Int J Aging Health Mov. **Vol. 6 No.2; September2024**

IJAHM
International Journal of Aging Health and Movement
IJAHM

Economic Strategies Through Exercise: Enhancing Healthy Aging for Women

Tuhin Das, [1]; Nita Bandyopadhyay, [2*].

1- Department of Physical Education, University of Kalyani, Kalyani, West Bengal, India. Email: tuhinphe18@klyuniv.ac.in
2- Department of Physical Education, University of Kalyani, Kalyani, West Bengal, India. Email: nitabandyopadhyay@klyuniv.ac.in

Corresponding author: Nita Bandyopadhyay, nitabandyopadhyay@klyuniv.ac.in

ARTICLE INFO

Article type:

Article history:
Received: 5 June. 2024
Received in revised form: 15 July. 2024
Accepted: 28 August 2024
Published: 31 September 2024
Keywords:
Exercise, Aging, Quality of life, Well-being, Women, Social isolation, Health, Aged

Conflicts of interest: None
Funding: None

How to Cite:
Das, T., and N. Bandyopadhyay. "Economic Strategies Through Exercise: Enhancing Healthy Aging for Women". *International Journal of Aging Health and Movement*, Vol. 6, no. 2, Nov. 2024, 1-9,

ABSTRACT
India is experiencing rapid demographic shifts, with its elderly population projected to reach 20% by 2050. Among this growing cohort, women face compound challenges, including higher vulnerability to chronic diseases and socio-economic disparities. This article explores exercise as a cost-effective strategy to promote healthy aging among Indian women, emphasizing its role in mitigating age-related health risks, reducing healthcare costs, and enhancing quality of life. Aging brings multifaceted physiological, psychological, and social challenges, from muscle loss and osteoporosis to cognitive decline and social isolation. Evidence suggests that regular physical activity, such as aerobic, strength, flexibility, and balance exercises, significantly improves cardiovascular health, muscle strength, and mental well-being. Notably, resistance training has shown to enhance upper and lower body strength, reduce depression, and improve overall quality of life in adults aged 60 and above. Moreover, group-based exercises, including yoga and Pilates, and multicomponent exercise foster social engagement, combating isolation. Despite these benefits, barriers such as economic constraints, cultural norms, and inadequate access to safe exercise environments hinder participation, particularly among rural and low-income women. To overcome these challenges, community-based exercise programs tailored to older adults are recommended. Incorporating physical activity into national public health strategies will not only extend lifespan but improve healthspan—ensuring that more years are spent in good health. By promoting exercise as a preventive, affordable intervention, India can support the physical and psychological well-being of its aging female population, fostering healthier, more independent lives and graceful, healthy aging.

Published by International Journal of Aging Health and Movement. Copyright(c) The author(s).This is an open-access article distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (http://creativecommons.org/licenses/by-nc/4.0/) .

1. Introduction

The global population is experiencing a significant demographic shift, with an increasing proportion of older adults due to rising life expectancy and declining fertility rates. By 2050, it is estimated that 16% of the world's population will be over the age of 65, compared to 9% in 2019 (1). This demographic transition presents profound social, economic, and healthcare challenges, particularly in developing countries like India, where aging populations are growing rapidly. India, home to over 1.4 billion people, is witnessing a notable increase in its elderly population, projected to reach 20% by 2050 (2). Indian women, in particular, experience the consequences of aging more acutely due to face greater health challenges, largely attributed to socio-economic disparities, lack of healthcare access, and gender-based inequalities throughout their lives. These challenges include greater susceptibility to chronic diseases, disabilities, and a higher likelihood of living in poverty, particularly in rural areas (2). With a life expectancy of about 71 years, Indian women are more vulnerable to age-related health issues such as osteoporosis, cardiovascular diseases, and diabetes (3). The aging process in Indian women is also complicated by socio-cultural norms, where women often prioritize family responsibilities over their own health, leading to neglect in seeking timely medical care and adopting healthy lifestyles (4). Understanding the aging patterns of Indian women is crucial for developing targeted public health policies and improving access to age-friendly healthcare systems.

