

Pengaruh Senam Lansia Posisi Duduk Dengan Menggunakan Kain Terhadap Beban Kardiovaskular

The Effect Of Senior Exercise In A Sitting Position Using Cloth On Cardiovascular Load

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Abstrak

Pendahuluan: Proses penuaan menyebabkan penurunan fungsi fisiologis, termasuk sistem kardiovaskular, yang berdampak pada meningkatnya risiko hipertensi dan penyakit jantung pada lansia. Aktivitas fisik seperti senam lansia terbukti mampu menjaga kebugaran dan menurunkan risiko penyakit tersebut. Namun, keterbatasan mobilitas dan kekhawatiran akan cedera membuat sebagian lansia sulit berpartisipasi. Oleh karena itu, diperlukan modifikasi senam yang aman dan efektif, salah satunya melalui senam duduk dengan media kain untuk membantu gerakan tanpa menambah beban berlebih pada tubuh. **Tujuan:** Penelitian ini bertujuan untuk mengetahui pengaruh senam lansia posisi duduk dengan menggunakan kain terhadap beban kardiovaskular pada lanjut usia. **Metode:** Penelitian ini menggunakan metode kuantitatif dengan desain pretest-posttest single group design. Subjek penelitian adalah lansia di Dusun Mantren, Desa Klodran, Kecamatan Colomadu, Kabupaten Karanganyar, yang memenuhi kriteria inklusi. Intervensi dilakukan sebanyak 10 kali pertemuan, masing-masing berdurasi 1 jam (10 menit pemanasan, 40 menit gerakan inti, dan 10 menit pendinginan). Pengukuran dilakukan sebelum dan sesudah senam menggunakan sphygmomanometer (tensimeter) untuk tekanan darah serta oxymetri untuk saturasi oksigen dan denyut nadi. Data dianalisis menggunakan uji normalitas Shapiro-Wilk dan uji t-berpasangan atau Wilcoxon sesuai distribusi data. **Hasil:** Analisis penelitian menunjukkan bahwa rata-rata tekanan darah sistolik dan diastolik menurun pada minggu pertama maupun minggu keempat setelah pemberian intervensi, sedangkan nilai SpO₂ tetap berada dalam kisaran normal. Uji normalitas mengindikasikan bahwa data tidak mengikuti distribusi normal, sehingga pengujian dilanjutkan menggunakan uji Wilcoxon. Hasil uji Wilcoxon memperlihatkan adanya perbedaan signifikan antara nilai sebelum dan sesudah intervensi pada seluruh parameter fisiologis ($p < 0,05$), ditandai dengan penurunan tekanan darah dan peningkatan nilai SpO₂ setelah intervensi. **Kesimpulan:** Intervensi yang diterapkan terbukti memberikan pengaruh positif terhadap parameter kardiovaskular dan oksigenasi pada lansia, ditunjukkan oleh penurunan signifikan tekanan darah serta peningkatan saturasi oksigen. Penelitian ini menunjukkan bahwa intervensi tersebut berpotensi menjadi pendekatan yang efektif untuk mendukung kesehatan kardiovaskular pada lansia, meskipun penelitian lanjutan dengan sampel lebih besar dan pengendalian variabel yang lebih optimal tetap diperlukan untuk memperkuat generalisasi temuan.

Kata kunci: Senam Lansia, Modifikasi Senam Duduk, Kain, Beban Kardiovaskular, Lansia

Abstract

Introduction: The aging process causes a decline in physiological functions, including the cardiovascular system, which increases the risk of hypertension and heart disease in the elderly. Physical activities like elderly gymnastics have been shown to maintain fitness and reduce the risk of these diseases. However, mobility limitations and concerns about injury make it difficult for some elderly individuals to participate. Therefore, safe and effective modifications of gymnastics are needed, one of which is seated exercises using fabric to assist movements without adding excessive strain to the body. **Objective:** This study aimed to determine the effect of seated elderly exercise using a cloth as an aid on cardiovascular load in older adults. **Method:** This quantitative study used a pretest-posttest single group design. The subjects were older adults in Mantren Hamlet, Klodran Village, Colomadu District, Karanganyar Regency, who met the inclusion criteria. The intervention was conducted in 10 sessions, each lasting 1 hour (10 minutes warm-up, 40 minutes core exercise, and 10 minutes cool-down). Blood pressure, oxygen saturation, and pulse rate are measured before and after the intervention using a

