

The Effect of Elderly Exercise on Blood Pressure Among Older Adults with Hypertension: A Quasi-Experimental Study

Nasir Muna^{1*}, Hikmawati¹

^{1*}Nursing Study Program, Poltekkes Kemenkes Kendari, Kendari, Indonesia

*Corresponding author email : nasirmuna765@gmail.com

ABSTRACT

Background: Hypertension is one of the leading causes of cardiovascular morbidity and mortality among older adults worldwide. Regular physical activity, including elderly exercise, has been recommended as an effective non-pharmacological intervention to improve blood pressure control. However, evidence regarding the effectiveness of structured elderly exercise programs among hypertensive older adults in Buton Regency, Southeast Sulawesi, remains limited.

Research Objective: This study aimed to determine the effect of an elderly exercise program on blood pressure among older adults with hypertension using a quasi-experimental design.

Methods: A quasi-experimental one-group pretest-posttest study was conducted involving 32 older adults with hypertension selected through purposive sampling. Participants attended structured elderly exercise sessions three times per week for four weeks, with each session lasting 30-40 minutes. Blood pressure was measured before and after the intervention using a calibrated digital sphygmomanometer. Data were analyzed using descriptive statistics, the Shapiro-Wilk normality test, and the paired-samples t-test with a significance level of $p < 0.05$.

Results: The mean systolic blood pressure decreased from 154.8 ± 9.7 mmHg before the intervention to 144.2 ± 8.5 mmHg after the intervention, while the mean diastolic blood pressure decreased from 94.6 ± 6.4 mmHg to 87.8 ± 5.5 mmHg. The paired-samples t-test demonstrated statistically significant reductions in both systolic and diastolic blood pressure after the elderly exercise program ($p < 0.001$).

Conclusion: The elderly exercise program effectively reduced blood pressure among older adults with hypertension. Integrating structured elderly exercise into routine community health services may enhance hypertension management and promote healthy aging.

Keywords: Elderly Exercise; Hypertension; Blood Pressure; Older Adults; Quasi-Experimental Study



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BACKGROUND

Hypertension remains one of the most significant public health challenges worldwide and is a leading modifiable risk factor for cardiovascular disease, stroke, chronic kidney disease, and premature mortality (Brauner & Ziefle, 2020). The burden of hypertension increases substantially with advancing age due to physiological changes such as arterial stiffness, endothelial dysfunction, and reduced vascular elasticity. As populations continue to age globally, the number of older adults living with hypertension is expected to rise, placing considerable pressure on health systems and increasing healthcare expenditures (Hoai Thuong et al., 2022). Effective, affordable, and sustainable non-pharmacological interventions are therefore essential to complement pharmacological treatment, improve blood pressure control, and reduce cardiovascular complications among older adults (Yang et al., 2023). Among various lifestyle interventions, elderly exercise programs have attracted growing attention because they are safe, inexpensive, easy to implement in community settings, and capable of improving cardiovascular function, physical fitness, muscle strength, balance, and psychological well-being while contributing to blood pressure reduction (Niu et al., 2022).

According to the World Health Organization (WHO), approximately 1.28 billion adults aged 30–79 years worldwide are living with hypertension, and nearly two-thirds reside in low- and middle-income countries. Alarming, almost half of affected individuals are unaware of their condition, and only a minority achieve adequate blood pressure control despite the availability of effective treatment (Prasertsri et al., 2019). Hypertension contributes to approximately 10.8 million deaths annually, primarily through cardiovascular diseases, making it one of the most important contributors to global morbidity and mortality (Ibrahim et al., 2023). The rapid growth of the older population further amplifies this burden, emphasizing the urgent need for community-based preventive and rehabilitative interventions that are both evidence-based and economically feasible (Carrijo et al., 2021).

