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The Effect of Leg Muscle Strength Training in Reducing Knee Pain Intensity among Elderly Women

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Abstract. Everyone will experience aging. This condition reduces physiological resilience and increases susceptibility to injury. The knee joint is the largest, also supports a huge load, and is susceptible to wear and tear and injury. Appropriate prevention and rehabilitation efforts are needed to avoid this. Exercises to strengthen leg muscles are important for people from the age of 45, because if the leg muscles are strong then they will absorb the weight of our body before it is placed on the knee joint. This study aimed to determine the effectiveness of leg muscle strength training in overcoming the intensity of knee pain by paying attention to the causes of knee pain, namely osteoarthritis and injury. This research is a quantitative research type, Pre-Experimental, One Group Pre-Test Post-Test Design. The population is residents of Gayamsari Village aged 45 years and over who experience knee pain, a sample of 42 people using a purposive sampling technique. The independent variable is leg muscle strength training; the dependent variable is the intensity of knee pain. Data collection was carried out 2x a week for 6 weeks. The instruments include a Numerical Rating Scale pain scale and an observation sheet. Statistical tests use the Wilcoxon signed ranks test. Test statistics are known as Asymp.Sig. (2-tailed) is worth 0.000. Because the value of 0.000 is smaller than <0.05, it means that there is a difference between the intensity of knee pain for the Pre Test and Post Test, so it can be concluded that there is an influence of leg muscle strength training on the intensity of knee pain in residents aged 45 years and over in Gayamsari Village, Semarang. Advice for residents from the age of 45 in Gayamsari Village who experience knee pain due to osteoarthritis or ligament injuries is to train the strength of their leg muscles
Keywords: leg muscle strength training; knee pain intensity

Abstrak. Kita semua secara alami akan mengalami penuaan. Kondisi tersebut menurunkan ketahanan fisiologis dan meningkatkan kerentanan terhadap kejadian cedera. Sendi lutut sebagai sendi terbesar dan juga penopang beban yang sangat besar, rentan untuk mengalami keausan dan cedera. Usaha pencegahan dan rehabilitasi yang tepat diperlukan untuk menghindari hal tersebut. Latihan untuk menguatkan otot kaki penting dilakukan untuk orang mulai usia 45 tahun, karena jika otot kaki kuat maka mereka akan menyerap beban tubuh kita sebelum dibebankan ke sendi lutut. Tujuan penelitian ini adalah untuk mengetahui efektivitas latihan kekuatan otot kaki dalam mengatasi intensitas nyeri lutut dengan memperhatikan penyebab nyeri lutut yaitu *osteoarthritis* dan cedera. Penelitian ini berjenis penelitian kuantitatif, Pra-Eksperimental, One Group Pre-Test Post-Test Design. Populasi adalah warga Kelurahan Gayamsari berusia 45 tahun ke atas yang mengalami nyeri lutut, sampel sebanyak 42 orang dengan teknik purposive sampling. Variabel bebas adalah latihan kekuatan otot kaki, variable terikat adalah intensitas nyeri lutut. Pengumpulan data dilaksanakan 2x seminggu selama 6 minggu. Instrumen berupa skala nyeri Numerical Rating Scale dan lembar observasi. Uji statistik menggunakan wilcoxon signed ranks test. Test statistics diketahui Asymp.Sig. (2-tailed) bernilai 0,000. Karena nilai 0,000 lebih kecil dari < 0,05, artinya terdapat perbedaan antara intensitas nyeri lutut untuk Pre Test dan Post Test, sehingga dapat disimpulkan terdapat pengaruh latihan kekuatan otot kaki terhadap intensitas nyeri lutut pada warga usia 45 tahun ke atas di Kelurahan Gayamsari Semarang. Saran bagi warga mulai usia 45 tahun di Kelurahan Gayamsari yang mengalami nyeri lutut dikarenakan osteoarthritis ataupun cedera ligamen adalah dengan melatih kekuatan otot kaki.
Kata Kunci: latihan kekuatan otot kaki; intensitas nyeri lutut

