (2022). In Malaysia, another study indicated that participating in walking football over an 8-week period with moderate intensity was effective in lowering cholesterol and glycemia among older individuals. Furthermore, this form of exercise also exhibited improvements in cardiorespiratory fitness and metabolism. Implementing a structured program, such as an 8-week regimen of imagery training, was shown to lead to decreased blood sugar levels, enhanced well-being, and improved athletic performance, as reported by Siswantoyo (2022).

It has been known for a very long time that walking can help senior's health. Numerous research over the years have shown the favorable effects of walking in a variety of bodily system as a result, any literacy sources agree that walking, among other thype of cardiovascular exercise, has a positive impact (Pavl, 2022). One of the recommended activities to positively influence and delay the onset aging in helathy senio persons is walking as physiological training. Of instance, one of these advantages is a decerase in resting heart rate. Reduced anxiety, enhanced mental health overall, higher self-selected walking speed, improved postural stability, and improved subjective impresson of exhaustion (Pavl, 2022). Therefore, it is ideal for seniors to walk frequently, improving their physical, mental, and social well-being (Andrea et al., 2019). Walking is the healthies type of exercise since it is the most natural and has a simple structure that is accessible to everybody without a bacground in sports. In line with other research published in the literature that discovered neuromuscular changes resulting from long-term, consistnt walking training in active participants as oppesed to inactive ones (Battaglia et al., 2020). They reiterate the ideas the engaging in some physical activity is preferable to doing nothing, that increasing in some physical activity is best for achieving optimal health outcomes, and they offer a fresh suggestion for lowering inactive habits. These recommendations stress the significance of routinely engaging in both aerobic and muscle-strenghtning excercise, and for the firs time, they include particular suggestions for different populations, such as pregnant and postpartum women, person with chronic diseases, and people with disabilities. The WHO Global Action Plan on Physical Activity 2018-2030 should be utilized as a reference point for national health programs, and these recommendations shloud be strenghenend surveillance systems that monitor progress toward both natonal and international goals (Bull et al., 2020).

CONCLUSSION

Walking is a physical activity that easy, cheap and can be done by anyone and does not require a place to walk with complicated infrastructure. Adjusted interval training encompasses modifications to conventional interval training methods. Walking, classified as an aerobic exercise, raises heart rate and respiration rates, culminating in heightened cardiovascular endurance. Consistent aerobic activities, like walking, have the potential to enhance the efficacy of the cardiovascular system, resulting in amplified oxygen uptake, improved blood circulation, and elevated VO_{2Max} levels. These findings underscore the affirmative influence of a sustained walking regimen. Walking stands as an uncomplicated and accessible form of physical activity, exerting less stress on joints when compared to high-impact pursuits like running or jumping. This characteristic renders it suitable for individuals spanning diverse fitness levels, including those with constraints or injuries. So the conclusion of this study shows that the provision of modified interval training in the form of walking exercises is very effective in increasing VO_{2Max} in students.