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sphygmomanometer and oximeter. Data are analyzed using the Shapiro–Wilk normality test and paired t-test or Wilcoxon test as appropriate. **Results:** Analysis of the study shows that the average systolic and diastolic blood pressure decreased in the first week and fourth week after the intervention, while SpO₂ values remained within the normal range. The normality test indicated that the data did not follow a normal distribution, so the test was continued using the Wilcoxon test. The Wilcoxon test results showed a significant difference between the values before and after the intervention in all physiological parameters ($p < 0.05$), marked by a decrease in blood pressure and an increase in SpO₂ values after the intervention. **Conclusion:** The intervention applied was proven to have a positive effect on cardiovascular and oxygenation parameters in the elderly, as indicated by a significant decrease in blood pressure and an increase in oxygen saturation. This study shows that the intervention has the potential to be an effective approach to support cardiovascular health in the elderly, although further research with a larger sample and more optimal control of variables is still needed to strengthen the generalization of the findings.

Keywords: Senior Exercise, Modified Chair Exercise, Fabric, Cardiovascular Load, Elderly

1. INTRODUCTION

By 2025, Indonesia is projected to become the country with the fifth largest elderly population in the world, after China, India, the United States, and Japan. Currently, around 8% of Indonesia's total population is classified as elderly. Assuming the population reaches 250 million people, it is estimated that there will be around 20 million elderly people. This percentage is an accumulation of increases that have occurred every decade, with 5.8% and 7.4% recorded in 1990 and 2000, respectively. It is predicted that by 2020, around 11.4% of Indonesia's population, or 29.2 million people, will be over 60 years old, and this figure is expected to increase to 19.7% or 55.5 million people by 2040. In the next three decades, the number of elderly people is predicted to exceed the number of children under the age of 14 [1]. This increase poses challenges in the health sector, especially in relation to non-communicable diseases such as hypertension and heart disease. Data from the 2018 Basic Health Research (Riskesdas) shows that the prevalence of hypertension among people aged ≥ 65 years reached 63.5% [2].

Aging is a natural process that affects a person's physical, psychological, and social condition, with these three aspects being interrelated. This condition has the potential to cause various general health disorders, as well as mental health problems that are often experienced by the elderly [3]. The elderly are individuals aged 60 and above. The term elderly is used to refer to someone who has entered late adulthood or old age [4]. The elderly have a high risk of cardiovascular disease due to various risk factors such as hypertension, obesity, diabetes mellitus, and high cholesterol levels. Controllable risk factors, including high blood pressure, cholesterol, obesity, smoking, lack of physical activity, and diabetes mellitus influence cardiovascular disease itself. Meanwhile, uncontrollable risk factors include age, gender, and family history [5].

Sports are a series of physical activities aimed at maintaining and improving body health. Nowadays, there are various types of sports that can be done, one of which is gymnastics. Gymnastics itself is a form of physical exercise consisting of systematically arranged movements to support physical fitness [6]. One of the efforts to maintain the health of the elderly themselves from a healthy lifestyle is through gymnastics, which can be done by anyone, especially the elderly [7]. Senior gymnastics is a series of rhythmic movements performed in a structured and planned manner by older adults in the form of physical exercises that affect their physical abilities [8]. This exercise helps the body stay fit and fresh by strengthening bones and helping to reduce free radicals in the body. The objectives of senior gymnastics include increasing endurance, strength, coordination, and maintaining health. In addition, exercise for the elderly also plays a role in slowing down physiological changes due to the aging process in the musculoskeletal system, preventing a decline in strength and flexibility, reducing the risk of injury, maintaining joint flexibility, and protecting the elderly from the risk of falling [9]. The duration of exercise is always related to the intensity, frequency, repetitions, and duration of the workout. The recommended duration of exercise to maintain the health of the elderly is in the morning and does not exceed the maximum heart rate limit of 60-70%. Exercise should be done for 20-30 minutes according to the ability of the elderly [10]. The implementation of seated exercises for the elderly often faces various obstacles, including declining physical condition with age, low motivation to move, and lack of support from health workers and family members. Seated exercises modified with cloth aids are an effective exercise alternative for the elderly. The cloth is used to perform various movements such as pulling, lifting, or holding, which serve to strengthen muscles and maintain joint flexibility in a safe and varied manner. In addition, this exercise helps improve body coordination and creates a