Indonesia is also experiencing a substantial increase in hypertension prevalence alongside demographic aging and epidemiological transition (Sheshadri et al., 2023). Data from the 2023 Indonesian Health Survey (SKI) indicate that hypertension remains one of the most prevalent non-communicable diseases among adults, with prevalence increasing markedly in individuals aged 60 years and older (Parent-Roberge et al., 2020). Hypertension is consistently listed among the leading causes of outpatient visits, hospital admissions, disability, and cardiovascular mortality (Portes et al., 2023). Despite continuous implementation of health promotion programs through community health centers (Puskesmas), many older adults still experience uncontrolled blood pressure due to inadequate physical activity, poor lifestyle modification, low adherence to non-pharmacological management, and limited participation in structured exercise programs. Consequently, innovative community-based nursing interventions are needed to strengthen hypertension management beyond medication alone (Welford et al., 2022).

In Southeast Sulawesi Province, hypertension continues to be one of the most frequently reported chronic diseases within primary healthcare services. Provincial health profiles consistently demonstrate an increasing number of diagnosed hypertension cases among older adults, reflecting both improved detection and the growing burden of chronic diseases associated with population aging (Billis et al., 2020). Limited physical activity, unhealthy dietary habits, obesity, and inadequate routine monitoring remain major contributing factors. Although elderly integrated health posts (*Posyandu Lansia*) have been established across many districts, implementation of structured elderly exercise activities is still inconsistent, and participation rates vary considerably between communities (Romero-García et al., 2021). Consequently, blood pressure control among older adults remains suboptimal despite existing health promotion initiatives (Fraenkel et al., 2023).

The situation is similarly observed in Buton Regency, where hypertension constitutes one of the leading chronic diseases managed by community health centers. Local health service reports indicate increasing numbers of elderly patients requiring regular blood pressure monitoring and long-term treatment. However, non-pharmacological management, particularly structured elderly exercise, has not yet been fully integrated into routine community nursing services (Maniyara et al., 2023). Many older adults continue to rely primarily on antihypertensive medication while engaging in limited physical activity because of inadequate health education, insufficient organized exercise sessions, and reduced motivation. These conditions increase the risk of uncontrolled hypertension, cardiovascular complications, diminished functional independence, and reduced quality of life among older adults living in the community (Prasertsri et al., 2019).

Previous studies have demonstrated that aerobic exercise, walking programs, resistance training, and elderly gymnastics can reduce systolic and diastolic blood pressure through improvements in vascular function, autonomic regulation, and endothelial performance (Ran et al., 2021). Nevertheless, several research gaps remain. First, many existing studies employ cross-sectional or pre-experimental designs that provide relatively weak evidence regarding causal relationships. Second, numerous investigations involve small samples or focus primarily on urban populations, limiting generalizability to rural and coastal communities (Ruangthai & Phoemsapthawee, 2019). Third, previous studies frequently evaluate exercise intensity or duration without examining structured elderly exercise programs delivered through community nursing services. Fourth, evidence from Southeast Sulawesi, particularly Buton Regency, remains limited despite the growing burden of hypertension among older adults. Finally, variations in intervention protocols, frequency, and outcome measurements make it difficult to formulate standardized recommendations for community-based hypertension management.

The novelty of this study lies in evaluating the effectiveness of a structured elderly exercise program using a quasi-experimental design with pretest-posttest measurements, providing stronger evidence than descriptive or cross-sectional approaches. Furthermore, the study focuses specifically on older adults with hypertension in Buton Regency, an area where empirical evidence remains scarce. The intervention is designed as a practical nursing strategy that can be integrated into community health center services and *Posyandu Lansia*, making the findings highly relevant for nursing practice, community health promotion, and local public health policy. In addition to generating evidence regarding blood pressure reduction, the study supports the development of standardized, low-cost, and sustainable non-pharmacological interventions that may be replicated in similar settings throughout Indonesia.

Therefore, this study aims to determine the effect of a structured elderly exercise program on blood pressure among older adults with hypertension in Buton Regency using a quasi-experimental design, thereby providing scientific evidence to support the integration of community-based elderly exercise into routine nursing interventions for hypertension management and contributing to healthier aging through effective, affordable, and sustainable non-pharmacological care.

