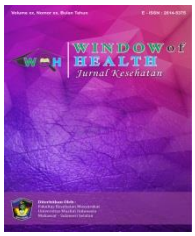
Window of Health : **Jurnal Kesehatan, Vol. 07 No. 03 (Juli, 2024) : 310-319** **E-ISSN 2614-5375**

Window of Health Jurnal Kesehatan
journal homepage : www.jurnal.fkmumi.ac.id



ARTICLE RESEARCH
URL artikel: http://jurnal.fkm.umi.ac.id/index.php/woh/article/view/woh7301

The Effect of Physical Activity on the Prevention of Degenerative Diseases of the Cardiovascular System

[C]Liliana Puspa Sari[1], Heru Santosa[2], Garry Kuan[3]
[1]Program Studi Pendidikan Jasmani Kesehatan dan Rekreasi, Sekolah Tinggi Olahraga dan Kesehatan Bina Guna
[2]Program Studi Ilmu Kesehatan Masyarakat, Fakultas Kesehatan Masyarakat, Universitas Sumatera Utara
[3]Exercise and Sports Science Programme, School of Health Sciences, Universiti Sains Malaysia
Email Penulis Correspondensi ([C]): lili.binaguna@gmail.com
lili.binaguna@gmail.com[1], heru@usu.ac.id[2], garry@usm.my[3]

ABSTRACT

Atherosclerotic plaque, which forms in blood arteries due to a lack of blood flow to the cells that produce blood flow, is a disease that causes a continuous decline in the function of body cells that characterizes degenerative diseases of the cardiovascular system. Through physical exercise, this study seeks to prevent several degenerative diseases of the cardiovascular system by reducing indicators of metabolic symptoms. The type of research applied is Action Research with the Spiral Model of Kemmis and Taggart, which is realized through the stages of Plan, Action, Observation, and Reflection. The sample used in this study has purposive sampling criteria, namely participant techniques based on age, namely 15-25 years old, who is studying at Bina Guna College of Sports and Health, and who has healthy body conditions and has symptoms of degenerative diseases of the cardiovascular system. The number of participants obtained was 30 people. 75% of participant data came from obesity measurements, 50% from hypertension, 45% from above-normal cholesterol levels, 20% from above-normal sugar measurements, and 50% from uric acid. The following metrics were used to assess the success of the physical activity model: (1) Body Mass Index (BMI) measurements were used to determine obesity levels; (2) blood pressure devices were used to measure hypertension; and (3) Autocheck was used to measure uric acid, sugar, and cholesterol. The implementation of two cycles led to a 30% decrease in obese patients, a 13% decrease in hypertension, a 13% decrease in cholesterol, a 10% decrease in blood sugar levels, and a 10% decrease in uric acid. The concept of physical fitness in the form of a movement activity concept developed as physical activity in the form of gymnastics based on structured and systematic movements, physical activity in the form of a daily activity schedule, and physical education as a diet as an example of a diet in carrying out activities, the prevention model through physical activity influences reducing the symptoms of degenerative diseases in the cardiovascular system.

Keywords : Prevention; Cardiovascular System; Physical Activity

PUBLISHED BY :
Faculty of Public Health
Universitas Muslim Indonesia
Address :
Jl. Urip Sumoharjo Km. 5 (Campus II UMI)
Makassar, Sulawesi Selatan.
Email :
jurnal.fkm@umi.ac.id
Phone :
+62 82188474722

Article history :
Received 2 January 2024
Received in revised from 23 July 2024
Accepted 24 July 2024
Available online 24 July 2024

INTRODUCTION

Studies on the prevention of degenerative diseases of the cardiovascular system through physical activity models have not been carried out much, some of the more common studies are looking at the relationship of several factors with physical activity. Even if a model is in question, the modeling is done statistically. The proportion of cardiovascular degenerative diseases in adults above and equal to 15 years from 2007 to 2018 has increased from 18.8 percent in 2007 to 26.6 percent in 2013 and increased again to 31.0 percent in 2018. [(1)] Data on the percentage of early adult behavior obtained based on observations in Medan City concluded that physical activity behavior is low. Data from 30 young adults (15-25 years old) taken randomly showed that 74.1 percent had low physical activity habits. The situation at hand illustrates that sedentary behavior carried out by early adults in Medan City has a risk of experiencing degenerative diseases of the cardiovascular system, which will have an impact on productivity at a decreased life expectancy and will experience a gap in the economy and the development of Human Resources (HR) of Medan City.