more enjoyable and less boring exercise atmosphere for elderly participants [11]. Modified exercise for the elderly can improve balance, flexibility, and muscle strength, as well as reduce the risk of falling [12]. Seated exercise modifications are a form of physical exercise performed in a seated position, specifically designed for older adults who have limited mobility or balance, so that they can remain physically active in a safe manner. Seated exercise is beneficial for older adults who are unable to exercise in a standing position. This exercise is performed entirely in a seated position using a chair as the main aid, making it safe for older adults who have physical limitations or are at high risk of falling. [13]. The instrument used to measure cardiovascular function using a sphygmomanometer (blood pressure monitor) is a device used to measure blood pressure. The blood pressure measured shows the relative difference between the pressure inside the blood vessels and the outside air pressure. In this measurement, the unit used is millimeters of mercury (mmHg) [14]. The instrument used to measure oxygen saturation using oximetry is a medical device that detects and measures oxygen levels and oxygen saturation in the blood without needing to be inserted into the body (non-invasive). This device can display oxygen levels as a percentage using the SpO2 symbol, as well as heart rate in beats per minute (bpm) [15].

2. METHODS

This study employed a quantitative research design using a pretest–posttest single-group approach to examine the effect of modified seated exercise using a cloth on cardiovascular load among elderly individuals. The research was conducted from May to July 2025 in Dusun Mantren, Klodran Village, Colomadu Sub-district, Karanganyar Regency, Central Java. The study population consisted of elderly residents in the area, and the sample was selected using purposive sampling based on predetermined inclusion and exclusion criteria. Participants were required to be aged 60 years or older, actively involved in community activities, willing to participate, and able to follow instructions. Those with severe illness, inability to communicate, or unwillingness to participate were excluded.

The independent variable in this study was the modified seated exercise using a cloth, while the dependent variable was cardiovascular load, measured through blood pressure, oxygen saturation, and pulse rate. The materials used included chairs and cloths for the exercise sessions, while the instruments consisted of a digital sphygmomanometer for blood pressure measurement and a pulse oximeter for assessing oxygen saturation and pulse rate. This study used two main instruments, namely a sphygmomanometer (blood pressure monitor), a device used to measure blood pressure, and an oximeter, a medical device that detects and measures oxygen levels.

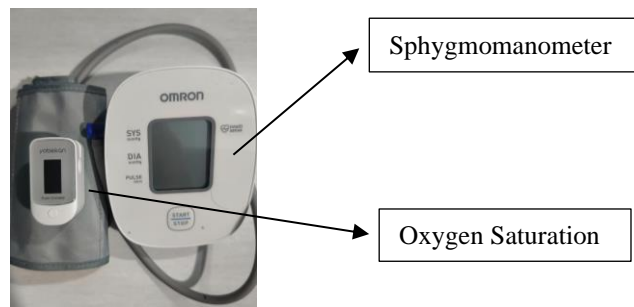


Figure 1. Measuring Instrument

The data collection procedure began with submitting an observation permit, determining the population and sample, and collecting respondents. The first measurement procedure was preparation, which involved measuring blood pressure, oxygen saturation, and recording patient identities, as well as socializing and requesting research consent from the elderly. The pretest data measurement process was carried out before the exercise program began. The next stage is the implementation of the intervention. The final stage is the post-test, which involves re-collecting data related to blood pressure and oxygen saturation. The measurement data is then analyzed using the SPSS S 20 application. The collected data was then analyzed using the Shapiro-Wilk normality test, with the condition that $p < 0.05$ was not normally distributed, so the Wilcoxon test was used. If $p > 0.05$, it was normally distributed using the Paired Samples T Test. Because the data results were not normally distributed, the Wilcoxon test was used, with the condition that $p < 0.05$ meant that the data was influential. If $p > 0.05$, the data was not significant. Study obtain ethical approval from the Faculty of Health Research Ethics Committee Knowledge Health Muhammadiyah University of Surakarta after going through a review process

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3. RESULT

Table 1. Descriptive Test .