India is undergoing a significant demographic transition, with the aging population growing at an unprecedented rate. According to the 2011 Census, the population aged 60 years and above was 8.6%, amounting to over 103 million people. This figure is expected to rise sharply in the coming decades, leading to an estimated 319 million elderly individuals by 2050 (5). Among this population, women constitute a larger proportion due to higher life expectancy compared to men, often referred to as the "feminization of aging" (6). This surge poses a substantial challenge to the healthcare system, especially in terms of managing non-communicable diseases (NCDs), which are prevalent in the aging population.Given the rising healthcare costs and limited resources, there is an urgent need for interventions that not only improve health outcomes but also reduce the financial burden on individuals and the healthcare system. Exercise, particularly as a preventive strategy, emerges as a highly cost-effective modality for promoting physical and mental well-being among older adults (7). Physical activity has been consistently shown to reduce the risk of chronic conditions such as cardiovascular diseases, type 2 diabetes, and musculoskeletal disorders, which are common among aging women (8). Moreover, regular physical activity can delay the onset of disability and dependence, thereby minimizing the need for costly medical treatments and long-term care (9). Thus, encouraging exercise as a routine practice among middle-aged and elderly women not only fosters healthier aging but also provides an affordable alternative to more expensive medical interventions. Public health strategies that emphasize physical activity, particularly in underprivileged and rural areas, can make a significant impact on reducing the economic strain while improving health outcomes for Indian women.

The present study explored the aging perspective of Indian women in relation to social, economic, and health challenges and how exercise can benefit them to age independently and gracefully.

2. The Perspective of Aging

Aging is a natural and inevitable process, influenced by a complex interaction of genetic, environmental, and lifestyle factors. It represents a progressive decline in the physiological functions of the body, leading to an increased risk of chronic diseases and reduced capacity for maintaining homeostasis under stress. As the global population ages, perspectives on aging are shifting from simply prolonging life to enhancing the quality of life in later years. This shift reflects a growing recognition of "healthy aging," which emphasizes maintaining physical, mental, and social well-being as individuals age, rather than merely focusing on the absence of disease (10,11). Historically, aging has been viewed through a biomedical lens, where the focus has primarily been on the physiological deterioration that comes with advancing years. This includes the loss of muscle mass (sarcopenia), decreased bone density, cognitive decline, and the increased prevalence of chronic conditions like cardiovascular diseases, diabetes, and neurodegenerative disorders (8,9). However, more contemporary perspectives emphasize a holistic approach, acknowledging that aging also includes psychological and social dimensions, and that promoting healthy behaviors and environments can significantly enhance the aging experience (12). In particular, the World Health Organization's framework for healthy aging focuses on the intrinsic capacity of the individual (the combination of physical and mental capacities) and the role of supportive environments in maximizing function and well-being (3,11). This perspective advocates for promoting physical activity, proper nutrition, mental health support, and social inclusion as critical components

of aging well. The growing interest in "successful aging" also emphasizes maintaining autonomy, independence, and active engagement in life activities as essential factors that contribute to quality aging (12).

Aging also differs across cultures and regions, with varying attitudes and support systems influencing the experience of aging. In many Western societies, aging is often associated with a loss of independence, and the elderly may experience social isolation or age-related discrimination (13). In contrast, many Asian cultures, including India, traditionally view aging as a stage that brings wisdom and respect, with strong familial support systems that play a vital role in care-giving for the elderly (2). However, with modernization and urbanization, these traditional structures are changing, and older adults may face new challenges related to isolation and insufficient healthcare support (5). Furthermore, advances in science are reshaping how aging is understood at a biological level. Research on cellular senescence, mitochondrial dysfunction, and age-related signalling pathways has deepened the understanding of how aging impacts the body at the molecular level (14). These insights offer the potential for interventions aimed at delaying the onset of age-related diseases and extending health span rather than merely lifespan.

Aging is no longer seen merely as a process of inevitable decline but is increasingly viewed as a dynamic phase of life that can be influenced by lifestyle choices, environmental factors, and policy interventions. Emphasizing a comprehensive approach to aging that includes physical, mental, and social dimensions holds promise for improving the quality of life for older adults across the globe.

3. The Consequences of Aging

Aging is a complex biological process that affects all individuals, regardless of gender, age, or socio-economic status. It is a journey that we all embark on, characterized by various physiological, psychological, and social changes. Early in life, physical and motor functions, as well as physiological capabilities, typically enhance, peaking between late adolescence and early adulthood, around the age of 30. Beyond this point, a gradual decline often commences, with an accelerated deterioration in physiological functions as age progresses (15).

