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Gait in the elderly: a narrative review

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ABSTRACT

Background: One of the most affected functional movements in the elderly due to aging is gait. Several parameters must be considered when conducting a gait analysis, including stride speed, length, width, and variability. This study aimed to provide an overview of gait in the elderly group.

Methods: The research method used was a literature review in the form of a literature review, compiled based on secondary data from several research journals related to gait in the elderly. This Literature Review contains journals from databases such as Google Scholar and PubMed.

Results: Through the elaboration of several studies comparing the elderly group with younger individuals, it could be seen that three aspects influence gait in the elderly, namely sensory, cognitive, and musculoskeletal.

Conclusion: The elderly have a loss in sensory, cognitive, and musculoskeletal function as they age, resulting in slower and shorter stride lengths when compared to younger people.

Keywords: Aging, elderly, gait, stride length

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Introduction

The aging process declines muscle flexibility and muscle strength.[1] The internal factors of aging are hormones, genetics, radicals free, and condition pathologies (i.e., diabetes mellitus and hypertension), while the external factors are stress, economic condition, lifestyle, and diet.[2]

Besides that, along with increasing age, the physiological function and function of the body will also experience change. The aged will endure physical changes in the sensory, musculoskeletal, cardiovascular, respiratory, urinary, and reproductive systems, morphological changes, and gradual atrophy in the nerve fibers. All these changes will undoubtedly impact individuals' quality of life and efficiency in their activities. The elderly population feels this problem.[3]

The elderly are defined as those who have achieved the age of 60 years or more.[4] Globally, according to World Population Aging data, there were 703 million older adults in 2019.[5] This 10% figure shows that Indonesia has started to enter the structure of the aging population phase.[6] Currently, Indonesia is entering a period of population aging. Indonesia experienced an increase in the elderly population from 7.56 percent in 2010 to 9.7 percent in 2019, and it is estimated that by 2035, it will be 15.77 percent.[7] The elderly are in a degenerative period accompanied by reduced function of the cognitive and physiological organs, and that causes the body of the elderly to become more prone compared with younger individuals. Decreasing such things will substantially impact individuals' activities and function effectively and efficiently to achieve a "sense of meaningful living."[8]

As people age, their musculoskeletal function declines. Decreasing musculoskeletal function causes various health problems.[9] One of the most significant impacts is gait. Gait is a cyclical activity divided into several segments or phases.[10] Gait is a movement that moves forward with the body upright using the lower extremities as propulsion.[11] Gait integrates several body components, starting from the musculoskeletal, nervous system (peripheral nervous and central nervous systems), cognitive, and external factors such as footwear and stepping surfaces. Apart from that, to realize this movement, many bodily functions play a role, starting from the ankle joints, leg joints, knee joints, hip joints, pelvic joints, and spine-to-arm swing.[12] Several things influence a person's gait, including age, leg length, body mass index, foot shape, footwear, and stepping surface. However, in the elderly population, age is the most significant contributing factor to changes in gait as a form of compensation for the inability of other aspects of body adaptation.[13] Several parameters must be considered when performing gait analysis, including stride speed de variability.[10]

However, not many articles discuss how gait changes occur in the elderly from various aspects. Most only discuss it from a motor perspective without paying attention to sensory and cognitive influences and organ systems. Based on this background, a literature review was conducted to more clearly describe gait in the elderly from various aspects so that it can be known what changes occur and what impact is caused.

Methods

The research method used was a literature review based on secondary data from several journals related to research on the role of the elderly. This literature review contains journals from databases such as Google Scholar and NCBI's PubMed Central (PMC). Inclusion criteria include: (1) Articles published in the last ten years (2013-2023). (2) Writing uses English. The exclusion criteria include: (1) If there are the same articles, other articles are excluded; (2) Abstracts, theses, theses, and case reports.

Results

Based on the search, five pieces of literature were found, with a range of publications from the last ten years that can describe walking styles in the elderly, which have been written in Table 1. Muyinat et al.'s study suggests marked changes in gait associated with aging, such as slower gait and increased gait variability.