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INTRODUCTION

Aging begins naturally around the age of forty-five and represents a gradual biological process influencing multiple physiological systems. Healthy aging without chronic disease is commonly accompanied by changes in cellular and metabolic function that contribute to reductions in skeletal muscle mass, strength, and coordination. Such declines often lead to mobility impairment, increased risk of falls, physical disability, and loss of independence, which collectively diminish quality of life. Midlife adults frequently experience musculoskeletal vulnerability, particularly in weight-bearing joints such as

the knees. The knee joint, being the largest and one of the most mechanically loaded joints in the human body, is prone to structural degeneration and injury due to repetitive stress and continuous weight-bearing activity. Knee disorders represent one of the most prevalent complaints observed in orthopedic and rehabilitation clinics. Epidemiological estimates indicate that knee pain affects approximately one-quarter of the global population, signifying a major burden on health systems. In the city of Semarang, reports from community health centers identify muscle and joint disorders among the top ten prevalent health problems, ranking tenth overall (Baraliu & Muharremi, 2023; Bogaerts & Raben, 2012; Febrianta et al., 2023; Judge et al., 2020; Tokuda & Mori, 2023).

Observations from local health forums and village administration in Gayamsari indicate that a considerable number of residents aged forty-five years and older experience knee discomfort of varying intensity, ranging from mild pain to severe functional limitation. The frequency of knee problems among middle-aged and older adults underscores the urgency for preventive and rehabilitative strategies capable of maintaining joint function and mitigating pain progression. Effective management approaches are necessary to preserve physical activity, delay functional decline, and reduce the economic and social consequences of musculoskeletal disorders (Caudet et al., 2025; Gok et al., 2024; Perkins & Canavan, 2023; Seals, 2023a).

Contemporary scientific literature identifies strength training as one of the most effective non-pharmacological interventions for counteracting age-related muscle deterioration. Controlled resistance exercise improves neuromuscular activation, enhances muscle mass, and increases joint stability, which collectively contribute to reduced pain and better mobility. Research by Gerard D'Onofrio, Jonathan Kirschner, Heidi Prather, David Goldman, and Alan Rozanski (2023) described musculoskeletal exercise as a critical determinant of health and longevity. Their findings emphasized that resistance training remains a frequently neglected yet essential component of overall health maintenance. Evidence also demonstrates that lower-limb strength training positively influences functional capacity in individuals with joint injuries. A study published in Sports Health in 2019 revealed that strengthening exercises for the leg muscles improved knee joint function and decreased pain among participants with ligamentous injury (Juhanis, 2015; Şar et al., 2025; Seals, 2023b; Sumartiningsih et al., 2022).

The structured leg muscle strengthening performed twice weekly over a period of one and a half months significantly reduced the intensity of knee pain. The consistency of these findings across different studies supports the hypothesis that targeted resistance exercise enhances musculoskeletal resilience, particularly in populations experiencing degenerative or mechanical knee conditions. Leg muscle strengthening contributes to joint stability by reinforcing surrounding musculature, improving proprioception, and optimizing load distribution across articular surfaces (Arsenis et al., 2020; Ayala et al., 2017; Nuhu et al., 2021; Oliano et al., 2017; Panchal et al., 2025).

Individual variability in health status and joint pathology influences the response to strengthening programs. Adults above the age of forty-five often present with diverse etiologies of knee pain, including degenerative changes, inflammatory processes, or mechanical imbalances. Therefore, further research remains essential to evaluate the effectiveness of lower-limb strength training as a rehabilitation approach that accounts for multiple causes of knee pain. A comprehensive understanding of exercise response within this demographic may contribute to more precise intervention planning and the personalization of rehabilitation programs (Bukry et al., 2024; Perkins & Canavan, 2023; Thai et al., 2020; Tokuda & Mori, 2023; Z. Zhou et al., 2024).

The present research focuses on determining the effectiveness of leg muscle strength training in reducing knee pain intensity among adults aged forty-five years and older, while considering the various underlying factors contributing to discomfort. The study aims to clarify the role of resistance-based exercise in restoring functional capacity and mitigating pain progression in individuals experiencing age-related musculoskeletal decline. A deductive approach was adopted to examine the relationship between systematic muscle strengthening and measurable improvements in joint comfort and mobility (de Camargo, 2023; Horan et al., 2023; Moadab et al., 2023; Seals, 2023a).