As individuals age, several significant physiological changes occur, impacting overall health and functioning. For instance, research indicates a decline in body weight associated with the aging process, largely due to the loss of muscle mass and alterations in muscle fiber composition (14). This reduction in muscle mass, known as sarcopenia, is characterized by a decrease in both the number and size of muscle fibers, adversely affecting mobility and strength. Additionally, aging results in decreased hydration of tendons, which may hinder physical performance and increase the risk of injuries (16).

In the skeletal system, the aging process leads to changes in bone density and structure. There is a noticeable shift in the balance between bone resorption and formation, resulting in osteoporosis and increased susceptibility to fractures. As bones lose mineral content, they become less dense and more fragile, significantly impacting skeletal integrity and overall stability (17). Furthermore, cardiovascular health deteriorates with age, characterized by increased arterial stiffness and reduced cardiac output. The heart's muscle fibers lose elasticity and become stiffer, contributing to a higher risk of hypertension and cardiovascular disease (18).Aging also impacts other vital systems, including the digestive, immune, renal, nervous, endocrine, and reproductive systems. The decline in these systems can lead to various age-related health issues such as diabetes, arthritis, Alzheimer’s disease, and a decline in sensory functions like vision and hearing (19). Cognitive functions may also be affected, with many older adults experiencing slower processing speeds and memory impairments, contributing to an increased risk of neurodegenerative diseases (20).

Psychologically, aging can have profound effects, often leading to issues such as depression and anxiety. Factors such as chronic illness, loss of loved ones, and social isolation can exacerbate mental health challenges, further diminishing the quality of life for older adults.Socially, older adults may face isolation and loneliness, significantly affecting their mental and physical health (21,22).

The consequences of aging are multifaceted, encompassing significant changes across physical, mental, and social dimensions. Understanding these changes is crucial for developing effective interventions and support systems aimed at enhancing the quality of life for older adults, enabling them to age gracefully and with dignity.

4. Aging and Exercise

4.1 Different Exercises for the Aged

Engaging in a diverse range of exercises can significantly enhance overall health, particularly in the prevention of aging-related conditions.Aerobic activities like walking, running, cycling, swimming, and dancing are beneficial for cardiovascular health. Regular aerobic exercise improves the heart's efficiency, lung efficiency, reduces blood pressure, and lowers cholesterol levels, which collectively decrease the risk of cardiovascular diseases (23). Additionally, aerobic activities support weight management, preventing obesity, a major risk factor for chronic diseases like diabetes and hypertension (23,24). Beyond physical benefits, aerobic exercises positively impact mental health by boosting mood and alleviating anxiety and depression through the release of endorphins (11,25). Strength training such as weightlifting, resistance band workouts, and bodyweight exercises (like push-ups and squats) are key to preserving muscle mass, improves bone density, thereby lowering the risk of osteoporosis and fractures, especially in postmenopausal women (26). Furthermore, it enhances metabolic health by improving insulin sensitivity and glucose metabolism, reducing the likelihood of developing type 2 diabetes (27). Flexibility and Stretching activities for aged women such as yoga, Pilates, Chair exercises, and stretching routines play an important role in improving flexibility and joint mobility, sleep quality, reducing the risk of injuries and falls and contribute to better posture and balance (28–31) and also help in reducing muscle tension and promoting relaxation (32), contributing to overall physical and mental well-being (33,34). Balance exercises like Tai Chi, single-leg stands, and stability ball workouts, are effective in enhancing balance and coordination. These activities are particularly important for fall prevention in older adults, as falls are a major health concern (35). Additionally, balance exercises improve core strength, which is crucial for maintaining proper posture and preventing injuries during daily activities, improve quality of life, and stimulates sensory orneuromuscular control mechanism (36).