Cardiovascular degenerative disease is currently a chronic disease trend in the early adult age group of 15-25 years old with the main contributors being unhealthy lifestyles such as smoking, drinking alcohol, diet and obesity, lack of physical activity, stress, and environmental pollution. [(2–5)] Penyakit-penyakit kronik degeneratif yang umumnya terjadi di Indonesia dan menjadi sumber utama diketahuinya penyakit degeneratif sistem kardiovaskular tersebut adalah dengan penghitungan denyut jantung, pemeriksaan hipertensi, dan diabetes. [(6–8)]

Degenerative diseases of the cardiovascular system that are determined as the dominant symptoms in Indonesia, namely hypertension, diabetes, and coronary heart disease are then determined with symptoms that generally occur in the community are obesity, hypertension, cholesterol, blood sugar, and gout caused by abnormalities in blood vessels called atherosclerosis, which is a condition of large and small arteries which is then characterized by deposits of fat, platelets, macrophages, and leukocytes throughout the tunica intima layer and eventually to the tunica media. [(9–12)] In atherosclerosis, the intima layer of the artery wall contains a lot of cholesterol or other fats that undergo calcification, hardening, and thickening. The hardening and narrowing of blood vessels by the deposition of cholesterol, calcium, and yellow fat is known as atherosclerosis.

Efforts made to overcome the emergence of degenerative diseases of the cardiovascular system by countries experiencing problems with degenerative diseases of the cardiovascular system are to carry out diet and physical activity patterns in achieving energy balance. [(13)] High-fat, high-calorie diets and sedentary lifestyles are two characteristics that are strongly associated with an increased prevalence of cardiovascular degenerative diseases or symptoms of cardiovascular degenerative diseases worldwide. [(14–17)] Another effort in overcoming degenerative diseases of the cardiovascular system is to consume medicinal plants that contain chemical compounds. [(18,19)] Cardiovascular degenerative diseases can be prevented by minimizing the risk factors that cause them, including unhealthy diet, lack of physical

activity, smoking, and increased stress and exposure to the causes of cardiovascular degenerative diseases. (20–22)

Prevention of degenerative diseases of the cardiovascular system through physical activity models still needs to be improved. Several sources emphasize the importance of physical activity in preventing degenerative diseases, such as heart disease, cancer, stroke, diabetes, hypertension, and atherosclerosis. The main risk factors for degenerative diseases include an unhealthy diet, lack of physical activity, smoking, and increased blood pressure. Efforts to prevent degenerative diseases can be made through regular physical activity and a healthy lifestyle, including measuring physical quality and applying the Dempster-Shafer method to diagnose degenerative diseases. However, improvements need to be made in the implementation of physical activity models to prevent degenerative diseases of the cardiovascular system.

The designed model not only offers various gymnastic movements but also physical activities and physical education, all of which become a model program for preventing degenerative diseases of the cardiovascular system. The gymnastic movements are designed by the researcher, while physical activity is determined independently by the early adult age group, while physical education is more about education about physical activity provided by the researcher to early adult age group participants through discussion communication. The perfection of the prevention model applied is carried out through the stages of action research, then the results will be seen based on changes in the symptoms of degenerative diseases of the cardiovascular system through established measurements. Based on this, the researcher is interested in creating gymnastic movements that can be useful for preventing degenerative diseases of the cardiovascular system as part of physical activity activities.