The relevance of this investigation is underscored by the continued prevalence of knee pain and the common reliance on passive management strategies such as rest, reduced movement, and pharmacological treatment. Such methods fail to stimulate muscle adaptation and may exacerbate weakness, leading to further instability and intensified pain. Leg muscle strengthening represents a proactive, evidence-based intervention designed to restore muscle support, enhance joint alignment, and prevent deterioration of knee function. By promoting consistent mechanical loading within safe limits,

structured exercise facilitates improved circulation, joint lubrication, and metabolic efficiency of surrounding tissues (Yalfani et al., 2020; Zanini et al., 2024; X. Zhou et al., 2022).

The broader implication of strengthening interventions extends to community health promotion and the prevention of disability in aging populations. Incorporating resistance training into daily routines can enhance long-term functional independence and reduce healthcare costs associated with chronic joint conditions. The physiological mechanisms underlying improvement in knee function align with principles of adaptation in exercise science, emphasizing the body's capacity to remodel tissue and restore functional equilibrium when exposed to controlled physical stress. Continued research exploring exercise dosage, frequency, and intensity for individuals aged forty-five and older will contribute to more refined guidelines for musculoskeletal health preservation.

The conceptual foundation of the study contributes to sports medicine and rehabilitation science by bridging preventive health approaches with performance optimization in older adults. Empirical evidence generated through this research supports the understanding that leg muscle strengthening serves not only therapeutic but also preventive roles in joint health maintenance. Application of this evidence can inform community-based exercise programs and clinical rehabilitation protocols targeting the growing population of adults susceptible to degenerative knee disorders. The integration of scientific knowledge on resistance training with public health initiatives promotes a sustainable approach to healthy aging, ensuring that individuals maintain mobility, autonomy, and overall quality of life into later adulthood.

METHODS

The study employed a quasi-experimental design with a one-group pretest–posttest approach. Participants consisted of elderly women residing in the Gayamsari District who were aged forty-five years or older. Inclusion criteria required participants to attend training sessions regularly and not be absent more than three times throughout the intervention period. All participants provided written informed consent before data collection. Ethical approval was obtained in accordance with the principles of the Declaration of Helsinki. A total of forty-two elderly women met the eligibility requirements and were included in the study.

The experimental intervention involved leg muscle strengthening exercises performed using a chair as a supporting tool. Training sessions were conducted twice per week for six consecutive weeks, with each session lasting approximately forty minutes. The intervention was designed to enhance lower-limb strength and improve functional stability among elderly participants.

Data collection was carried out before and after the six-week training period. The primary outcome measure was the intensity of knee pain, assessed using a Numeric Rating Scale (NRS). The pain scale ranged from 0 to 10, representing a continuum from no pain to the most severe level of pain experienced.

Data analysis included a normality test to determine the distribution characteristics of the collected data, followed by selection of the appropriate statistical test for hypothesis evaluation. The analytical process aimed to identify significant differences in knee pain intensity before and after the implementation of the leg muscle strength training program.

RESULTS AND DISCUSSION

Table 1 presents the demographic and baseline characteristics of forty-two elderly women who participated in the study. Participant ages ranged from forty-four to seventy-nine years, with a mean age of 62.9 years (SD = 7.9). The relatively small standard deviation compared to the mean indicates that the age data were concentrated around the average value, suggesting homogeneity among participants. The average frequency of exercise attendance was 11.1 days (SD = 1.2) during the six-week intervention, reflecting consistent participation and adherence to the training schedule. The mean pretest knee pain score was 3.2 (SD = 2.2), whereas the mean post-test score decreased to 0.9 (SD = 1.4). The reduction in mean pain scores demonstrates that leg muscle strengthening performed over six weeks contributed to a marked improvement in knee pain intensity.

Table 1. Characteristics of Elderly Women (n = 42)

Variable	N	Mean ± SD
Age (years)	42	62.9 ± 7.9
Exercise Frequency (day)	42	11.1 ± 1.2
Pain Pre-test (scale)	42	3.2 ± 2.2
Pain Post-test (scale)	42	0.9 ± 1.4

The pretest pain scores ranged from a minimum value of 1 to a maximum value of 9, yielding a mean value of 3.19 with a standard deviation of 2.22. The standard deviation smaller than the mean indicates that most pain scores were close to the average value. The post-test scores ranged from 0 to 5, with a mean of 0.90 and a standard deviation of 1.41. The reduced mean and consistent distribution reveal that nearly all participants experienced reduced pain following the intervention.

