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Effects of Different Walking Models on the Health-Related Fitness Parameters of Elderly Persons: A Systematic Review

Andrea Marković[1], Aleksandra Aleksić Veljković[1], Borko Katanić[2], Branislav Majkić[1], Duško Bjelica[3], Diellza Kelmendi[4]

[1]University of Nis, Faculty of Sport and Physical Education, Nis, Serbia, [2]Montenegrin Sports Academy, Podgorica, Montenegro, [3]University of Montenegro, Faculty for Sport and Physical Education, Niksic, Montenegro, [4]Kosovo Olympic Committee, Pristina, Kosovo

Abstract

Exercise and physical activity are widely promoted as an effective means of improving the health and physical functioning of older adults. Walking as a recreational activity is one of the safest and most appropriate forms of physical activity for older adults. The aim of the study was to explain, by searching the available literature, how different walking models affect the health-related fitness parameters of the elderly. The search and analysis of the studies were done in accordance with the PRISMA guidelines, and the study protocol was registered with PROSPERO, number CRD42023461140. An electronic databases search (Google Scholar, PubMed, Mendeley, Science Direct, and Scopus) yielded 225 relevant studies conducted in the last 15 years. A total of 15 studies were included in the qualitative synthesis, which analyzed the effects of different types of walking, such as Nordic walking, normal walking, and other unconventional walking programs, such as dog walking, ecological walking, walking with ankle weights, and continuous stair walking, on various health fitness variables in the older population. Nordic walking has been shown to be an effective exercise for improving body composition, cardiovascular fitness, motor abilities, and balance in the elderly individuals. Normal walking has also been found to positively influence body composition and muscle strength, while improving VO2max, balance, and flexibility. Unconventional walking programs such as dog walking, ecological walking, walking with ankle weights, and continuous stair walking have also shown positive results in improving aerobic endurance, leg strength, upper limb strength, and functionality of heart capacity. However, it is important to ensure proper intensity and volume of training to avoid potential negative outcomes, such as an increase in subcutaneous fat or overtraining. Overall, walking programs can be an effective and accessible way for elderly individuals to improve their physical fitness and overall health. The obtained results indicate the necessity of physical activity in old age in order to lead a quality and healthy life.

Keywords: *physical activity, walking program, fitness status, functional ability, older adults*

Introduction

Exercise and physical activity are widely promoted as effective means of improving the health and physical functioning of older adults and elderly people (Carlson et al., 1999; Evans, 2002; Singh, 2002). One of the biggest problems of modern society is the lack of physical activity (Pedišić, Jurakić, Rakovac, Hodak, & Dizdar, 2011). Regular physical activity significantly reduces the risk of developing coronary heart disease (CHD) (Mora, Cook, Buring, Ridker, & Lee, 2007), and non-insulin-dependent diabetes mellitus (Lynch

Correspondence:

Diellza Kelmendi
Kosovo Olympic Committee, Agim Ramadani Str. No. 253, 10000 Pristina, Kosovo
E-mail: diellza.kelmendi@noc-kos.academy

et al., 1996) over an average follow-up period of 8.5 years, with a dose-response relationship indicating that higher levels of physical activity offer greater protection against both conditions. Moreover, the studies reveal that higher adiposity levels and lower physical fitness are associated with an increased risk of developing diabetes, and that higher levels of physical fitness may mitigate the risk associated with higher adiposity levels to some extent. These findings emphasize the importance of engaging in regular physical activity for the prevention of CHD and diabetes, and highlight the complex interplay between physical activity, adiposity, and fitness in disease development (Berlin & Colditz, 1990; Helmrich, Ragland, Leung, & Paffenbarger Jr, 1991; Katzmarzyk, Craig, & Gauvin, 2007; Lindsted, Tonstad, & Kuzma, 1991). The level of physical activity is associated with health status, and in many scientific studies it has been proven that elderly people who engage in aerobic exercise are able to improve muscle strength, aerobic capacity, bone density, body composition and achieve a wide range of additional health benefits (Čaprić et al., 2025; Kelley & Kelley, 2001; Lemura, Von Duvillard, & Mookerjee, 2000; Palombaro, 2005; Špirtović et al., 2023). The health benefits of physical activity may be greater in the elderly compared to the younger population, as inactivity, falls, osteoporosis, functional limitations, disability, and depression are more common in older age (World Health Organization, 2010). Regular physical activity in older adults has profound physiological effects on the body. Aerobic exercise enhances cardiovascular fitness by increasing heart rate, cardiac output, and oxygen consumption, improving the delivery of oxygen and nutrients to the muscles. Strength training stimulates muscle hypertrophy, leading to increased strength and endurance, while also promoting bone health through the stimulation of bone mineral density (Nelson et al., 2007). At the cellular level, physical activity triggers mitochondrial biogenesis, improving energy production and metabolic function. Exercise also modulates inflammation, reducing the release of pro-inflammatory molecules and promoting an anti-inflammatory state. These physiological adaptations collectively contribute to improved cardiovascular health, muscle function, bone density, metabolic regulation, and inflammatory profile in older adults, emphasizing the importance of regular physical activity for maintaining overall health and well-being in this population (Nelson et al., 2007).