METHOD

Action Research is used to explore a model for preventing degenerative diseases of the cardiovascular system based on the changes that occur in a person's physical condition to detect degenerative diseases of the cardiovascular system. The Action Research action design used is the Spiral Model from Kemmis and Taggart. The spiral model from Kemmis and Taggart is a model whose realization uses the terms plan, action, observation, and Reflection. (23)

The location of research conducted by researchers was in Tanjung Mulia Hilir Village, Medan Deli District, in a place that has extensive field facilities for carrying out physical activities and is easy to access. The research was carried out from January 2020 to June 2021 in accordance with an action research design, namely changes in symptoms of degenerative diseases of the cardiovascular system.

Participants in this research were all levels of early adulthood, namely ages 15-25 years. The reason for selecting ages 15–25 years is because prevention of degenerative diseases of the cardiovascular system in individuals aged 15–25 years is critical due to the early onset of cardiovascular risk factors and the direct relationship between these factors and adult cardiovascular events and mortality. (24,25) The participant group consisted of men and women who were categorized as having symptoms of degenerative diseases of the cardiovascular system, which were calculated based on BMI, blood pressure, and

Autocheck. The number of participants obtained was 30 people as research samples. The participants used in this study had purposive sampling criteria, namely a participant technique based on age, namely 15-25 years, who were currently studying at the Bina Guna Sports and Health College, and were in healthy body condition and had symptoms of degenerative diseases of the cardiovascular system.

The technique for measuring changes in respondents related to changes in symptoms of degenerative diseases of the cardiovascular system is by using Body Mass Index (BMI) measurements, digital blood pressure devices to measure blood pressure, and Autocheck to calculate sugar, cholesterol, and uric acid levels.

The research results were obtained from calculating data obtained using analysis with SPSS version 29 software to see the effect of physical activity on preventing degenerative diseases of the cardiovascular system.

RESULT

Based on metabolic conditions, data on the level of symptoms of degenerative diseases of the cardiovascular system was obtained, resulting from the impact of metabolic changes, shifting disease patterns, and excess nutrition. The results of the measurement of respondents obtained measurements of obesity levels in as many as 23 people or 77 percent, hypertension in as many as 11 people or 37 percent, cholesterol levels above normal in as many as 13 people or 43 percent, sugar levels above normal as many as ten people or 33 percent, and gout as many as 13 people or 43 percent. This data is supported by information that each sample has one to three of the five symptoms of degenerative diseases of the cardiovascular system, as data in Appendix twelve. The metabolic symptoms of degenerative diseases of the cardiovascular system will impact productivity and lead to decreased life expectancy. It will experience gaps in the economy and the development of Human Resources (HR), as shown in Figure 1.

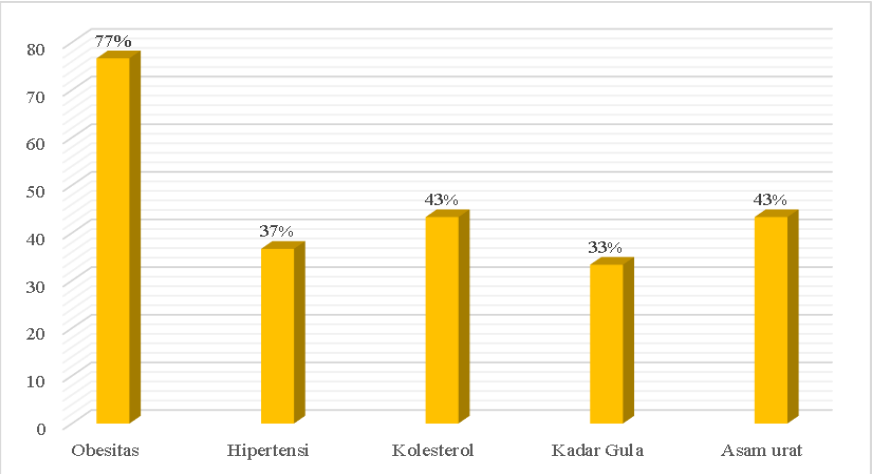


Figure 1. Cardiovascular system degenerative disease symptom level data

Table 1. Research Result Data

Measurement	Initial Measurement		Cycle I Step 1		Cycle I Step 2		Cycle II Step 1		Cycle II Step 2	
	n	%	n	%	n	%	n	%	n	%
Obesity	25	83	24	80	23	77	21	70	16	53
Hipertention	9	30	8	27	8	27	7	23	5	17
Cholestrol	13	43	12	40	12	40	11	37	9	30
Glucose	10	33	10	33	10	33	9	30	7	23
Gout	15	50	14	47	14	47	13	43	12	40