The normality of the data distribution was examined using the Kolmogorov–Smirnov test, and the results are shown in Table 2. The obtained significance value was p = 0.000, which is lower than 0.05, indicating that the residual data were not normally distributed. The non-normal distribution of data justified the use of a nonparametric statistical approach for further hypothesis testing.

Table 2. One-Sample Kolmogorov–Smirnov Test

Parameter	Statistic
N	42
Mean	0.0000000
Std. Deviation	1.74082963
Most Extreme Differences	
Absolute	0.273
Positive	0.152
Negative	-0.273
Test Statistic	0.273
Asymp. Sig. (2-tailed)	0.000

The results of the normality analysis confirm that the assumption of a normal data distribution was not met. Therefore, the Wilcoxon signed-rank test was selected to evaluate the hypothesis concerning differences between pretest and post-test pain intensity scores.

Table 3 presents the results of the Wilcoxon signed-rank test. The analysis showed that forty participants had negative ranks, indicating reductions in pain levels after the intervention. The mean rank was 20.50, and the total sum of ranks was 820.00. No positive ranks were recorded, which signifies that none of the participants reported increased pain intensity following the exercise program. Two participants exhibited tied scores, meaning that their pretest and post-test pain scores were identical. The tied data corresponded to participants who recorded knee pain scores of one and four, respectively, suggesting stable pain levels possibly influenced by underlying medical conditions such as gout or hypertension.

Table 3. Ranks Summary (n = 42)

Category	N	Mean Rank	Sum of Ranks
Negative Ranks (Post-test < Pre-test)	40	20.50	820.00
Positive Ranks (Post-test > Pre-test)	0	0.00	0.00
Ties (Post-test = Pre-test)	2	–	–

The predominance of negative ranks demonstrates a uniform decline in pain levels across participants. The absence of positive ranks emphasizes that the intervention did not exacerbate knee pain in any case. The presence of only two ties suggests that the vast majority of participants responded

favorably to the leg strengthening exercises.

The test statistics presented in Table 4 indicate a Z-score of –5.578 with an Asymp. Sig. (2-tailed) value of 0.000. The p-value below 0.05 confirms a statistically significant difference between pretest and post-test pain intensity levels. The results support the acceptance of the alternative hypothesis, which states that leg muscle strengthening significantly reduces knee pain intensity among elderly women aged forty-five years and older.

Table 4. Test Statistics (Wilcoxon Signed-Rank Test)

Variable	Z-score	Asymp. Sig. (2-tailed)
Post-test – Pre-test	–5.578	0.000

The significant Z-score value indicates a strong effect of leg muscle strengthening on pain reduction. The analysis reveals that the six-week exercise program successfully improved knee comfort without adverse outcomes. The results demonstrate that structured strengthening exercises can serve as an effective non-pharmacological intervention to alleviate musculoskeletal pain among elderly women.

Table 5. Hypothesis Summary

Variable	Pre-test Mean ± SD	Post-test Mean ± SD	Z-score	p-value	Interpretation
Knee Pain Intensity	3.2 ± 2.2	0.9 ± 1.4	–5.578	0.000	Significant

The results illustrate that the mean pain score decreased from 3.2 before the intervention to 0.9 after the intervention, representing a substantial improvement in knee pain intensity. The statistical evidence confirms that leg muscle strength training effectively reduced knee pain intensity in the sample population.

The findings of the present research demonstrate that leg muscle strength training performed twice per week for six weeks significantly reduced knee pain intensity among elderly women residing in the Gayamsari District of Semarang. The mean reduction from 3.2 to 0.9 points on the pain scale, supported by a statistically significant Wilcoxon test result ($Z = –5.578$, $p = 0.000$), provides strong empirical evidence that systematic lower-limb strengthening can serve as an effective non-pharmacological strategy for pain management in elderly populations. The results confirm the working hypothesis that increased lower-limb strength contributes directly to improvements in joint function and pain reduction by enhancing muscular stability, load distribution, and neuromuscular coordination around the knee joint.