As life expectancy in the population around the world increases, there is interest in maintaining and improving physical activity levels and function in older adults (Chodzko-Zajko et al., 2009; Garber et al., 2011; Song, Yoo, Choi, & Kim, 2013; Takeshima et al., 2013). Physical activity programs are being implemented to improve quality of life, as older people prefer a higher quality of life rather than longevity (Hörder, Skoog, & Frändin, 2013; Phelan, Anderson, Lacroix, & Larson, 2014). Recreational sports not only encourage and enhance an individual's fitness components (Lee et al., 2011), but they also play a vital role in promoting both individual and societal health by emphasizing the positive effects of regular physical activity on chronic disease prevention, mental well-being, social integration, and economic benefits (Khan et al., 2012).

Available physical activity recommendations for older adults include aerobic endurance training (Bull et al., 2020). Aerobic training primarily activates mitochondrial biogenesis and angiogenesis leading to enhanced cardiovascular function and muscle metabolism (Beere, Russell, Morey, Kitzman, & Higginbotham, 1999). Although the impact of aerobic exercise on cardiovascular and metabolic function is well known, the influence of aerobic training on muscle function is currently being established. Some studies suggest that aerobic training leads to muscle hypertrophy and increases muscle strength in older adults (Harber et al., 2009). The observed muscle hypertrophy is linked to enhanced ability to produce muscle power, better myofiber contraction function, and an increase in the composition of myosin heavy chain (MHC) I protein (Harber et al., 2012).

Walking, as a recreational aerobic activity, improves motivation in older adults and it is one of the safest and most appropriate forms of activity for older adults (Ekkekakis, Hall, VanLanduyt, & Petruzzello, 2000). The World Health Organization (WHO) at least 150 minutes of aerobic physical activity of moderate intensity per week, or 300 minutes per week for additional health benefits for people over the age of 65 (World Health Organization, 2010). As one of the most frequently recommended, preferred and most represented activities, walking is easily feasible in everyday life with the possibility of maintenance even in old age (Morris & Hardman, 1999). While aging after age 50 modifies many gait characteristics, shorter steps and slower walking speed may be the most functionally meaningful (Jerome et al., 2015). Jerome et al. (2015) found that the degree of reduction in step length and walking speed is linked to the extent of health decline during aging. Previous studies have examined physiological indicators of aerobic walking effort, such as oxygen consumption, ventilation, lactate, muscle activation, and heart rate, as well as how effort affects physical activity in the elderly (LaRoche et al., 2018).

Increased cardiovascular, pulmonary, neuromuscular, and metabolic responses during a fixed-speed walk in older adults were associated with lower daily stepping time and fewer up-down transitions per day, suggesting that walking intensity plays a mediating role in their daily activity patterns; furthermore, Walking Effort was found to mediate the effects of age and BMI on Daily Activity, while the rating of perceived exertion and VO2 were not linked to Walking Effort or other activity parameters such as daily stepping time, energy expenditure, up-down transitions, or sitting/lying time (LaRoche et al., 2018).

Previous research has proven that older adults should aim for at least 150 minutes of moderate-intensity aerobic activity or 75 minutes of vigorous-intensity aerobic activity per week, in addition to muscle-strengthening exercises on two or more days, to mitigate the risk of chronic diseases and prioritize balance exercises for fall prevention (Nelson et al., 2007). Furthermore, a critical review highlighted the numerous benefits of regular physical activity in later life, including a reduced risk of functional limitations, improved physical performance measures such as walking speed and balance, and an enhanced overall quality of life (Keysor, 2003). Specifically, walking exercise training in elderly individuals has been shown to enhance immune response, with increased natural killer cell activity and production of interferon-gamma (Kimura et al., 2006). Forest walking, compared to city walking, significantly improves heart rate variability (an average increase of 56.1 ms) and reduces systolic blood pressure (a decrease of 3.7 mmHg) (Lee & Lee, 2014).

Nordic walking has demonstrated significant improvements in functional ability, indicated by a 9.9% increase in the 6-minute walk test distance, and noteworthy reductions in systolic blood pressure (7.6 mmHg) and diastolic blood pressure (4.1 mmHg) in elderly women (Mikalački, Čokorilo, & Katić, 2011). Lastly, regular dog-walking has been found to lead to significant improvements in physical capacity among elderly patients after myocardial infarction, with an average increase of 24.5 meters in the 6-minute walk test distance and a significant improvement in exercise duration on a treadmill by 3.8 minutes (Ružić, Miletić, Ružić, Peršić, & Laškarin, 2011). These findings emphasize the importance of engaging in various forms of physical activity to promote health and well-being in older adults.

Despite the considerable focus on walking and its influence on the fitness aspects of the elderly, there is a necessity for extensive research that integrates all available studies. Therefore, the aim of the study was to investigate, by searching the available literature, how different walking models affect the health-related fitness parameters of the elderly and which type of walking will yield the best results on specific fitness parameters of elderly individuals.