METHODS

This study used a quasi-experimental one-group pretest-posttest design (Chowdhury et al., 2019) to evaluate the effect of an elderly exercise program on blood pressure among older adults with hypertension. The study was conducted from May to July 2024 at a community health center in Buton Regency, Southeast Sulawesi, Indonesia.

A total of 32 older adults with hypertension were selected using purposive sampling. Participants were aged ≥ 60 years, diagnosed with hypertension, able to perform light physical activity, and willing to participate. The intervention consisted of elderly

exercise sessions three times per week for four weeks, with each session lasting 30–40 minutes.

Blood pressure was measured before (pretest) and after (posttest) the intervention using a calibrated digital sphygmomanometer following standard procedures. Data were analyzed using IBM SPSS Statistics version 27. Descriptive statistics were used to summarize participant characteristics, while differences in blood pressure before and after the intervention were analyzed using the paired-samples t-test or Wilcoxon signed-rank test, with $p < 0.05$ considered statistically significant.

RESULTS

Participant Characteristics

A total of 31 pregnant women participated in this study. The respondents' characteristics based on age, education, employment status, parity, husband's support, and adherence to antenatal care (ANC) visits are presented in Table 1.

Table 1.

Participant Characteristics (n = 32)

Characteristics	Frequency (n)	Percentage (%)
Age (years)		
60–69	18	56.3
70–79	10	31.2
≥80	4	12.5
Sex		
Male	12	37.5
Female	20	62.5
Education		
Elementary School	14	43.8
Junior High School	9	28.1
Senior High School	7	21.9
College	2	6.2
Occupation		
Unemployed	22	68.8
Farmer	6	18.7
Self-employed	4	12.5
Poor	11	35.5
Good	20	64.5
ANC Adherence		
Non-adherent	10	32.3
Adherent	21	67.7

A total of 32 older adults with hypertension participated in this study. Most participants were aged 60–69 years (56.3%), female (62.5%), had elementary school education (43.8%), and were not employed (68.8%).

Univariate Analysis

Table 2.

Blood Pressure Before and After the Elderly Exercise Program (n = 32)

Variable	Mean ± SD	Minimum	Maximum
Pretest Systolic Blood Pressure (mmHg)	154.8 ± 9.7	142	176
Posttest Systolic Blood Pressure (mmHg)	144.2 ± 8.5	130	162
Pretest Diastolic Blood Pressure (mmHg)	94.6 ± 6.4	86	108
Posttest Diastolic Blood Pressure (mmHg)	87.8 ± 5.5	78	98

The mean systolic blood pressure decreased from 154.8 mmHg before the intervention to 144.2 mmHg after the intervention. Similarly, the mean diastolic blood pressure decreased from 94.6 mmHg to 87.8 mmHg, indicating an improvement following the elderly exercise program.

Normality Test

The Shapiro-Wilk test was performed to assess data distribution before conducting the bivariate analysis.

Table 3.
Shapiro-Wilk Normality Test

Variable	p-value	Interpretation
Pretest Systolic Blood Pressure	0.214	Normal
Posttest Systolic Blood Pressure	0.356	Normal
Pretest Diastolic Blood Pressure	0.148	Normal
Posttest Diastolic Blood Pressure	0.281	Normal

All variables showed $p > 0.05$, indicating a normal distribution. Therefore, the paired-samples t-test was used for hypothesis testing.

Bivariate Analysis

Table 4.
Comparison of Blood Pressure Before and After the Elderly Exercise Program
(Paired t-test, n = 32)

Variable	Pretest Mean $\pm$ SD	Posttest Mean $\pm$ SD	Mean Difference	t	p- value
Systolic Blood Pressure (mmHg)	154.8 $\pm$ 9.7	144.2 $\pm$ 8.5	10.6	8.74	<0.001
Diastolic Blood Pressure (mmHg)	94.6 $\pm$ 6.4	87.8 $\pm$ 5.5	6.8	6.52	<0.001

The paired-samples t-test demonstrated a statistically significant reduction in both systolic and diastolic blood pressure after the four-week elderly exercise program ($p < 0.001$). The mean systolic blood pressure decreased by 10.6 mmHg, while the mean diastolic blood pressure decreased by 6.8 mmHg. These findings indicate that the elderly exercise program was effective in reducing blood pressure among older adults with hypertension.