Physical activity influences changes in obesity levels by 53 percent, a decrease in obesity levels from the original 83 percent. The decrease experienced due to the application of physical activity is 30 percent or as many as nine samples from the obese category to normal. Physical activity influences changes in hypertension levels, with measurement results showing 17 percent, which has decreased from the original 30 percent. The decrease obtained was 13 percent or equivalent to a decrease in hypertension by four people from the hypertension category to normal. Physical activity influences cholesterol measurement conditions by 30 percent from 43 percent. Cholesterol conditions decreased by 13 percent or equivalent to a change in 4 people from high cholesterol conditions to normal. Physical activity influences the condition of measuring blood sugar levels by 23 percent from the original 33 percent. The results of blood sugar measurements decreased by 10 percent, equivalent to a change in the sample of 3 people from the high blood sugar category to normal. Physical activity influences the measurement of uric acid, obtaining results of 40 percent from the original 50 percent. The measurement results decreased by 10 percent, which is equivalent to a change of 3 people from high uric acid conditions to normal.

DISCUSSION

Prevention of degenerative diseases of the cardiovascular system through physical activity models has been studied extensively in recent years. Physical activity has been shown to have a strong positive effect on the cardiovascular system, improving physical and mental conditions, reducing the risk of disease, and aiding recovery. [26,27] It has also been noted that physical activity has therapeutic effects in patients with neurodegenerative disorders, contributing to improved cognition, memory, and reduced anxiety. [28] The relationship between physical activity and cardiovascular disease is well established, with physical inactivity being a major risk factor for CVD [29]. In addition, the use of machine learning algorithms, including deep learning algorithms, has significantly improved the accuracy of predicting cardiovascular risk, enabling the identification of high-risk individuals. [30,31] Therefore, there has been significant research and progress in developing models for the prevention of degenerative diseases of the cardiovascular system through physical activity.

The role of physical activity in obesity is based on the hormone leptin, which acts as a negative feedback in regulating energy balance. Circulating leptin through the blood and brain interacts with receptors on neurons to affect energy balance and reduces adipocytes by reducing appetite and increasing thermogenesis. [32] The decrease in obesity is influenced by the stability of the power (energy) needs expended during physical activity. The energy possessed is used by converting adenosine diphosphate (ADP) into adenosine triphosphate (ATP) used in physical activity through gymnastics is transformed into a series of active transport of molecules through cell membranes, muscle contraction and mechanical work, synthetic reactions, delivery of nerve impulses, and cell growth and division.

The decrease in hypertension is obtained based on the benefits of physical activity in gymnastics, which creates heart work so that its capacity increases in size and strength. [33] These two things will increase the efficiency of the heart's work so that it will not need too frequent beats. The movements in gymnastics can reduce systolic and diastolic pressure in people with mild high blood pressure. The effect is caused by a beta blocker that can explain the sympathetic nervous system and slow the heart rate.

Physical activity training affects the efficiency of heart work with a heart rate intensity of 150-170 per minute. Physical activity movement has a significant effect after being done three times a week. It can relax the blood vessels so that blood pressure decreases. [34] The development of decreased hypertension also causes nerve activity, hormone receptors, and hormone production to decrease and then reduces systolic blood pressure to 0-4 mmHg and diastolic to 0-6 mmHg. The results of the decrease were also influenced by changes in dietary behavior and daily physical activity of the sample.