In research conducted by Katherine et al., the results stated that age's overall standardized effect (SE) on ankle kinematics indicated a moderate impact at older Age (SE= -0.67; p=0.00). A significant standardized effect was found for ankle ROM (SE=-0.89, p=0.00). There was no significant effect on age (p=0.17) and walking patterns related to knee kinetics. Results showed a significant standardized moderate to large effect of age on ankle kinematics, ankle moments, and strength.

Research conducted by Fan Yifang et al. stated that differences between adult and elderly groups were found for the three speeds tested (normal, fast, slow) (p<0.01). The stride length of older people at different speeds is shorter than that of adults, and the difference is significant (p<0.01). The walking speed of older people is lower than that of young people, with the percentage differences in normal, fast, and slow speeds being 20.87%, 13.44%, and 17.53%, respectively. The percentage differences in step length at normal, fast, and slow speeds are 19.02%, 18.96%, and 15.89%, respectively, while for cadence, they are -1.27%, 5.22% and -1.44%.

Research conducted by Muir et al. stated that an interaction effect (number of steps by age group) was observed for walking speed (F (6.896) = 4.26, p<0.01). Each age group progressively increased walking speed from steps 1–3. An interaction effect was observed for Stride length (F(6.896) = 2.12, p=0.05). Post hoc analysis revealed that Step length for all age groups differed at each step.

Research conducted by LaRoche et al. stated that TMT-A time was significantly correlated with age (r=0.58, p<0.001), as was TMT-B time (r=0.42, p=0.003), while MMSE score was not associated with age (r= ÿ0.01, p=0.486).

Discussion

The spinal cord, brain stem, cerebellum, and forebrain control gait. Reciprocal circuits between the cortex-basal ganglia and the cerebellar cortex regulate gait, including postural tone, balance, and coordination of limb movements. Many gait disorders arise from the front of the brain, which is important for providing objective walking. It contains the basal ganglia, frontal subcortex, and motor cortex.[14] However, along with the aging process, many changes may occur, including functional, sensory, and cognitive changes. If we look at the prevalence, it is estimated that 35% of elderly adults aged 70 years and over living in the community experience gait.[14]

As we get older, we will experience changes in the structure and physiology of the brain, which will affect blood flow and brain metabolism, impacting decreased cognitive function. This cognitive impairment will hurt the process of thinking, remembering, and processing information.[15] Measures of cognitive function were significantly correlated with changes in gait during combined activity walking with two tasks. With increasing age, the decline in cognitive function will make it difficult for older adults to maintain normal, rhythmic gait patterns when carrying out cognitive tasks. The elderly group showed a slower walking speed, and longer strides became shorter. They spent more time in double support than the group with more adolescents due to the reduced ability of the elderly to make decisions and solve problems.[16]

The decline in the sensory system in the elderly also has implications for the reduced ability of the elderly to adapt to changes in the environment and balance care. The sensory system plays an important role during this process by providing information via visual, somatosensory, and body balance regarding the surrounding environment when the elderly walk.[14] There are obvious changes in gait when it comes to the sensory system due to aging. This is because the integration of sensory input in the elderly has decreased, so it takes them longer to adapt to changes. This causes older people to adopt protective gait styles such as slower walking speed and increased gait variability.[14]

The overview of gait in the elderly can also be seen from the musculoskeletal aspect. Kinematically, the ankle shows a smaller ROM in the elderly. At the time of the-off and peak flexion, the elderly do less plantar flexion than younger individuals. In contrast, at the heel strike, when the

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foot first touches the ground, the dorsiflexion performed by the elderly tends to be less. At the knee, the elderly have a greater ROM. Younger individuals have more knee extension, multiple heel strikes, and swing phases to match speed conditions. If you look at the superior area, the elderly show greater hip flexion than the younger ones at heel strike and peak flexion, accompanied by less movement extension. Overall, older

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Table 1. Results of articles following the gait in the elderly