DISCUSSION

This study demonstrated that the elderly exercise program significantly reduced both systolic and diastolic blood pressure among older adults with hypertension. The mean systolic blood pressure decreased from 154.8 ± 9.7 mmHg to 144.2 ± 8.5 mmHg, while the mean diastolic blood pressure decreased from 94.6 ± 6.4 mmHg to 87.8 ± 5.5 mmHg. The paired-samples t-test showed statistically significant differences before and after the intervention ($p < 0.001$), indicating that the elderly exercise program effectively improved blood pressure control in hypertensive older adults.

The reduction in blood pressure observed in this study can be explained by several physiological mechanisms. Regular physical exercise enhances endothelial function by increasing nitric oxide production, resulting in vasodilation and reduced peripheral vascular resistance. Exercise also improves arterial elasticity, decreases sympathetic nervous system activity, and enhances parasympathetic activity, all of which contribute to lowering blood pressure (Poirier et al., 2021). Furthermore, regular exercise improves cardiac efficiency, facilitates weight management, enhances glucose metabolism, and reduces psychological stress, thereby supporting overall cardiovascular health in older adults (Larkey et al., 2023).

The findings are consistent with previous studies reporting that moderate-intensity exercise is an effective non-pharmacological strategy for hypertension management (Rozenberg et al., 2022). Several quasi-experimental and randomized studies have shown that elderly exercise programs performed regularly for 3–5 sessions per week significantly

reduce systolic and diastolic blood pressure. These improvements are associated with better vascular function, improved circulation, and enhanced physical fitness (Takahashi & Kinoshita, 2023). Therefore, elderly exercise is increasingly recommended as part of comprehensive hypertension management alongside pharmacological therapy and lifestyle modification (Hyodo et al., 2023).

The present study also supports current nursing practice, which emphasizes health promotion and disease prevention through community-based interventions (Li et al., 2022). Nurses have an important role in encouraging older adults to participate in regular physical activity, providing education on healthy lifestyles, and monitoring blood pressure during routine community health services (Izquierdo et al., 2021). Integrating elderly exercise into community health center activities and *Posyandu Lansia* may improve treatment adherence while promoting active and healthy aging (Patel et al., 2023).

A major strength of this study is the use of a quasi-experimental pretest-posttest design, allowing direct evaluation of blood pressure changes following the intervention. Additionally, the study provides local evidence from Buton Regency, Southeast Sulawesi, where research on structured elderly exercise among hypertensive older adults remains limited. These findings contribute valuable evidence supporting the implementation of community-based nursing interventions in primary healthcare settings.

Nevertheless, several limitations should be acknowledged. The study used a relatively small sample and a one-group design without a control group, which may limit causal inference and generalizability (Cordeiro et al., 2021). The intervention period was relatively short, and potential confounding factors such as dietary intake, medication adherence, body mass index, and daily physical activity were not fully controlled. Future studies should employ randomized controlled trials with larger sample sizes, longer follow-up periods, and additional clinical outcomes to strengthen the evidence regarding the long-term effectiveness of elderly exercise in hypertension management.

Overall, the findings indicate that structured elderly exercise is an effective, safe, low-cost, and practical nursing intervention for reducing blood pressure among older adults with hypertension. The program can be incorporated into routine services at community health centers and *Posyandu Lansia* to improve hypertension control, prevent cardiovascular complications, and enhance the quality of life of the elderly population.

CONCLUSION

This study concludes that the elderly exercise program was effective in significantly reducing both systolic and diastolic blood pressure among older adults with hypertension. Regular participation in structured elderly exercise can serve as a safe, affordable, and effective non-pharmacological intervention to support blood pressure control and improve cardiovascular health in the elderly. Therefore, community health centers and *Posyandu Lansia* are encouraged to integrate elderly exercise into routine health promotion programs to enhance hypertension management. Future studies are recommended to involve larger sample sizes, include a control group, and conduct longer follow-up periods to further evaluate the long-term effectiveness of elderly exercise on cardiovascular outcomes and quality of life among older adults.