Cholesterol reduction is obtained based on the benefits of gymnastic physical activity, namely through the body's reaction in the use of energy three energy metabolism pathways that can be used by the body to produce ATP, namely phosphocreatine hydrolysis, glucose anaerobic glycolysis, and burning carbohydrate, fat, and protein stores. [35] Cholesterol in the body is the dominant content found in fats, which is a group of acids that are basically attached to a chain of carbon atoms with two hydrogen atoms. Most of the fat in the blood consists of triglycerides, which are divided into two types: saturated fat and unsaturated fat. Gymnastic physical activity extends the time and forces the body to improve its circulatory system. [36] The reaction to gymnastic movements is to increase the volume of oxygen to be transported throughout the body to increase cardiovascular and muscular endurance. This reaction then makes the circulatory channel better when the blood is pumped by the heart. The effect of these conditions is that High-Density Lipoprotein is increased, and the ratio of the amount of cholesterol and High-Density Lipoprotein will be reduced, thus reducing the risk of developing atherosclerosis or hardening of the arteries.

The series of movements in gymnastics can increase the density of Lipoprotein due to the fact that the movements have a moderate intensity when compared to warm-up and cool-down movements. [37] The increase in High-Density Lipoprotein is caused by fat burning and has an impact on decreasing triglycerides and VLDL, which ultimately causes High-Density Lipoprotein to increase. In addition to

these reactions, another reaction that is caused is a decrease in the activity of the enzyme liase in the day so that it inhibits HDL catabolism.

The reduction of risk factors for blood sugar is obtained through physical activity of gymnastic movements based on the reaction of movements that can burn calories and reduce body fat so as to increase the metabolic ability of cells to absorb and store glucose. [38] The activity of gymnastic movements performed can reduce disturbances in insulin resistance and insulin secretion so that the body's metabolism does not experience serious disturbances, which are mentioned in the state of hyperglycemia. Physical fitness that is applied can cause insulin function to stabilize even when the muscles are doing active work and require glucose. The process of muscle work in physical fitness, namely gymnastics, provides an increase in the sensitivity of insulin receptors in active muscles through the process of blood vessels. When compared to the lack of muscle activity, the blood vessels will not work optimally, and there is deposition of energy reserves and plaque in the blood vessels due to the deposition process, which is called atherosclerotic.

The decrease in uric acid is obtained based on the benefits of gymnastic physical activity, which has a reaction to changes in the body according to the type, length, and intensity of the exercise performed. [39]. Exercise done regularly at a sufficient dose will cause changes in the heart, blood vessels, lungs, muscles, bones, ligaments and tendons, joints and cartilage, and acclimatization to heat. The impact of exercise also makes the elasticity of blood vessels increase due to the reduction of fat deposits and additional muscle contraction of the blood vessel wall. High elasticity of blood vessels will facilitate the passage of blood and prevent the onset of hypertension. [40] Muscle strength, flexibility, and endurance will increase due to the increase in the size of muscle fibers and the increase in the energy supply system in the muscles from sports activities. Density also occurs when enzyme activity is added to the bones, which will increase the density, strength, and size of the bones, in addition to preventing bone loss. The strength of ligaments and tendons will increase; thus, this situation will make the ligaments and tendons able to withstand the load and not easily injured.

Physical activity will create nitrogen excretion that occurs in protein metabolism. The process of protein metabolism will make 90 percent of nitrogen decomposed and excreted in the urine as uric acid. The resulting physical movement will create carbon dioxide diffusion from the blood of the fetus, which then diffuses back through the placental membrane and is excreted due to energy burning. [41] The physical activity of this gymnastics will utilize kidney function to filter plasma first through the glomeruli into the tubules in large quantities and then absorb the substances needed by the body into the blood. In this process, uric acid will be excreted either in the form of sweat or through the renal tubules and incorporated into urine.

CONCLUSION AND RECOMMENDATIONS

Prevention of degenerative diseases of the cardiovascular system through efforts to reduce metabolic symptom indicators is organized in the form of physical activity developed in the form of gymnastics on the basis of structured and systematic movements or called the concept of physical fitness.