Authors	Title	Methods	Results
Muyinat, et al. (2019)	Balance and gait in the elderly: A Contemporary Review	Used a database in the form of PubMed I Cochrane Library to search for articles from 1980-2019 related to gait and balance in older adults (>60) and younger adults (<60). Search terms used included balance, posture, gait, locomotion, gait variability, gait disorders, elderly, aging, falls, vision, visual, vestibular, and virtual reality. Studies were excluded if subjects were diagnosed with a gait or balance disorder.	This study suggests marked changes in gait associated with aging, such as a slower gait and increased gait variability.
Katherine et al. (2017)	Systematic review and meta-analysis of gait mechanics in young and older adults	Literature search and analysis used the "Meta-analysis of Observational Studies in Epidemiology" approach. The analysis included cross-sectional studies rather than clinical trials. The database used is Pubmed with filters limited to literature written in English, using human studies and not reviews. The search yielded a total of 8,326 articles for consideration. All articles were reviewed independently by at least two reviewers.	The overall standardized effect (SE) of age on ankle kinematics indicated a moderate impact at older Age (SE= -0.67; *p*=0.00). A large standardized effect was found for ankle ROM (ROM) (SE=-0.89, *p*=0.00). Overall, the standardized effect of age on ankle kinetics is small (SE=-0.49; *p*=0.00). Overall, the standardized effect of age on knee kinematics is small (SE=-0.40; *p*=0.00). There was no significant effect on age (*p*=0.17) and walking patterns related to knee kinetics. Overall, the standardized effect of age on small pelvis kinematics (SE=-0.49; *p*=0.00). Overall, standardized effect of age on hip kinetics (SE=-0.29; *p*=0.02). Results showed a significant standardized moderate to large effect of age on ankle kinematics, ankle moments, and strength.
Fan Yifang, et al. (2016)	The influence of gait speed on the stability of walking among the elderly	The study design uses a clinical trial approach. The measuring tool used is the lantar pressure system: Zebris FDM System Gait Analysis (Long platform). Participants involved 30 students (16 men, average Age 21.1 ± 1.31 years and 14 women, average age 21.7 ± 1.30 years) and 25 elderly people (15 men, average age - mean 68.1±3.31 years and 10 women, mean age 66.5±3.10 years), participants were screened by administering a questionnaire accompanied by an annual medical record review. Participants will be measured at three speeds (normal, fast, and slow).	Differences between adult and elderly groups were found for the three speeds tested (normal, fast, slow) (*p*<0.01). The stride length of older people at different speeds is shorter than that of adults, and the difference is significant (*p*<0.01). The walking speed of older people is lower than that of young people, with the percentage differences in normal, fast, and slow speeds being 20.87%, 13.44%, and 17.53%, respectively. The percentage differences in step length at normal, fast, and slow speeds are 19.02%, 18.96%, and 15.89%, respectively, while for cadence they are -1.27%, 5.22% and -1.44%.

ANOVA one-way analysis of variance, *MMSE* Mini-Mental State Exam, *RM-ANOVA* Repeated measures analysis of variance, *SPPB* Short Physical Performance Battery, *TMT* Trail Making Test

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Table 1. -Continued

Authors	Title	Methods	Results
Muir, et al . (2013)	Gait initiation: The first four steps in adults aged 20–25 years, 65–79 years, and 80–91 years	Forty-eight participants were grouped by age (20–25 years, 65–79 years, and 80-91 years). With the criteria, participants must be healthy, without neuromuscular or orthopedic disorders that would impact gait, walk without using assistive devices, and be able to climb 1.5 stairs (37 steps).	An interaction effect (number of steps by age group) was observed for walking speed (F(6.896) = 4.26, *p*<0.01). Each age group progressively increased walking speed from steps 1–3. An interaction effect was observed for Stride length (F(6.896) = 2.12, *p* = 0.05, Figure 2a). Post hoc analysis revealed that Step length for all age groups differed at each step.
Table 1. -Continued			
LaRoche, et al. (2014)	Interaction of Age, cognitive function, and gait performance in 50–80-year-olds	Involved 42 male and female participants living in independent communities aged between 50 and 80 years and able to walk without assistance. Research instruments in the form of MMSE, TMT carried out two times (TMT-A & TMT-B), SPPB, 10-min habituation walk at 0.8 m s −1 on an instrumented gait analysis treadmill, Kolmogorov-Smirnov and Levene statistics (IBM SPSS Statistics, v. 20, IBM Corporation, Armonk, NY, USA), ANOVA, Tukey's post hoc analysis, RM-ANOVA.	TMT-A time was significantly correlated with age (*r*= 0.58, *p*<0.001), as was TMT-B time (*r*=0.42, *p*= 0.003), while MMSE score was not associated with age (*r*= ÿ0.01, *p*=0.486).