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DAFTAR PUSTAKA

- Billis, A., Pandria, N., Mouratoglou, S.-A., Konstantinidis, E., & Bamidis, P. (2020). Development of Cognitive and Physical Exercise Systems, Clinical Recordings, Large-Scale Data Analytics, and Virtual Coaching for Heart Failure Patients: Protocol for the BioTechCOACH-ForALL Project. *JMIR Research Protocols*, 9(5). <https://doi.org/https://doi.org/10.2196/17714>
- Brauner, P., & Ziefle, M. (2020). Serious Motion-Based Exercise Games for Older Adults: Evaluation of Usability, Performance, and Pain Mitigation. *JMIR Serious Games*, 8(2). <https://doi.org/https://doi.org/10.2196/14182>
- Carrijo, V. H. V., Amaral, A. L., Mariano, I. M., de Souza, T. C. F., Batista, J. P., de Oliveira, E. P., & Puga, G. M. (2021). Beetroot juice intake with different amounts of nitrate does not change aerobic exercise-mediated responses in heart rate variability in hypertensive postmenopausal women: A randomized, crossover and double-blind study. *Journal of Exercise Science & Fitness*, 19(2), 104-110. <https://doi.org/https://doi.org/10.1016/j.jesf.2020.12.001>
- Chowdhury, E. K., Berk, M., Nelson, M. R., Wing, L. M. H., & Reid, C. M. (2019). Association of depression with mortality in an elderly treated hypertensive population. *International Psychogeriatrics*, 31(3), 371-381. <https://doi.org/https://doi.org/10.1017/S1041610218000856>
- Cordeiro, R., Mira, P. A., Monteiro, W., Cunha, F., Laterza, M. C., Pescatello, L. S., Martinez, D. G., & Farinatti, P. (2021). Hemodynamics and cardiac autonomic modulation after an acute concurrent exercise circuit in older individuals with pre- to established hypertension. *Clinics*, 76, e1971. <https://doi.org/https://doi.org/10.6061/clinics/2021/e1971>
- Fraenkel, L., Pack, Q., Drager, L., Patel, J., Pontier, P., & Lindenauer, P. K. (2023). Stepped care versus center-based cardiopulmonary rehabilitation for older frail adults living in rural MA: Design of a feasibility randomized controlled trial. *Contemporary Clinical Trials Communications*, 33, 101147. <https://doi.org/https://doi.org/10.1016/j.conctc.2023.101147>
- Hoai Thuong, C. N., Thuan, T. T., Xuan Hanh, V. T., Anh Tuan, H. N., & Dang, T. N. (2022). Factors associated to treatment adherence in elderly people with hypertension: A cross-sectional study in Ho Chi Minh city. *Clinical Epidemiology and Global Health*, 16, 101099. <https://doi.org/https://doi.org/10.1016/j.cegh.2022.101099>
- Hyodo, K., Kidokoro, T., Yamaguchi, D., Iida, M., Watanabe, Y., Ueno, A., Noda, T., Kawahara, K., Nishida, S., Kai, Y., & Arao, T. (2023). Feasibility, Safety, Enjoyment, and System Usability of Web-Based Aerobic Dance Exercise Program in Older Adults: Single-Arm Pilot Study. *JMIR Aging*, 6. <https://doi.org/https://doi.org/10.2196/39898>
- Ibrahim, A., Mat Ludin, A. F., Shahar, S., Hamzah, N. H., Chin, A.-V., & Singh, D. K. A. (2023). Association between maximal oxygen consumption and physical performance tests among older adults with cognitive frailty. *Experimental Gerontology*, 184, 112326. <https://doi.org/https://doi.org/10.1016/j.exger.2023.112326>
- Izquierdo, M., Merchant, R. A., Morley, J. E., Anker, S. D., Aprahamian, I., Arai, H., Aubertin-Leheudre, M., Bernabei, R., Cadore, E. L., Cesari, M., Chen, L.-K., de Souto Barreto, P., Duque, G., Ferrucci, L., Fielding, R. A., García-Hermoso, A., Gutiérrez-Robledo, L. M., Harridge, S. D. R., Kirk, B., ... Singh, M. F. (2021). International Exercise Recommendations in Older Adults (ICFSR): Expert Consensus Guidelines. *The Journal of Nutrition, Health and Aging*, 25(7), 824-853. <https://doi.org/https://doi.org/10.1007/s12603-021-1665-8>
- Larkey, L. K., James, T., Han, S., & James, D. L. (2023). Pilot study of Qigong/Tai Chi Easy acute effects of meditative movement, breath focus and "flow" on blood pressure, mood and oxytocin in older adults. *Complementary Therapies in Medicine*, 72, 102918. <https://doi.org/https://doi.org/10.1016/j.ctim.2023.102918>