The conclusion in the study is that there is an effect of physical activity on the prevention of degenerative diseases of the cardiovascular system with changes in the level of obesity, hypertension, cholesterol, blood sugar levels, uric acid.

ACKNOWLEDGMENTS

For all humility and sincerity, the author expresses his deep gratitude to the Medan Development Foundation for providing the research location.

REFERENCES

1. Tim Riskesdas 2018. Laporan Nasional Riskesdas 2018. Lembaga Penerbit Badan Penelitian dan Pengembangan Kesehatan; 2018. 1–628 p.
2. Zhang K, Ma Y, Luo Y, Song Y, Xiong G, Ma Y, et al. Metabolic diseases and healthy aging: identifying environmental and behavioral risk factors and promoting public health. Vol. 11, Frontiers in Public Health. Frontiers Media SA; 2023.
3. Alotaibi MI, Elsamad G, Aljardahi AN, Alghamdi AN, Alotaibi AI, Alorabi HM, et al. Changes in dietary and lifestyle behaviors and mental stress among medical students upon Ramadan diurnal intermittent fasting: a prospective cohort study from Taif/Saudi Arabia. BMC Public Health. 2023 Dec 1;23(1).
4. Timsina YP, Pandey P, Mondal IH, Dar AH. Non-pharmacological management of hypertension: A systematic review. Vol. 3, Food Chemistry Advances. Elsevier Ltd; 2023.
5. Guo X, Gong S, Chen Y, Hou X, Sun T, Wen J, et al. Lifestyle behaviors and stress are risk factors for overweight and obesity in healthcare workers: a cross-sectional survey. BMC Public Health. 2023 Dec 1;23(1).
6. Yuni Gumala NM, Nursanyoto H, Ambartana IW. THE RISK OF DEGENERATIVE DISEASES BASED ON ENERGY CONSUMPTION AND EXERCISE HABITS. Jurnal Riset Kesehatan. 2023 Jun 2;12(1):50–6.
7. Permanasari A, Saftarina F. Relationship Between Nutritional Status And Degenerative Diseases In The Elderly [Internet]. Vol. 2, International Journal Of Health, Engineering And Technology. 2023. Available from: https://ijhet.com/index.php/ijhess/
8. Haykal TB, Sitepu A, Ilyas KK. Prevalence of Valvular Heart Disease and Pulmonary Hypertension in Children in Rantau-Prapat City, North Sumatra, Indonesia. Journal of Endocrinology, Tropical Medicine, and Infectious Disease (JETROMI) [Internet]. 2023 Nov 30;5(4):177–86. Available from: https://talenta.usu.ac.id/jetromi/article/view/14333
9. Dalili S, Hassanzadeh Rad A, Salkhori O, Dabbaghi S, Karambin MM, Badeli H, et al. Potentials of Hyperuricemia and Insulin Levels in Predicting Hypertension in Obese Children: A Cross-Sectional Study. Journal of Comprehensive Pediatrics [Internet]. 2023 Dec 15;15(1). Available from: https://brieflands.com/articles/jcp-139577
10. Beki J. Issue 5 203 Citation J. Beki, Coronary artery disease. EJCMPR [Internet]. 2023;2(5):203–11. Available from: https://doi.org/10.5281/zenodo.8263024
11. Sakr HF, Sirasanagandla SR, Das S, Bima AI, Elsamanoudy AZ. Insulin Resistance and Hypertension: Mechanisms Involved and Modifying Factors for Effective Glucose Control. Vol. 11, Biomedicines. Multidisciplinary Digital Publishing Institute (MDPI); 2023.

12. Wojtasińska A, Frąk W, Lisińska W, Sapeda N, Młynarska E, Rysz J, et al. Novel Insights into the Molecular Mechanisms of Atherosclerosis. Vol. 24, International Journal of Molecular Sciences. Multidisciplinary Digital Publishing Institute (MDPI); 2023.