The outcomes of the current research align closely with previous studies demonstrating that resistance and strength training improve musculoskeletal function and alleviate pain among older adults. Even low-intensity strength training can substantially reduce pain and improve functional mobility in individuals with knee osteoarthritis. The results of the current study reaffirm these findings by illustrating similar patterns of improvement within a community-based elderly population. Furthermore, the progressive balance and strength exercises enhance muscle control, proprioception, and functional outcomes in patients with ligament injuries. The convergence of these studies suggests that muscle strengthening exerts a multidimensional benefit, enhancing both the physiological and biomechanical aspects of joint function. The present findings extend this understanding by demonstrating that such benefits are not confined to clinical or rehabilitative settings but can be achieved effectively through structured programs implemented in community environments with minimal equipment and supervision (Bukry et al., 2024; Cierson et al., 2025; Davidovica et al., 2025; Jiang, 2025; Seyedi et al., 2023; Soussi et al., 2025).

The observed decrease in knee pain can be explained through physiological and biomechanical mechanisms. Strength training facilitates hypertrophy and improved neuromuscular activation of the quadriceps, hamstrings, and surrounding stabilizing muscles, which are essential for knee joint function. Enhanced muscle strength allows for greater absorption of body weight and external forces, thereby reducing compressive stress on articular cartilage and subchondral bone. Increased muscle endurance also leads to more stable movement patterns and better energy transfer across joints, minimizing microtrauma and inflammation that often exacerbate knee pain. The findings reported that muscle

strengthening improves knee alignment, reduces shear forces, and enhances the shock-absorbing capacity of the lower limbs, which collectively contribute to pain reduction in patients with degenerative knee conditions (Aamodt et al., 2024; Jin, 2023; Levine, 2023; Nutma, 2023; Vaillant-Ciszewicz et al., 2023; Verberk et al., 2021).

The results also highlight the importance of neuromuscular adaptation as a contributing factor to improved outcomes. Regular repetition of controlled, functional movements improves motor learning and coordination, leading to more efficient activation patterns during daily activities such as walking, standing, and stair climbing. Improved neuromuscular control reduces compensatory movement patterns that often lead to excessive strain on joint structures. This adaptation is particularly relevant for elderly individuals, as age-related declines in proprioception and balance increase susceptibility to falls and joint overload. Therefore, the strengthening protocol used in the current study not only mitigated pain but may also contribute to enhanced movement safety and fall prevention (Ayala et al., 2017; Jäger et al., 2017; Maleki et al., 2025; Parsons et al., 2019; Perez de Arrilucea Le Floc‘ h et al., 2025).

The consistency of improvement across the majority of participants underscores the robustness of the intervention, while the two non-responding cases provide valuable insights into potential limitations. Both participants reported comorbid conditions gout and hypertension which are known to influence inflammatory and circulatory processes that may impede recovery. Gout involves urate crystal deposition in joint spaces, leading to recurrent inflammation, while hypertension can cause vascular stiffness and reduced perfusion of joint tissues. The hypertension is associated with a higher prevalence of osteoarthritis due to compromised blood flow and impaired cartilage metabolism. These findings suggest that while muscle strengthening is beneficial for most elderly individuals, concurrent management of comorbidities is essential for optimizing intervention outcomes. Future research should therefore include comprehensive health assessments and stratification of participants based on underlying conditions to refine training protocols and ensure safety (Abbate et al., 2023; Barbach et al., 2023; Kucharska-Newton et al., 2023; Marcadenti et al., 2024; Pagano et al., 2024).

The results also provide significant contributions to the field of geriatric rehabilitation and community health promotion. The intervention’s simplicity and accessibility demonstrate that effective pain management does not necessarily require advanced medical facilities or specialized equipment. Conducting sessions in a community setting, with minimal resources such as a chair and sufficient space, illustrates the feasibility of scaling similar programs across various regions. Such accessibility holds implications for public health policy, particularly in low- and middle-income countries, where healthcare access for the elderly is often limited. Implementing low-cost exercise interventions at the community level can reduce the long-term economic burden associated with chronic musculoskeletal conditions and improve quality of life among aging populations (Asgari et al., 2022; Brzezińska et al., 2022; Susilowati et al., 2018; Zarei et al., 2021; X. Zhou et al., 2022).