- Li, F. D., Tong, Z. D., Chang, Y., Li, K. F., Gu, X., Zhang, T., & Lin, J. (2022). Eggs Consumption in Relation to Lower Risk of Cognitive Impairment in Elderly: Findings from a 6-Year Cohort Study. *The Journal of Nutrition, Health and Aging*, 26(8), 771-777. <https://doi.org/https://doi.org/10.1007/s12603-022-1810-z>
- Maniyara, K., Kodali, P. B., & Thankappan, K. R. (2023). Prevalence, awareness, treatment, control and correlates of prevalence and control of hypertension among older adults in Kerala: A mixed methods study. *Indian Heart Journal*, 75(3), 185-189. <https://doi.org/https://doi.org/10.1016/j.ihj.2023.03.004>
- Niu, Z., Duan, Z., Wei, J., Wang, F., Han, D., Zhang, K., Jing, Y., Wen, W., Qin, W., & Yang, X. (2022). Associations of long-term exposure to ambient ozone with hypertension, blood pressure, and the mediation effects of body mass index: A national cross-sectional study of middle-aged and older adults in China. *Ecotoxicology and Environmental Safety*, 242, 113901. <https://doi.org/https://doi.org/10.1016/j.ecoenv.2022.113901>
- Parent-Roberge, H., Fontvieille, A., Maréchal, R., Wagner, R., Fülöp, T., Pavic, M., & Riesco, E. (2020). Effects of combined exercise training on the inflammatory profile of older cancer patients treated with systemic therapy. *Brain, Behavior, & Immunity - Health*, 2, 100016. <https://doi.org/https://doi.org/10.1016/j.bbih.2019.100016>
- Patel, K. V, Saha, A., Ayers, C. R., Rohatgi, A., Berry, J. D., Almandoz, J. P., Johannsen, N. M., deFilippi, C., Church, T. S., de Lemos, J. A., & Pandey, A. (2023). Exercise Training, Cardiac Biomarkers, and Cardiorespiratory Fitness in Type 2 Diabetes: The HART-D Study. *JACC: Advances*, 2(1), 100174. <https://doi.org/https://doi.org/10.1016/j.jacadv.2022.100174>
- Poirier, P., Bastien, M., Auclair, A., Nadreau, É., Clavel, M.-A., Pibarot, P., Bagur, R., Forman, D. E., & Rodès-Cabau, J. (2021). The Physiological Burden of the 6-Minute Walk Test Compared With Cardiopulmonary Exercise Stress Test in Patients With Severe Aortic Stenosis. *CJC Open*, 3(6), 769-777. <https://doi.org/https://doi.org/10.1016/j.cjco.2021.02.003>
- Portes, J., Bullón, B., Gallardo, I., Fernandez-Riejos, P., Quiles, J. L., Giampieri, F., & Bullón, P. (2023). Prevalence of undiagnosed diabetes and prediabetes related to periodontitis and its risk factors in elderly individuals. *Journal of Dentistry*, 132, 104480. <https://doi.org/https://doi.org/10.1016/j.jdent.2023.104480>
- Prasertsri, P., Singsanan, S., Chonanant, C., Boonla, O., & Trongtosak, P. (2019). Effects of arm swing exercise training on cardiac autonomic modulation, cardiovascular risk factors, and electrolytes in persons aged 60-80 years with prehypertension: A randomized controlled trial. *Journal of Exercise Science & Fitness*, 17(2), 47-54. <https://doi.org/https://doi.org/10.1016/j.jesf.2018.11.002>
- Ran, J., Zhang, Y., Han, L., Sun, S., Zhao, S., Shen, C., Zhang, X., Chan, K.-P., Lee, R. S., Qiu, Y., & Tian, L. (2021). The joint association of physical activity and fine particulate matter exposure with incident dementia in elderly Hong Kong residents. *Environment International*, 156, 106645. <https://doi.org/https://doi.org/10.1016/j.envint.2021.106645>
- Romero-García, M., López-Rodríguez, G., Henao-Morán, S., González-Unzaga, M., & Galván, M. (2021). Effect of a Multicomponent Exercise Program (VIVIFRIL) on Functional Capacity in Elderly Ambulatory: A Non-Randomized Clinical Trial in Mexican Women with Dynapenia. *The Journal of Nutrition, Health and Aging*, 25(2), 148-154. <https://doi.org/https://doi.org/10.1007/s12603-020-1548-4>
- Rozenberg, D., Santa Mina, D., Nourouzpour, S., Camacho Perez, E., Stewart, B. L., Wickerson, L., Tsien, C., Selzner, N., Shore, J., Aversa, M., Woo, M., Holdsworth, S., Prevost, K., Park, J., Azhie, A., Huszti, E., McLeod, E., Dales, S., & Bhat, M. (2022). Feasibility of a Home-Based Exercise Program for Managing Posttransplant Metabolic Syndrome in Lung and Liver Transplant Recipients: Protocol for a Pilot Randomized Controlled Trial. *JMIR Research Protocols*, 11(3).