A meta-analysis on15 randomized controlled trials by Yao et al. (2021) showed positive effect of aerobic exercises training (three times a week, at least 30 minute per session for 8 weeks) on mental health among older adults(37). Various research studies showed that positive effect of aerobic exercises on cognitive function (20), psychological well-being (25), and health-related physical fitness (grip strength, lower body muscle endurance)and cardiorespiratory fitness like VO2max, anaerobic threshold, work (38) among older adults. Many meta-analysis and systematic reviews have demonstrated that resistance training significantly improves health-related quality of life, reduces depression, enhance upper and lower limb muscle strength in adults aged 60 and older (21,22). Many studies typically involved resistance training interventions lasting 12 weeks or more, with sessions occurring multiple times per week (21,39), both high-intensity (75-85% 1RM) and low-intensity (55-65% 1RM) resistance programs have been associated with significant improvements in muscle strength (with improvements ranging from 24% to 33% across various exercises)(40), body composition, mood, and physical self-efficacy (39,41). A 10-week stretching program, conducted three times per week, demonstrated significant improvements in physiological functions (e.g., blood pressure, cholesterol levels, body fat percentage), physical fitness (e.g., balance, flexibility, strength), psychological well-being (reduced depression), and activities of daily living among elderly women (30,33,42). Meta-analyses have revealed improvements in gait speed, range of motion, and balance (31,43), decrease passive stiffness in the muscle-tendon unit, potentially enhancing movement efficiency (32), and improve health-related quality of life (8) in older adults.Meta-analyses reveal that at least 40 minutes/session and 2-3 times per week for typically range from 8 weeks to several months, practice of balance exercises improves dynamic balance, perceived balance, flexibility, muscle strength,reduce fall rates, as well as psychological factors such as quality of life and depression in both healthy older adults and those with clinical conditions (35,36,44).

Many research studies emphasize that exercise interventions significantly reduce healthcare costs by lowering the incidence of hospitalizations and improving overall quality of life (45,46). In a country like India, where the majority of the population pays for healthcare out-of-pocket, such cost-effective measures can be critical in supporting healthy aging (24,47).

4.2 Social and Community Engagement through Physical Activity

The social benefits of physical activity are also noteworthy. Exercise programs, particularly group-based activities such as yoga, Pilates, walking clubs, Chair exercises, multicomponent exercises, Aerobics & Zumba dance, etc. offer older adults the opportunity to engage with others, fostering social connections and reducing the feelings of isolation that are common in aging populations. Social isolation can have detrimental effects on mental health, including increased risk of depression and cognitive decline, making group exercise an effective way to improve psychological well-being while promoting physical health (21,22,25,48). The communal aspect of group yoga or other community-based fitness classes creates a supportive environment where aging individuals can share their experiences and motivate one another, further enhancing their adherence to physical activity.

4.3 Barriers to Physical Activity in Aging Populations

Despite the well-documented benefits, many aging adults face barriers to engaging in regular physical activity. These barriers can include physical limitations, lack of motivation, fear of injury, and inadequate access to safe exercise environments. In India, particularly among women, cultural factors such as traditional gender roles and societal expectations may discourage participation in physical activity (13). Additionally, the economic burden associated with gym memberships or access to fitness facilities can be a deterrent for many older adults, especially those from lower-income or rural backgrounds.

To overcome these barriers, it is essential to promote community-based exercise programs that are accessible, culturally appropriate, and tailored to the unique needs of older women. According to the World Health Organization's "Global Recommendations on Physical Activity for Health," adults aged 65 and above should aim for 150 minutes of moderate-intensity aerobic exercise or 75 minutes of vigorous-intensity activity each week, along with muscle-strengthening exercises at least two days a week (3). Similarly, the U.S. Department of Health and Human Services (HHS) advises older adults, especially those experiencing frailty, to incorporate a mix of balance exercises, muscle-strengthening activities (at least twice a week), and moderate-intensity aerobic exercises at least three times a week. These sessions should last between 30 to 45 minutes and be sustained for 3 to 5 months to effectively improve functional capacity (8). Despite these guidelines, older adults often fall short of recommended activity levels. For instance, a U.S. Behavioral Risk Factor Surveillance Survey that tracked around 350,000 adults aged 18–80 years showed only a modest rise in the proportion of individuals meeting both aerobic and resistance training guidelines from 17% to 23% between 2015 and 2019 (49). Globally, data from 2017 suggest that failing to meet physical activity guidelines accounts for about 1.3 million deaths annually among people aged 25 and older, or 17 deaths per 100,000 individuals (3,8). Public health campaigns that educate individuals about the importance of physical activity and provide free or low-cost exercise options can help encourage participation across diverse populations.

4.4 Exercise: as a Sustainable Path to Healthy Aging in India

Ultimately, the role of physical activity in aging cannot be overstated. Exercise not only extends lifespan but also enhances healthspan—the period of life spent in good health, free from serious disease or disability (7). As India's population continues to age, particularly among women, promoting physical activity as a cost-effective and preventive measure is crucial. By encouraging older adults to stay physically active, society can help ensure that aging is not only about living longer but also about living better, healthier, and more fulfilling lives.A meta-analysis by Wahid et al. found that physically active individuals had a lower risk of developing cardiovascular diseases, stroke, and diabetes compared to their inactive counterparts (23). For Indian women, particularly those transitioning into old age, physical activity provide an affordable and accessible way to manage the health risks associated with these chronic conditions.