Variabel	N	Mean	Minimum/Maximum	Std.Deviation
Tensi Sistole (Pre 1)	19	131.63	110-163	16.500
Tensi Diastole (Pre 1)	19	81.89	70-107	11.642
SpO2 (Pre 1)	19	96.99	96-98	.809
Tensi Sistole (Post 1)	19	125.58	108-159	14.151
Tensi Diastole (Post 1)	19	73.47	60-98	10.400
SpO2 (Post 1)	19	96.11	93-98	1.370
Tensi Sistole (Pre 2)	19	137.53	108-171	18.736
Tensi Diastole (Pre 2)	19	82.89	60-100	10.832
SpO2 (Pre 2)	19	96.21	93-98	1.619
Tensi Sistole (Post 2)	19	130.26	101-159	16.397
Tensi Diastole (Post 2)	19	74.63	54-91	9.674
SpO2 (Post 2)	19	95.21	92-98	2.043

Based on the results of descriptive analysis of 19 respondents, it was found that in the first week there was a decrease in average blood pressure. The mean systolic blood pressure decreased from 131.63 mmHg to 125.58 mmHg, while the mean diastolic blood pressure decreased from 81.89 mmHg to 73.47 mmHg after the intervention. The SpO2 value remained within the normal range, from 96.89% to 96.11%.

In the fourth week, the average systolic blood pressure also showed a decrease from 137.53 mmHg to 130.26 mmHg after the intervention, and the average diastolic blood pressure decreased from 82.89 mmHg to 74.63 mmHg. The average SpO2 remained stable within normal limits, namely from 96.21% to 95.21%. Overall, these results indicate an improvement in blood pressure after the intervention in both the first and fourth weeks..

Table 2. Normality Test .

Variabel	Shapiro-Wilk		
	Statistic	df	Sig.
Tensi Sistole (Pre 1)	.828	19	.003
Tensi Diastole (Pre 1)	.844	19	.005
SpO2 (Pre 1)	.805	19	.001
Tensi Sistole (Post 1)	.917	19	.101
Tensi Diastole (Post 1)	.876	19	.018
SpO2 (Post 1)	.933	19	.194
Tensi Sistole (Pre 2)	.965	19	.671
Tensi Diastole (Pre 2)	.938	19	.240
SpO2 (Pre 2)	.889	19	.031
Tensi Sistole (Post 2)	.977	19	.901
Tensi Diastole (Post 2)	.945	19	.330
SpO2 (Post 2)	.905	19	.060

Based on the results of the Shapiro-Wilk normality test, some variables showed a significant value of <0.05 , indicating that the data were not normally distributed. Therefore, the analysis of differences before and after the intervention was performed using the Wilcoxon Signed Rank Test.

Table 3. Wilcoxon Test .

Variabel	Z	p-value (Asymp Sig.)	Keterangan
Tensi Sistol (Pre 1) - Tensi Sistol (Post 1)	-3.123	0.002	Signifikan
Tensi Diastole (Pre 1) - Tensi Diastole (Post 1)	-3.826	0.000	Signifikan
SpO2 (Pre 1) - SpO2 (Post 1)	-2.564	0.010	Signifikan
Tensi Sistol (Pre 2) - Tensi Sistol (Post 2)	-2.618	0.009	Signifikan
Tensi Diastole (Pre 2) - Tensi Diastole (Post 2)	-3.828	0.000	Signifikan
SpO2 (Pre 2) - SpO2 (Post 2)	-2.150	0.032	Signifikan

Based on the Wilcoxon Signed Rank Test, there was a significant difference between the pre-test and post-test values for all research variables. The results of the analysis using the Wilcoxon test showed significant changes in all physiological parameters measured. In the first week, both systolic and diastolic blood pressure decreased significantly after the intervention, as indicated by a p-value < 0.05 . SpO₂ values also showed significant changes with an upward trend after the intervention.

In the fourth week, similar results were again observed. Systolic and diastolic blood pressure showed a significant decrease after the intervention, while SpO₂ values also experienced a significant increase. Overall, these findings indicate that the intervention provided had a positive effect on the blood pressure and oxygen saturation of the respondents, both in the first week and the fourth week.

4. DISCUSSION

The physiological changes that occurred before and after treatment indicate a positive response by the body to the intervention. The decrease in systolic and diastolic blood pressure in both the first and fourth weeks indicates relaxation of the cardiovascular system. Physiologically, the activities or interventions performed can stimulate vasodilation of blood vessels, decrease peripheral resistance, and increase parasympathetic nervous system activity. This condition reduces the workload on the heart, causing blood pressure to decrease after treatment. In addition, the increase in SpO₂ values after treatment reflects an improvement in the efficiency of oxygen exchange in the lungs. Interventions that stimulate respiratory activity or increase body relaxation can help improve the balance between ventilation and perfusion, allowing oxygen to enter the bloodstream more optimally.