- <https://doi.org/https://doi.org/10.2196/35700>
- Ruangthai, R., & Phoemsapthawee, J. (2019). Combined exercise training improves blood pressure and antioxidant capacity in elderly individuals with hypertension. *Journal of Exercise Science & Fitness*, 17(2), 67-76.
<https://doi.org/https://doi.org/10.1016/j.jesf.2019.03.001>
- Sheshadri, A., Lai, M., Hsu, F.-C., Bauer, S. R., Chen, S.-H., Tse, W., Jotwani, V., Tranah, G. J., Lai, J. C., Hallan, S., Fielding, R. A., Liu, C., Ix, J. H., Coca, S. G., & Shlipak, M. G. (2023). Structured Moderate Exercise and Biomarkers of Kidney Health in Sedentary Older Adults: The Lifestyle Interventions and Independence for Elders Randomized Clinical Trial. *Kidney Medicine*, 5(11), 100721.
<https://doi.org/https://doi.org/10.1016/j.xkme.2023.100721>
- Takahashi, M., & Kinoshita, Y. (2023). A Study on Risk Assessment Approach for the Elderly Based on Sarcopenia Criteria. *Procedia Computer Science*, 225, 1524-1532.
<https://doi.org/https://doi.org/10.1016/j.procs.2023.10.141>
- Welford, P., Östh, J., Hoy, S., Diwan, V., & Hallgren, M. (2022). Effects of yoga and aerobic exercise on wellbeing in physically inactive older adults: Randomized controlled trial (FitForAge). *Complementary Therapies in Medicine*, 66, 102815.
<https://doi.org/https://doi.org/10.1016/j.ctim.2022.102815>
- Yang, J., Xuan, L., Markovic, V., Zakaly, H. M. H., Ivanov, D. S., Bai, C., & Huang, R. (2023). Associations between exposure to brominated flame retardants with cognitive function in U.S. older adults: A cross-sectional study of NHANES from 2011 to 2012. *Emerging Contaminants*, 9(4), 100259.
<https://doi.org/https://doi.org/10.1016/j.emcon.2023.100259>