5. Recommendations

Based on the reviewing articles on women and exercise in aging, the following recommendations may be adopted by the government and non-government organizations to ensure healthy aging of Indian women.

i. Local health and fitnessprograms may be designed for the elderly populationin the community.

ii. Exercise program for the aged may be designed incorporatingfun activities.
iii. A specially designed fitness centeror senior citizens' clubs for aged may be developed.
iv. The Indian government needs to promote health and fitness policies among older adults through various initiatives and awareness programs.
v. Collaboration with non-governmental organizations (NGOs) may be instrumental in promoting physical activity among aging women in India.
vi. A Geriatric fitness and wellness workshop, certificate course, or diploma maybe introduced.
vii. Geriatric health awareness, health check-up camps, and behaviourmodification sessions may be organized in the community.
viii. Intervention of technology and online platforms can be effective to promote physical activity among older adults.

6. Conclusion

Exercise stands as a sustainable path to healthy aging for women in India, offering multifaceted benefits that extend beyond the physical realm. As society collectively prioritizes the health of its aging population, the commitment to promoting exercise will undoubtedly contribute to a healthier, more vibrant future for women as they age. Different government and non-government agencies may adopt policies and take initiative to conduct community-based exercise programs. Embracing this approach will not only empower individuals but also strengthen communities and enhance the overall well-being of the nation.

Acknowledgments

Not applicable.

References

1. Dorling D. World population prospects at the UN: our numbers are not our problem? In: Deeming C, editor. The Struggle for Social Sustainability. Policy Press; 2021 [cited 2024 Oct 6]. p. 129–54. DOI: https://doi.org/10.51952/9781447356127.ch007
2. George LS. Ageing in India: An Intricate Phenomenon. In: Selin H, editor. Aging Across Cultures [Internet]. Cham: Springer International Publishing; 2021 [cited 2024 Oct 6]. p. 165–79. (Science Across Cultures: The History of Non-Western Science; vol. 10). DOI: https://doi.org/10.1007/978-3-030-76501-9_11
3. Bull FC, Al-Ansari SS, Biddle S, Borodulin K, Buman MP, Cardon G, et al. World Health Organization 2020 guidelines on physical activity and sedentary behavior. Br J Sports Med. 2020 Dec;54(24):1451–62. DOI: https://doi.org/10.1136/bjsports-2020-102955. PMID: 33239350; PMCID: PMC7719906
4. Banerjee S. Determinants of rural-urban differential in healthcare utilization among the elderly population in India. BMC Public Health. 2021 May 17;21(1):939. DOI: https://doi.org/10.1186/s12889-021-10773-1. PMID: 34001026; PMCID: PMC8130530
5. Malik C, Khanna S, Jain Y, Jain R. Geriatric population in India: Demography, vulnerabilities, and healthcare challenges. J Family Med Prim Care. 2021 Jan;10(1):72–6. DOI: https://doi.org/10.4103/jfmpc.jfmpc_1794_20. PMID: 34017706; PMCID: PMC8132790
6. Cepellos VM. Feminization of aging: A multifaceted phenomenon beyond the numbers. Rev adm empres. 2021;61(2):e20190861. https://doi.org/10.1590/S0034-759020210208
7. Warburton DER, Bredin SSD. Health benefits of physical activity: a systematic review of current systematic reviews. Curr Opin Cardiol. 2017 Sep;32(5):541–56. DOI: https://doi.org/10.1097/HCO.0000000000000437. PMID: 28708630
8. Izquierdo M, Merchant RA, Morley JE, Anker SD, Aprahamian I, Arai H, et al. International Exercise Recommendations in Older Adults (ICFSR): Expert Consensus Guidelines. J Nutr Health Aging. 2021 Jul;25(7):824–53. DOI: https://doi.org/10.1007/s12603-021-1665-8. PMID: 34409961
9. Anderson E, Durstine JL. Physical activity, exercise, and chronic diseases: A brief review. Sports Med Health Sci. 2019 Dec 1;1(1):3–10. DOI: https://doi.org/10.1016/j.smhs.2019.08.006. PMID: 35782456; PMCID: PMC9219321
10. Shi H, Hu FB, Huang T, Schernhammer ES, Willett WC, Sun Q, et al. Sedentary Behaviors, Light-Intensity Physical Activity, and Healthy Aging. JAMA Netw Open. 2024 Jun 11;7(6):e2416300. DOI: https://doi.org/10.1001/jamanetworkopen.2024.16300. PMID: 38861256; PMCID: PMC11167497