REFERENCES

- An, N., & Chuo, J. (2022). Walking and Activeness : The First Step toward the Prevention of. 2022. *Computational Intelligence and Neuroscience Volume 7*, <https://doi.org/10.1155/2022/3440437>
- Andrea, N., Oliveira, H. B., Silva, E. S., Id, R. C., Kanitz, A. C., Liedtke, G. V., Schuch, F. B., & Peyre, L. A. (2019). Effects of Nordic walking training on quality of life , balance and functional mobility in elderly : A randomized clinical trial. *PLoS ONE 14*(1), 1–21. <https://doi.org/10.1371/journal.pone.0211472>
- Bai, X., Soh, K. G., Dev, R., Dev, O., Talib, O., Xiao, W., Soh, K. L., Ong, S. L., Zhao, C., & Galeru, O. (2022). Aerobic Exercise Combination Intervention to Improve Physical Performance Among the Elderly : A Systematic Review. *Front Physiol 12*, 1–13. <https://doi.org/10.3389/fphys.2021.798068>
- Battaglia, G., Giustino, V., Messina, G., & Faraone, M. (2020). Walking in Natural Environments as Geriatrician ’ s Recommendation for Fall sustainability Walking in Natural Environments as Geriatrician ’ s Recommendation for Fall Prevention : Preliminary Outcomes from the “ Passiata Day ” Model. *Sustainability 12*(7) . <https://doi.org/10.3390/su12072684>
- Barajas, L., Salazar, C., Del Río, J., Flores, P., Gómez, J., & Gómez, E. (2021). Perfil antropométrico y composición corporal de la selección mexicana varonil mayor de voleibol anthropometric profile and body composition of the mexican men’s volleyball team. *Int. J. Morphol, 39*(1), 90–94. DOI:10.4067/S0717-95022021000100090
- Benziger, C. P., Roth, G. A., & Moran, A. E. (2016). The Global Burden of Disease Study and the Preventable Burden of NCD. *Global Heart, 11*(4), 393–397. <https://doi.org/10.1016/j.ghheart.2016.10.024>
- Bull, F. C., Al-, S. S., Biddle, S., Borodulin, K., Buman, M. P., Cardon, G., Carty, C., Chaput, J.-P., Chastin, S., Chou, R., Dempsey, P. C., Dipietro, L., Ekelund, U., Firth, J., Friedenreich, C. M., Garcia, L., Gichu, M., Jago, R., Katzmarzyk, P. T., ... Willumsen, J. F. (2020). World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *Br J Sports Med 2020*;541451–1462. <https://doi.org/10.1136/bjsports-2020-102955>
- Castagna, C., Impellizzeri, F. M., Chamari, K., Carlomagno, D., & Rampinini, E. (2006). Aerobic fitness and yo-yo continuous and intermittent tests performances in soccer players: a correlation study. *The Journal of Strength & Conditioning Research, 20*(2), 320-325. doi: 10.1519/R-18065.1. PMID: 16689621.
- Devasahayam, A. J., Downer, M. B., & Ploughman, M. (2017). The Effects of Aerobic Exercise on the Recovery of Walking Ability and Neuroplasticity in People with Multiple Sclerosis : A Systematic Review of Animal and Clinical Studies. 2017. <https://doi.org/10.1155/2017/4815958>
- DiCesare, C. A., Montalvo, A., Foss, K. D. B., Thomas, S. M., Hewett, T. E., Jayanthi, N. A., & Myer, G. D. (2019). Sport specialization and coordination differences in multisport adolescent female basketball, soccer, and volleyball athletes. *Journal of athletic training, 54*(10), 1105-1114. doi: 10.4085/1062-6050-407-18
- Guthold, R., Stevens, G. A., Riley, L. M., & Bull, F. C. (2020). Articles Global trends in insufficient physical activity among adolescents : a pooled analysis of 298 population-based surveys with 1 · 6 million participants. *The Lancet Child and Adolescent Health, 4*(1), 23–35. [https://doi.org/10.1016/S2352-4642\(19\)30323-2](https://doi.org/10.1016/S2352-4642(19)30323-2)
- Hojman, P., Gehl, J., Christensen, J. F., & Pedersen, B. K. (2017). Molecular Mechanisms Linking Exercise to Cancer Prevention and Treatment. *Cell Metabolism, 27*(1), 10–21. <https://doi.org/10.1016/j.cmet.2017.09.015>
- Id, M. G. R., & Wadsworth, D. W. (2019). The effect of 2 walking programs on aerobic fitness , body composition , and physical activity in sedentary office employees. *PLoS ONE 14*(1) 1–15. . <https://doi.org/10.1371/journal.pone.0210447>