13. Andrade C. Physical Exercise and Health, 3: The Health Care Professional and Patient's Guide to Understanding What to Do, How, and Why-Part 1. Vol. 84, J Clin Psychiatry. 2023.

14. Arora S, Santiago JA, Bernstein M, Potashkin JA. Diet and lifestyle impact the development and progression of Alzheimer's dementia. Vol. 10, Frontiers in Nutrition. Frontiers Media SA; 2023.

15. Popa-Wagner A, Dumitrascu D, Capitanescu B, Petcu E, Surugiu R, Fang WH, et al. Dietary habits, lifestyle factors and neurodegenerative diseases. Vol. 15, Neural Regeneration Research. Wolters Kluwer Medknow Publications; 2020. p. 394–400.

16. Gomez-Delgado F, Katsiki N, Lopez-Miranda J, Perez-Martinez P. Dietary habits, lipoprotein metabolism and cardiovascular disease: From individual foods to dietary patterns. Vol. 61, Critical Reviews in Food Science and Nutrition. Bellwether Publishing, Ltd.; 2021. p. 1651–69.

17. Sharifi-Rad J, Rodrigues CF, Sharopov F, Docea AO, Karaca AC, Sharifi-Rad M, et al. Diet, lifestyle and cardiovascular diseases: Linking pathophysiology to cardioprotective effects of natural bioactive compounds. Vol. 17, International Journal of Environmental Research and Public Health. MDPI AG; 2020.

18. Vandana Sonaji Amle, Dharmaraj Arjun Rathod, Keshamma E., Vijender Kumar, Roshan Kumar, Purabi Saha. Bioactive Herbal Medicine Use for Eye Sight: A Meta Analysis. Journal for Research in Applied Sciences and Biotechnology. 2022 Aug 8;1(3):42–50.

19. Bhattacharya T, Soares GABE, Chopra H, Rahman MM, Hasan Z, Swain SS, et al. Applications of Phyto-Nanotechnology for the Treatment of Neurodegenerative Disorders. Vol. 15, Materials. MDPI; 2022.

20. Divella R, Marino G, Infusino S, Lanotte L, Gadaleta-Caldarola G, Gadaleta-Caldarola G. The Mediterranean Lifestyle to Contrast Low-Grade Inflammation Behavior in Cancer. Vol. 15, Nutrients. MDPI; 2023.

21. Furman D, Campisi J, Verdin E, Carrera-Bastos P, Targ S, Franceschi C, et al. Chronic inflammation in the etiology of disease across the life span. Nat Med. 2019 Dec 1;25(12):1822–32.

22. Garza-Juárez A, Pérez-Carrillo E, Arredondo-Espinoza EU, Islas JF, Benítez-Chao DF, Escamilla-García E. Nutraceuticals and Their Contribution to Preventing Noncommunicable Diseases. Vol. 12, Foods. Multidisciplinary Digital Publishing Institute (MDPI); 2023.

23. Suharsaputra U. Metode Penelitian Kuantitatif, Kualitatif, dan Tindakan. Bandung: Refika Aditama; 2018.

24. Chung RJ, Touloumtzis C, Gooding H. Staying Young at Heart: Cardiovascular Disease Prevention in Adolescents and Young Adults. Curr Treat Options Cardiovasc Med. 2015 Dec 29;17(12):61.

25. Kodithuwakku V, Climie RE. More to Determine About Early Vascular Ageing in Young People. Heart Lung Circ. 2022 Nov;31(11):1427–8.

26. Makmun A, Karim M, Bamahry A, Vitayani S, Purnama ID. Kejadian Obesitas Pada Pasien Yang Berobat Di Rumah Sakit Ibnu Sina. Window of Health:Jurnal Kesehatan. 2023;6(2):218–26.

27. Masnah C, Kaimudin. Efektivitas Senam Siginjai Terhadap Penurunan Gula Darah Penderita Diabetes Melitus Tipe 2 Di Kota Jambi. Window of Health : Jurnal Kesehatan. 2021;4(4):223–30.