11. World Health Organization. Decade of healthy ageing: baseline report. World Health Organization; 2021. 224 p. Available from https://www.google.co.in/books/edition/World_Health_Statistics_2018/sXeyDwAAQBAJ?hl=en&gbpv=0
12. Rowe JW, Kahn RL. Successful Aging 2.0: Conceptual Expansions for the 21st Century. J Gerontol B Psychol Sci Soc Sci. 2015 Jul;70(4):593–6. DOI: https://doi.org/10.1093/geronb/gbv025. PMID: 25878054
13. Löckenhoff CE, De Fruyt F, Terracciano A, McCrae RR, De Bolle M, Costa PT, et al. Perceptions of aging across 26 cultures and their culture-level associates. Psychol Aging. 2009;24(4):941–54. DOI: https://doi.org/10.1037/a0016901. PMID: 20025408; PMCID: PMC2933107
14. López-Otín C, Blasco MA, Partridge L, Serrano M, Kroemer G. The Hallmarks of Aging. Cell. 2013 Jun;153(6):1194–217. DOI: https://doi.org/10.1016/j.cell.2013.05.039. PMID: 23746838; PMCID: PMC3836174
15. Montecino-Rodriguez E, Berent-Maoz B, Dorshkind K. Causes, consequences, and reversal of immune system aging. J Clin Invest. 2013 Mar 1;123(3):958–65. DOI: https://doi.org/10.1172/JCI64096. PMID: 23454758; PMCID: PMC3582124
16. Larsson L, Degens H, Li M, Salviati L, Lee Y il, Thompson W, et al. Sarcopenia: Aging-Related Loss of Muscle Mass and Function. Physiol Rev. 2019 Jan 1;99(1):427–511. DOI: https://doi.org/10.1152/physrev.00061.2017. PMID: 30427277; PMCID: PMC6442923
17. Boskey AL, Coleman R. Aging and Bone. J Dent Res. 2010 Dec;89(12):1333–48. DOI: https://doi.org/10.1177/0022034510377791. PMID: 20924069; PMCID: PMC2991386
18. Sun Z. Aging, Arterial Stiffness and Hypertension. Hypertension. 2015 Feb;65(2):252–6. DOI: https://doi.org/10.1161/HYPERTENSIONAHA.114.03617. PMID: 25368028; PMCID: PMC4288978
19. Flint B, Tadi P. Physiology, Aging. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 [cited 2024 Oct 6]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK556106/
20. Zheng G, Xia R, Zhou W, Tao J, Chen L. Aerobic exercise ameliorates cognitive function in older adults with mild cognitive impairment: a systematic review and meta-analysis of randomised controlled trials. Br J Sports Med. 2016 Dec;50(23):1443–50. DOI: https://doi.org/10.1136/bjsports-2015-095699. PMID: 27095745
21. Hart PD, Buck DJ. The effect of resistance training on health-related quality of life in older adults: Systematic review and meta-analysis. Health Promot Perspect. 2019 Jan 23;9(1):1–12. DOI: https://doi.org/10.15171/hpp.2019.01. PMID: 30788262; PMCID: PMC6377696
22. Khodadad Kashi S, Mirzazadeh ZS, Saatchian V. A Systematic Review and Meta-Analysis of Resistance Training on Quality of Life, Depression, Muscle Strength, and Functional Exercise Capacity in Older Adults Aged 60 Years or More. Biol Res Nurs. 2023 Jan;25(1):88–106. DOI: https://doi.org/10.1177/10998004221120945. PMID: 35968662
23. Wahid A, Manek N, Nichols M, Kelly P, Foster C, Webster P, et al. Quantifying the Association Between Physical Activity and Cardiovascular Disease and Diabetes: A Systematic Review and Meta-Analysis. J Am Heart Assoc. 2016 Sep 14;5(9):e002495. DOI: https://doi.org/10.1161/JAHA.115.002495. PMID: 27628572; PMCID: PMC5079002
24. Bandyopadhyay N. Exercise as a cost-effective modality for healthy aging of Indian women. In: Emerging Trends of Physical Education and Sports Science [Internet]. New Delhi (India): International Sunmarg Publishers and Distributors; 2022. p. 58–62. [cited 2024 Oct 6]. Available from: https://www.researchgate.net/publication/363470162_EXERCISE_AS_A_COST-EFFECTIVE_MODALITY_FOR_HEALTHY_AGING_OF_INDIAN_WOMEN
25. Netz Y, Wu MJ, Becker BJ, Tenenbaum G. Physical activity and psychological well-being in advanced age: a meta-analysis of intervention studies. Psychol Aging. 2005 Jun;20(2):272–84. DOI: https://doi.org/10.1037/0882-7974.20.2.272. PMID: 16029091
26. Bocalini DS, Serra AJ, dos Santos L, Murad N, Levy RF. Strength training preserves the bone mineral density of postmenopausal women without hormone replacement therapy. J Aging Health. 2009 Jun;21(3):519–27. DOI: https://doi.org/10.1177/0898264309332839. PMID: 19252142
27. Brooks N, Layne JE, Gordon PL, Roubenoff R, Nelson ME, Castaneda-Sceppa C. Strength training improves muscle quality and insulin sensitivity in Hispanic older adults with type 2 diabetes. Int J Med Sci. 2007;19–27. DOI: https://doi.org/10.7150/ijms.4.19. PMID: 17211497; PMCID: PMC1752232
28. Bandyopadhyay N, Das T, Biswas A, Mondal S, Koley A. Effects of Exercise Interventions on Sleep Quality of Older Adults: A Systematic Review. Int J Aging Health Mov. 2022 Dec 21;4(2):1–9. DOI: https://doi.org/10.7575/ijahm.v4i2.52