- Krause, J. S., & Gregory, C. M. (2017). HHS Public Access. 54(9), 675–681. <https://doi.org/10.1038/sc.2015.212>.
- Kusumaningtyas, M., & Handari, H. K. (2021). The Effects of Skipping Rope Exercise, Brisk Walking Exercise, and Weight Training on Cardiorespiratory Endurance in Physiotherapy Students. *Indonesian Journal of Medicine*, 6(4), 423–429. <https://doi.org/10.26911/theijmed.2021.06.04.08>
- Lo, Y., Chiang, S., Lin, C., Liu, H., & Chiang, L. (2021). Effects of Individualized Aerobic Exercise Training on Physical Activity and Health-Related Physical Fitness among Middle-Aged and Older Adults with Multimorbidity : A Randomized Controlled Trial. *Int. J. Environ. Res. Public Health*, 18, 1–16. <https://dx.doi.org/10.3390/ijerph18010101>
- Lorenzo, A. De. (2021). Diet , Nutrition and Chronic Degenerative Diseases. *Nutrients* 2021, 13, 1372. 13–15 <https://doi.org/10.3390/nu13041372>
- Milić, M., Grgantov, Z., Chamari, K., Ardigò, L. P., Bianco, A., & Padulo, J. (2017). Anthropometric and physical characteristics allow differentiation of young female volleyball players according to playing position and level of expertise. *Biology of sport*, 34(1), 19-26. doi: 10.5114/biol sport.2017.63382
- Mcmillan, K., Helgerud, J., Macdonald, R., & Hoff, J. (2005). Physiological adaptations to soccer specific endurance training in professional youth soccer players. *British journal of sports medicine*, 39(5), 273-277. DOI: 10.1136/bjism.2004.012526
- Malisoux, L., Frisch, A., Urhausen, A., Seil, R., & Theisen, D. (2013). Monitoring of sport participation and injury risk in young athletes. *Journal of science and medicine in sport*, 16(6), 504-508. DOI: 10.1016/j.jsams.2013.01.008
- Moeskops, S., Oliver, J. L., Read, P. J., Cronin, J. B., Myer, G. D., & Lloyd, R. S. (2022). Practical Strategies for Integrating Strength and Conditioning into Early Specialization Sports. *Strength and Conditioning Journal*, 44(1), 34-45. DOI: 10.1519/SSC.0000000000000665
- Norton, K., & Olds, T. (2001). Morphological evolution of athletes over the 20th century. *Sports Medicine*, 31(11), 763-783. DOI: 10.2165/00007256-200131110-00001
- Oja, L. (2022). Physical Activity and Sports Participation among Adolescents : Associations with Sports-Related Knowledge and Attitudes. *Int. J. Environ. Res. Public Health* 2022, 19, 6235. <https://doi.org/10.3390/ijerph19106235>
- Patel, H., Alkhawam, H., Madanieh, R., Shah, N., Kosmas, C. E., Vittorio, T. J., Madanieh, R., Shah, N., Vittorio, T. J., & Francis, S. (2017). *cardiovascular system*. 9(2), 134–138. <https://doi.org/10.4330/wjc.v9.i2.134>
- Pavl, D. (2022). Influence of Walking as Physiological Training to Improve Respiratory Parameters in the Elderly Population. *Int. J. Environ. Res. Public Health* 2022, 19. <https://doi.org/10.3390/ijerph19137995>
- Puchalska-sarna, A., Baran, R., Kustra, M., Pop, T., Herbert, J., & Baran, J. (2022). The Level and Factors Differentiating the Physical Fitness of Adolescents Passively and Actively Resting in South-Eastern Poland — A Pilot Study. *Children* 2022, 9, 1341. <https://doi.org/10.3390/children9091341>
- Read, P. J., Oliver, J. L., & Lloyd, R. S. (2020). Seven pillars of prevention: Effective strategies for strength and conditioning coaches to reduce injury risk and improve performance in young athletes. *Strength & Conditioning Journal*, 42(6), 120-128. DOI:10.1519/SSC.0000000000000588
- Renzo, L. Di, Gualtieri, P., Frank, G., & Lorenzo, A. De. (2023). Diseases and COVID-19. *Nutrients* 2023, 15, 2253. 8–11. <https://doi.org/10.3390/nu15102253>
- Rikberg, A., and Raudsepp, L. (2011). Multidimensional performance characteristics in talented male youth volleyball players. *Pediatr. Exerc. Sci.* 23, 537–548. doi: 10.1123/pes.23.4.537