Research conducted by [16] states that although the direct benefits of Chair-Based Exercise (CBE) on cardiovascular indicators such as blood pressure or heart rate have not been widely studied through standardized quantitative studies, instructors report an increase in general physical ability in older adults who participate in this program regularly. Furthermore, in practice, CBE can be modified by adding components of endurance training and light cardiovascular intervals tailored to individual capacity [16].

Findings from the study [17] reinforce the importance of cardiovascular-based physical activity in reducing cardiac workload, especially for individuals with autonomic regulation disorders or physical activity limitations. The results from [18] show that the duration of physical exercise plays an important role in the recovery process of the autonomic nervous system after activity, particularly in parasympathetic nerve activity, which is closely related to heart rate regulation. In groups that underwent longer exercise sessions, heart rate variability (HRV) recovery was slower, meaning that the cardiovascular system took longer to return to normal. This condition is particularly relevant in the context of the elderly, as in older populations, the autonomic response to physical activity is generally slower and the heart's adaptation to physiological stress also tends to decline due to the aging process.

The results of a study conducted by [19] found that physical exercise in the form of seated exercise has a positive impact on cardiometabolic health, including the cardiovascular system in the elderly. This study shows that regular participation in seated exercise can lower systolic blood pressure, increase a healthier resting heart rate, and improve endothelial function, all of which are important indicators of cardiovascular health.

Descriptive data showed a decrease in blood pressure after the intervention. The normality test results indicated that the data were not normally distributed, so the Wilcoxon test was used for analysis. The Wilcoxon test then proved that the intervention caused significant changes in the respondents' blood pressure and SpO₂, both in the first week and the fourth week.

5. CONCLUSION

The findings of this study indicate that the treatment given had a significant effect on the physiological responses of the participants. A significant decrease in systolic and diastolic blood pressure and an increase in oxygen saturation, as indicated by a p-value < 0.05 in the Wilcoxon test, confirm that the intervention had a positive effect on the cardiovascular function and oxygenation status of the elderly.

Overall, this study has the advantage of a pre-post test design that allows direct observation of changes, as well as the use of objective measuring instruments such as a tensiometer and pulse oximeter. However, the limited duration of the study and frequency of measurements are areas that need to be improved in future studies. For future studies, it is recommended that they be conducted over a longer period, with repeated measurements and better control of external variables.

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REFERENCE

- [1] L. A. Pramono and C. Fanumbi, "Permasalahan Lanjut Usia di Daerah Perdesaan Terpencil," *Kesmas Natl. Public Heal. J.*, vol. 6, no. 5, p. 201, 2012, doi: 10.21109/kesmas.v6i5.85.
- [2] S. Anggoro, "Edukasi Pentingnya Senam Ergonomis untuk Hipertensi Lansia," *PERAWAT MENGABDI (Jurnal Pengabdian Kpd. Masyarakat)*, vol. 2, no. 1, pp. 21–28, 2023.
- [3] Kartinah, "MASALAH PSIKOSOSIAL PADA LANJUT USIA Kartinah * Agus Sudaryanto **," *Masal. Psikososial pada Lanjut Usia*, vol. 1, p. 93, 2018, [Online]. Available: <http://hdl.handle.net/11617/486>
- [4] A. Al-Finatunni'mah and T. Nurhidayati, "Pelaksanaan Senam Otak untuk Peningkatan Fungsi Kognitif pada Lansia dengan Demensia," *Ners Muda*, vol. 1, no. 2, p. 139, 2020, doi: 10.26714/nm.v1i2.5666.
- [5] S. G. Sazlina *et al.*, "Cardiovascular disease risk factors among older people: Data from the National Health and Morbidity Survey 2015," *PLoS One*, vol. 15, no. 10 October, pp. 1–11, 2020, doi: 10.1371/journal.pone.0240826.
- [6] G. Risangdiptya and E. Ambarwati, "Perbedaan Antara Keseimbangan Tubuh Sebelum Dan Sesudah Senam Pilates Pada Wanita Usia Muda," *J. Kedokt. Diponegoro (Diponegoro Med. Journal)*, vol. 5, no. 4, pp. 911–916, 2016, [Online]. Available: <https://ejournal3.undip.ac.id/index.php/medico/article/view/14452>
- [7] S. P. Handayani, R. P. Sari, and W. Wibisono, "Literature Review Manfaat Senam Lansia Terhadap Kualitas Hidup Lansia," *BIMIki (Berkala Ilm. Mhs. Ilmu Keperawatan Indones.)*, vol. 8, no. 2, pp. 48–55, 2020, doi: 10.53345/bimiki.v8i2.143.
- [8] E. Eviyanti, H. N. Wijayanti, and S. Khadijah, "Pengaruh Senam Lansia terhadap Penurunan Tekanan Darah pada Lansia," *J. Kebidanan Harapan Ibu Pekalongan*, vol. 8, no. 1, pp. 18–23, 2021, doi: 10.37402/jurbidhip.vol8.iss1.117.
- [9] W. P. B. Aji, "Pengaruh Senam Lansia Terhadap Tekanan Darah Pada Lansia Penderita Hipertensi Di Posyandu Lansia Dusun Banaran 8 Playen Gunungkidul," *J. Keperawatan Terpadu*, p. 12, 2015.