29. Bandyopadhyay N, Das T, Biswas A, Koley A. Effects of Yogic Intervention on Sleep Quality of Healthy Elderly: A Systematic Review. Univers. J. Public Health. 2023 Feb;11(1):78–88. DOI: https://doi.org/10.13189/ujph.2023.110109
30. Bandyopadhyay N, Das T. Home-Based Pilates Exercise Regimen Can Alter the Balance and Trunk Mobility of Non-Exercising Middle-Aged Women: A Pilot Study. Int. J. Kinesiol. Sport Sci. 2023 Jul 31;11(3):36–45. DOI: https://doi.org/10.7575/aiac.ijkss.v.11n.3p.36
31. Klempel N, Blackburn NE, McMullan IL, Wilson JJ, Smith L, Cunningham C, et al. The Effect of Chair-Based Exercise on Physical Function in Older Adults: A Systematic Review and Meta-Analysis. Int J Environ Res Public Health. 2021 Feb 16;18(4):1902. DOI: https://doi.org/10.3390/ijerph18041902. PMID: 33669357; PMCID: PMC7920319
32. Nakamura M, Sato S, Kiyono R, Yahata K, Yoshida R, Fukaya T, et al. Comparison of the Acute Effects of Hold-Relax and Static Stretching among Older Adults. Biology. 2021 Feb 5;10(2):126. DOI: https://doi.org/10.3390/biology10020126. PMID: 33562673; PMCID: PMC7914644
33. Meikis L, Wicker P, Donath L. Effects of Pilates Training on Physiological and Psychological Health Parameters in Healthy Older Adults and in Older Adults With Clinical Conditions Over 55 Years: A Meta-Analytical Review. Front Neurol. 2021 Oct 25;12:724218. DOI: https://doi.org/10.3389/fneur.2021.724218. PMID: 34759879; PMCID: PMC8574969
34. Bandyopadhyay N, Das T, Biswas A, Mondal D. Effects of Mindfulness-Based Stress Reduction Program on Mental Health of Non-Clinical Older Adults: A Systematic Review on Randomized Controlled Trials. Int J Aging Health Mov. 2023 Sep 30;5(2):16–23. DOI: https://doi.org/10.7575/ijahm.v5i2.105
35. Papalia GF, Papalia R, Diaz Balzani LA, Torre G, Zampogna B, Vasta S, et al. The Effects of Physical Exercise on Balance and Prevention of Falls in Older People: A Systematic Review and Meta-Analysis. J Clin Med. 2020 Aug 11;9(8):2595. DOI: https://doi.org/10.3390/jcm9082595. PMID: 32796528; PMCID: PMC7466089
36. Dunsky A. The Effect of Balance and Coordination Exercises on Quality of Life in Older Adults: A Mini-Review. Front Aging Neurosci. 2019 Nov 15;11:318. DOI: https://doi.org/10.3389/fnagi.2019.00318. PMID: 31803048; PMCID: PMC6873344
37. Yao L, Fang H, Leng W, Li J, Chang J. Effect of Aerobic Exercise on Mental Health in Older Adults: A Meta-Analysis of Randomized Controlled Trials. Front Psychiatry. 2021 Oct 6;12:748257. DOI: https://doi.org/10.3389/fpsyt.2021.748257. PMID: 34867538; PMCID: PMC8634786
38. Lo YP, Chiang SL, Lin CH, Liu HC, Chiang LC. 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. 2021 Jan;18(1):101. DOI: https://doi.org/10.3390/ijerph18010101. PMID: 33375668; PMCID: PMC7794827