- Saputra, E. (2019). The Effect Of Velocity Based Resistance Training Towards Regional Training Camps Athletes In Koni Jambi. *Cerdas Sifa Pendidikan*, 8(2), 49-56. DOI: <https://doi.org/10.22437/csp.v8i2.8006>
- Segal N, J. B., Jeffrey. (2004). The Effects of Pilates Training on Flexibility and Body Composition: An Observational Study. *Arch Phys Med Rehabil*, 85, 1977-1981. DOI: 10.1016/j.apmr.2004.01.036
- Singh, M. J. P., & Kachhawa, P. (2020). Effects of plyometric exercise and circuit training on physical fitness selected variably speed and agility of tennis players. *IJPESH 2020*; 7(2): 140-142 <https://www.kheljournal.com/archives/2020/vol7issue2/PartC/7-2-15-449.pdf>
- Siswantoyo, Kukul H.P., Jahet N., Kumar R., Rozita A.L. (2022). *Influence of walking football on decreasing cholesterol and blood glycemc level*. *Jurnal Keolahragaan*; 10(1), 10.21831/jk.v10i1.48691
- Sheppard, J.M.; Gabbett, T.J.; Stanganelli, L.-C.R. An Analysis of Playing Positions in Elite Men's Volleyball: Considerations for Competition Demands and Physiologic Characteristics. *J. Strength Cond. Res.* 2008, 23, 1858–1866. doi: 10.1519/JSC.0b013e3181b45c6a. PMID: 19675472
- Smith, S. M., Juhl, C. B., Bricca, A., Harris, L. K., & Madalina, J. (2020). *Benefits and harms of exercise therapy in people with multimorbidity: A systematic review and meta-analysis of randomised controlled trials*. 63(May). <https://doi.org/10.1016/j.arr.2020.101166>
- Toselli, S., & Campa, F. (2018). Anthropometry and Functional Movement Patterns in Elite Male Volleyball Players of Different Competitive Levels. *Journal of Strength and Conditioning Research*, 32(9), 2601–2611. doi:10.1519/jsc.0000000000002368
- Tillman, M. D., Criss, R. M., Brunt, D., & Hass, C. J. (2004). Landing constraints influence ground reaction forces and lower extremity EMG in female volleyball players. *Journal of Applied Biomechanics*, 20(1), 38-50. DOI: <https://doi.org/10.1123/jab.20.1.38>
- Wahid, A., Manek, N., Nichols, M., Kelly, P., Foster, C., Roberts, N., & Scarborough, P. (2016). *Quantifying the Association Between Physical Activity and*. <https://doi.org/10.1161/JAHA.115.002495>
- Wang, Y., Ashokan, K., Cesar, P., & Silveira, L. (2021). *Physical Exercise: An Overview of Benefits From Psychological Level to Genetics and Beyond*. 12(August), 10–13. <https://doi.org/10.3389/fphys.2021.731858>
- Wang, M.H.; Chen, K.C.; Hung, M.H.; Chang, C.Y.; Ho, C.S.; Chang, C.H.; Lin, K.C. Effects of plyometric training on surface electromyographic activity and performance during blocking jumps in college division I men's volleyball athletes. *Appl. Sci.* 2020, 10, 4535. DOI:10.3390/app10134535
- Wells, K. F., & Dillon, E. K. (1952). The Sit and Reach-A Test of Back and Leg Flexibility. *Research Quarterly. American Association for Health, Physical Education and Recreation*, 23(1), 115-118. DOI:10.1080/10671188.1952.10761965
- Yokoro, M., Otaki, N., Yano, M., Imamura, T., & Tanino, N. (2023). Low Dietary Variety Is Associated with Incident Frailty in Older Adults during the Coronavirus Disease 2019 Pandemic: A Prospective Cohort Study in Japan. *Nutrients* 2023, 15, 1145. <https://doi.org/10.3390/nu15051145>