28. Mahalakshmi B, Maurya N, Lee S Da, Kumar VB. Possible neuroprotective mechanisms of physical exercise in neurodegeneration. Int J Mol Sci. 2020 Aug 2;21(16):1–17.

29. Bucciarelli V, Mattioli AV, Sciomer S, Moscucci F, Renda G, Gallina S. The Impact of Physical Activity and Inactivity on Cardiovascular Risk across Women's Lifespan: An Updated Review. Vol. 12, Journal of Clinical Medicine. Multidisciplinary Digital Publishing Institute (MDPI); 2023.

30. Dalal S, Goel P, Onyema EM, Alharbi A, Mahmoud A, Algarni MA, et al. Application of Machine Learning for Cardiovascular Disease Risk Prediction. Comput Intell Neurosci. 2023 Mar 1;2023:1–12.

31. Oikonomou EK, Khera R. Machine learning in precision diabetes care and cardiovascular risk prediction. Vol. 22, Cardiovascular Diabetology. BioMed Central Ltd; 2023.

32. Aydi B, Selmi O, Marsigliante S, Souissi MA, Souissi N, Muscella A. Integration of Obese Children in Physical Education Sessions: An Exploratory Study. Children. 2023 Jan 1;10(1).

33. Ridwan A, Nurhadi FI, Yachsie BTPWB, Nasrulloh A, Rismaningsih N. The effect of the simple fitness exercise model to improve the vocational students' physical fitness. Jurnal Keolahragaan. 2023 Sep 30;11(2):228–36.

34. Andrade C. Physical Exercise and Health, 3: The Health Care Professional and Patient's Guide to Understanding What to Do, How, and Why-Part 1. Vol. 84, J Clin Psychiatry. 2023.

35. Ianiro G, Niro A, Rosa L, Valenti P, Musci G, Cutone A. To Boost or to Reset: The Role of Lactoferrin in Energy Metabolism. Vol. 24, International Journal of Molecular Sciences. Multidisciplinary Digital Publishing Institute (MDPI); 2023.

36. Qiu Y, Fernández-García B, Lehmann HI, Li G, Kroemer G, López-Otín C, et al. Exercise sustains the hallmarks of health. Vol. 12, Journal of Sport and Health Science. Elsevier B.V.; 2023. p. 8–35.

37. Choi JH, Park HY, Sun Y, Seo J, Lee E, Kim SW, et al. Effect of exercise intervention using mobile healthcare on blood lipid level and health-related physical fitness in obese women: a randomized controlled trial. Phys Act Nutr. 2023 Sep 30;27(3):064–70.

38. Eroglu MN, Rodríguez-Longobardo C, Ramírez-Adrados A, Colina-Coca C, Burgos-Postigo S, López-Torres O, et al. The Effects of 24-h Fasting on Exercise Performance and Metabolic Parameters in a Pilot Study of Female CrossFit Athletes. Nutrients. 2023 Nov 1;15(22).

39. Zare R, Devrim-Lanpir A, Guazzotti S, Ali Redha A, Prokopidis K, Spadaccini D, et al. Effect of Soy Protein Supplementation on Muscle Adaptations, Metabolic and Antioxidant Status, Hormonal Response, and Exercise Performance of Active Individuals and Athletes: A Systematic Review of Randomised Controlled Trials. Sports Medicine. Springer Science and Business Media Deutschland GmbH; 2023.

40. Ma J, Li Y, Yang X, Liu K, Zhang X, Zuo X, et al. Signaling pathways in vascular function and hypertension: molecular mechanisms and therapeutic interventions. Vol. 8, Signal Transduction and Targeted Therapy. Springer Nature; 2023.

41. Sukadiono S, Zahrah SF, Nasrullah D, Supatmi S, Fitriyani VR. The effect of physical exercise on vital lung capacity in Tapak Suci athletes. Jurnal Keolahragaan. 2022 Sep 26;10(2):166–74.