39. Tsutsumi T, Don BM, Zaichkowsky LD, Delizonna LL. Physical Fitness and Psychological Benefits of Strength Training in Community-Dwelling Older Adults. Appl Human Sci. 1997;16(6):257–66. DOI: https://doi.org/10.2114/jpa.16.257. PMID: 9545677
40. Peterson MD, Rhea MR, Sen A, Gordon PM. Resistance exercise for muscular strength in older adults: A meta-analysis. Ageing Res Rev. 2010 Jul;9(3):226–37. DOI: https://doi.org/10.1016/j.arr.2010.03.004. PMID: 20385254; PMCID: PMC2892859
41. Borde R, Hortobágyi T, Granacher U. Dose-Response Relationships of Resistance Training in Healthy Old Adults: A Systematic Review and Meta-Analysis. Sports Med. 2015 Dec;45(12):1693–720. DOI: https://doi.org/10.1007/s40279-015-0385-9. PMID: 26420238; PMCID: PMC4656698
42. Kim YS, Jeong IS, Jung HM. The Effects of a Stretching Exercise Program in Elderly Women. J Korean Acad Nurs. 2004;34(1):123. DOI: https://doi.org/10.4040/jkan.2004.34.1.123. PMID: 15314346
43. Sanchez-Lastra MA, Molina AJ, Martin V, Fernández-Villa T, Cancela JM, Ayan C. Is Stretching Exercise An Adequate Control Group in Clinical Trials Aimed at Improving Physical Fitness and Function of Older Adults? A Systematic Review and Meta-Analysis. J Aging Phys Act. 2020 Dec 1;28(6):889–910. DOI: https://doi.org/10.1123/japa.2019-0257. PMID: 32498038
44. Fang Q, Ghanouni P, Anderson SE, Touchett H, Shirley R, Fang F, et al. Effects of Exergaming on Balance of Healthy Older Adults: A Systematic Review and Meta-analysis of Randomized Controlled Trials. Games Health J. 2020 Feb;9(1):11–23. DOI: https://doi.org/10.1089/g4h.2019.0016. PMID: 31800322
45. Eriksson MK, Hagberg L, Lindholm L, Malmgren-Olsson EB, Osterlind J, Eliasson M. Quality of life and cost-effectiveness of a 3-year trial of lifestyle intervention in primary health care. Arch Intern Med. 2010 Sep 13;170(16):1470–9. DOI: https://doi.org/10.1001/archinternmed.2010.301. PMID: 20837834

46. Schnelle JF, Kapur K, Alessi C, Osterweil D, Beck JG, Al-Samarrai NR, et al. Does an Exercise and Incontinence Intervention Save Healthcare Costs in a Nursing Home Population? J Am Geriatr Soc. 2003 Feb;51(2):161–8. DOI: https://doi.org/10.1046/j.1532-5415.2003.51053.x. PMID: 12558711
47. Bandyopadhyay N. Role of low-cost multi-component exercise programme on aging of Indian women. Theory Methods Phys Educ Sports. 2020 Nov 24;04:62–6. DOI: https://doi.org/10.32652/tmfvs.2020.4
48. Bandyopadhyay N, Das T. Effectiveness of Ten Weeks Community-Based Multicomponent Exercise Program on Physiological Health of Elderly Women. Int. J. Kinesiol. Sport Sci. 2022 Oct 31;10(4):25–33. DOI: https://doi.org/10.7575/aiac.ijkss.v.10n.4p.25
49. Centers for Disease Conrol and Prevention. Physical Activity Basics. 2024 [cited 2024 Oct 1]. Adult Activity: An Overview. Available from: https://www.cdc.gov/physical-activity-basics/guidelines/adults.html