- [10] Syahrudin, “Kebugaran Jasmani Bagi Lansia Saat Pandemi Covid-19 Physical,” *JUARA J. Olahraga*, 2020, doi: <https://doi.org/10.33222/juara.v5i2.943>.
- [11] I. R. Ramasari and A. R. Mutnawasitoh, “Perbedaan Pemberian Core Stability Exercise dan Chair Based Exercise terhadap Peningkatan Fleksibilitas Lumbal Lansia,” vol. 1, no. 3, 2024, [Online]. Available: <https://journal.lpkd.or.id/index.php/QuWell/article/view/737/1204>
- [12] C. Sherrington *et al.*, “Exercise for preventing falls in older people living in the community,” *Cochrane Database Syst. Rev.*, vol. 2019, no. 1, 2019, doi: 10.1002/14651858.CD012424.pub2.
- [13] B. P. Sexton and N. F. Taylor, “To sit or not to sit? A systematic review and meta-analysis of seated exercise for older adults,” *Australas. J. Ageing*, vol. 38, no. 1, pp. 15–27, 2019, doi: 10.1111/ajag.12603.
- [14] M. Zuhdi, J. Ardhuha, and M. Taufik, “Jurnal Penelitian dan Pembelajaran Fisika Indonesia Keunggulan Pengukuran Tekanan Darah Menggunakan Tensimeter Digital Dibandingkan dengan Tensimeter Pegas,” pp. 4–7, 2020.
- [15] S. H. Baiq Nurul Laili, Budiani Destyningtias, “Jurnal Spo2 3(Cara Kerja),” *Jur. Tek. Elektro Fak. Tek. Univ. Semarang*, 2019, [Online]. Available: <https://repository.usm.ac.id/files/journalmhs/C.441.17.0009-20200309100518.pdf>
- [16] K. R. Robinson, T. Masud, and H. Hawley-Hague, “Instructors’ Perceptions of Mostly Seated Exercise Classes: Exploring the Concept of Chair Based Exercise,” *Biomed Res. Int.*, vol. 2016, 2016, doi: 10.1155/2016/3241873.
- [17] C. H. Gibbons, G. Silva, and R. Freeman, “Cardiovascular exercise as a treatment of postural orthostatic tachycardia syndrome: A pragmatic treatment trial,” *Hear. Rhythm*, vol. 18, no. 8, pp. 1361–1368, 2021, doi: 10.1016/j.hrthm.2021.01.017.
- [18] S. Michael, O. Jay, K. S. Graham, and G. M. Davis, “Longer exercise duration delays post-exercise recovery of cardiac parasympathetic but not sympathetic indices,” *Eur. J. Appl. Physiol.*, vol. 117, no. 9, pp. 1897–1906, 2017, doi: 10.1007/s00421-017-3673-2.
- [19] P. Mackie and J. J. Eng, “The influence of seated exercises on balance, mobility, and cardiometabolic health outcomes in individuals living with a stroke: A systematic review and meta-analysis,” *Clin. Rehabil.*, vol. 37, no. 7, pp. 927–941, 2023, doi: 10.1177/02692155221150002.