From a scientific perspective, the current research reinforces the growing evidence base supporting exercise-based interventions as primary modalities for managing chronic musculoskeletal pain. Non-pharmacological approaches such as strength training offer advantages over medication-based therapies by avoiding potential side effects and fostering self-efficacy among participants. Moreover, consistent engagement in physical activity stimulates cardiovascular and metabolic adaptations that further enhance overall health and longevity. The resistance training is often underutilized in health promotion despite being one of the most potent methods for maintaining physical and metabolic resilience during aging. The findings of the present study substantiate this argument, demonstrating that even moderate exercise frequencies yield meaningful improvements in musculoskeletal health and pain perception (Alkaissi & McFarlane, 2023a, 2023b; Barbach et al., 2023; Diffidenti et al., 2023; Xiong, 2023).

The research also contributes to the growing discourse linking health promotion strategies to the Sustainable Development Goals (SDGs), particularly SDG 3, which focuses on ensuring healthy lives and promoting well-being for all ages. By emphasizing prevention and functional independence rather than reactive treatment, the intervention aligns with the principle of sustainable community health. Regular strength training not only reduces pain but also enhances mobility and participation in daily and social activities, thus reinforcing psychological well-being and social engagement among elderly individuals. Such multidimensional benefits underscore the broader relevance of the intervention beyond individual health outcomes, highlighting its role in promoting active aging and community vitality (Amrullah & Aini, 2024; Bing, 2021; Ma et al., 2024).

The critical analysis of the results reveals several areas for future exploration. Longitudinal studies are needed to evaluate the sustainability of pain reduction and the progression of functional improvements beyond the initial six-week intervention period. Research extending the duration of training could determine the optimal frequency and intensity required for maintaining long-term benefits while minimizing fatigue or injury risk. Additionally, incorporating balance, flexibility, and aerobic components alongside strength training may produce synergistic effects, providing a more comprehensive approach to musculoskeletal health. Comparative studies across genders and diverse socioeconomic backgrounds would also help generalize the findings and ensure that interventions are adaptable to different populations (Edis et al., 2023; Gianturco et al., 2018; Lourenço et al., 2024).

Another important direction for future investigation involves integrating qualitative methodologies to explore participant perceptions, motivation, and barriers to consistent exercise participation. Understanding psychological and social determinants of adherence is essential for designing programs that encourage long-term lifestyle changes. individuals often face challenges such as fear of injury, lack of social support, or limited access to facilities, which can affect participation. Incorporating motivational strategies, community engagement, and peer support could enhance adherence and overall program success (Aamodt et al., 2024; Khandre, 2023; Kucharska-Newton et al., 2023; Vaillant-Ciszewicz et al., 2023; Westbye et al., 2023).

From a theoretical standpoint, the study reinforces the biopsychosocial model of pain management, which recognizes that musculoskeletal pain is influenced by biological, psychological, and social factors. Strengthening exercises address the biological component by improving tissue function and reducing inflammation, while group-based participation provides social reinforcement and psychological motivation. Such multidimensional benefits highlight the value of community-based exercise interventions as holistic approaches to elderly care (Asgari et al., 2022; Brzezińska et al., 2022; Larsman, 2006; Susilowati et al., 2018).

The study provides compelling evidence that leg muscle strength training is an effective, safe, and accessible intervention for reducing knee pain intensity in elderly women. The findings not only validate the physiological rationale underlying muscle strengthening but also demonstrate the practical feasibility of implementing such programs in community settings. By bridging clinical evidence with real-world application, the research contributes to advancing geriatric health care, informing public health policies, and promoting sustainable aging practices. Future research should continue to explore individualized, integrative, and culturally adaptive exercise interventions to enhance musculoskeletal health, functional independence, and overall well-being among aging populations worldwide.

CONCLUSION

The research demonstrates that leg muscle strength training conducted twice weekly for six weeks at low to moderate intensity effectively reduces knee pain intensity among elderly women aged forty-five years and older. The intervention improved muscle stability and joint support, resulting in decreased discomfort and enhanced mobility. The findings confirm that regular lower-limb strengthening serves as a practical and non-pharmacological method for managing knee pain and maintaining functional independence in older adults. The study contributes to scientific understanding by highlighting the importance of accessible, community-based exercise programs as sustainable strategies to improve musculoskeletal health and quality of life in aging populations.

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