ANOVA one-way analysis of variance, *MMSE* Mini-Mental State Exam, *RM-ANOVA* Repeated measures analysis of variance, *SPPB* Short Physical Performance Battery, *TMT* Trail Making Test

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people have a greater hip ROM width than younger individuals. The elderly showed greater use of hip strength as compensation for the ankle when cycling. So when older people have to walk at the same speed as younger people, they do so with an increased hip contribution of .[17]

The biomechanical process of musculoskeletal system problems that occur will, of course, impact the resulting movements. So, the gait will change due to the compensation that occurs. Based on research conducted comparing three age groups (20–25 years, 65–79 years, and 80–91 years)[18], it is clear that there are several changes in gait in the elderly when compared with older and younger people in several age groups. Based on the post hoc analysis that has been carried out, the speed of each step decreases with increasing age, with the ratio between ages 65-79 years and 20-25 years being 20%, 16%, 13%, and 8% for steps 1-4. Meanwhile, the ratio between ages 80-91 and 20-25 years is 35%, 31%, 29%, and 23% for steps 1-4. Step length at ages 20–25 years increases progressively in steps 1–3, while step 4 is shorter than step 3. For ages 65–79 years, step 2 is longer than step 1, but steps 2–4 are also the same. It was similar to the other steps, and for ages 80–91 years, step length increased with each step in steps 1–3, and step 4 did not differ from step 3.[18]

The above statement is also in line with research conducted by comparing two age groups at three different walking speeds (normal, fast, slow)[19], explaining that the walking speed of older people is lower than that of young individuals, with a percentage difference in normal speed, fast and slow respectively at 20.87%, 13.44%, and 17.53%. Meanwhile, the percentage difference in step length at normal, fast, and slow speeds is 19.02%, 18.96%, and 15.89%, respectively, and for cadence, it is -1.27%, 5.22% and -1.44%, respectively.[17] It can be said that older people walk slowly because their stride length is shorter, not because their rhythm is smaller[19].

Stride length is the distance of successive placements of the same foot. Older people generally have shorter stride lengths than younger individuals as a form of compensation. The decrease in stride length in the elderly is due to changes in the musculoskeletal system, such as the strength of the leg, hip, and spine joints, as well as reduced muscle strength and atrophy of muscle fibers, reduced rotation of the joints of the lower limbs resulting in shortening of the stride.[20] Stride Length and Walking Speed have a relationship in the same direction. In simple terms, if the stride is longer, then the walking speed will increase, and vice versa.[21]

The weakness of this research is that it cannot explain the percentage of impact produced by each aspect (cognitive, sensory, and musculoskeletal), so it is not known which aspect has more dominant implications for the gait of the elderly. Further research is needed to compare the magnitude of the impact of each element (cognitive, sensory, and musculoskeletal) on changes in gait in the elderly.

Conclusion

Three aspects influence gait in the elderly, including sensory, cognitive, and musculoskeletal elements. These aspects show results that are not much different, namely an impact on decreasing speed and length of step. The elderly experience a decline in sensory, cognitive, and musculoskeletal functions due to the aging process, causing changes in gait to become slower and stride length to become shorter compared to younger individuals.

Funding

This study received no grants from any institution.

Conflict of interest

This study has no conflicts of interest.

Ethical consideration

The researchers conducted a literature review on the subject. There was no need for ethical approval because the study just evaluated existing data and did not involve human subjects or collect new data.

Author contributions

PADP prepares study designs, collects data, processes data, and writes manuscripts. PASS and AAGAPN are directing data collection and revising the manuscript.

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