Methods

Search strategy

Studies were searched and analyzed in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Page et al., 2021). This review was performed following the methods documented in the protocol registered with the PROSPERO database prior to commencement (#CRD42023461140). The research included studies conducted from 2006 to 2021, covering the last 15 years and ensuring up-to-date findings that reflect current trends in the field. The search was conducted until December 15, 2021, with a final update in January 2022. The studies were searched through the following electronic databases: Google Scholar, PubMed, Mendeley, Science Direct, and Scopus. The keywords used in the search strategy were derived from the following key concepts "walking", "elderly persons", and "fitness status". The following keywords were used for the search: ("walking" OR "free walking" OR "nordic walking" OR "stair walking" OR "brisk walking") AND ("elderly" OR "older adults" OR "aging" OR "old people" OR "pensioners") AND ("fitness" OR "body fitness" OR "motor skills" OR "motor status") AND ("cardiorespiratory" OR "functional ability" OR "VO2max"). In order to include the relevant studies and analyze the obtained data, a descriptive method was used. Likewise, to increase sensitivity, we had to adapt to the particular database. The sensitivity, i.e., search filters in each database, was based on the year of publication, set from 2006 to 2021. Then, titles and abstracts were checked for relevance, and whole studies were retrieved and considered for inclusion. Scientific studies were searched exclusively in English, and only the original research (pre-post treatments and cross-sectional studies) with a sample of participants older than 55 years was considered.

Inclusion criteria

Eligibility criteria were presented according to the PICO model for eligibility criteria (participant, intervention, comparison, and outcome) (Nishikawa-Pacher, 2022). The studies that were included in the final analysis had the following criteria defined: 1. Original scientific studies; 2. Studies written exclusively in English; 3. Studies with older adults; 4. Interventionary studies involving animals or humans, and other studies that require ethical approval, must list the authority that provided approval and the corresponding ethical approval code. Studies where measuring instruments were applied in laboratory and field conditions; 5. Studies where accompanied walking is excluded for elderly people; 6. Studies examining the connection between walking results and fitness components; 7. Studies with experimental walking treatment.

Exclusion criteria

Studies were excluded from further analysis based on the following results: 1. Studies written in other languages; 2. Inadequate sample of respondents (athletes, younger people, people with disabilities, etc.); 3. Studies in which the results are not adequately presented or the parameters for further analysis are missing; 4. Studies where non-standardized measuring instruments were applied; 5. All studies that are not longitudinal.

Risk of bias assessment

The risk of bias was assessed using the PEDro scale (de Morton, 2009) to determine the quality of reviewed studies and the potential risk of bias. Two independent authors (A.M. and B.K.) assessed the quality and risk of bias using checklists. Concordance between reviewers was estimated using the k-statistic data to review the full text and assess relativity and risk of bias. In case of discordance as to findings of the risk of bias assessment, the obtained data were assessed by the third reviewer (A.A.V.), who also gave the final decision. The k rate of concordance between reviewers' findings was k=0.87.

Data extraction

The standardized data extraction protocol was applied (Cochrane Consumer and Communication Review Group's) (Prictor & Hill, 2013), and for each research, the following parameters are shown: 1. First author and year of publication; 2. Information about respondents, such as sample size, gender, and ethnicity; 3. Experimental treatment (duration, frequency, scope, intensity); 4. Variables; 5. Results; 6. Conclusion. Data extraction was conducted independently by two authors (A.M. and B.K.), and the lists of references from previously assessed and original research were also reviewed. After that, each author cross-examined the found studies, which were then taken for further analysis or rejected. After a detailed identification process, studies were considered to be relevant if they met the inclusion criteria.

Results

Quality of the studies

Of the total number of studies that were included in the qualitative synthesis, and based on the points each study scored on the PEDro scale, the final study assessment scores were defined. According to Maher et al. (2003) a score between 0–3 points, that study will be classified with "poor" quality, 4–5 points with "fair" quality, 6–8 points with "good" quality, and 9–10 points with "excellent" quality. Of all studies included in this systematic review, 2 studies showed fair quality, and 13 studies showed good quality, as shown in Table 1. The average score of all studies is 6.4, which means good quality.

Table 1. PEDro scale results

	Criterion											
Study	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**Σ**
Audette et al. (2006)	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	6
Kimura et al. (2006)	N	N	N	N	N	N	N	Y	Y	Y	Y	4
Kubo et al. (2008)	Y	N	N	Y	N	N	N	Y	Y	Y	Y	6
Hagner et al. (2009)	N	Y	N	Y	N	N	N	Y	Y	Y	Y	6
Yoo et al. (2010)	Y	Y	N	Y	N	Y	N	Y	Y	Y	Y	7
Mikalački et al. (2011)	N	Y	N	Y	N	N	N	Y	Y	Y	Y	6
Ružić et al. (2011)	N	N	N	Y	N	N	N	Y	Y	Y	Y	5
Magistro et al. (2013)	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	7
Song et al. (2013)	Y	Y	N	Y	N	Y	N	Y	Y	Y	Y	7
Prakhinkit et al. (2014)	Y	Y	N	Y	N	Y	N	Y	Y	Y	Y	7
Chen et al. (2017)	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	6
Rogers et al. (2017)	Y	Y	N	Y	N	Y	N	Y	Y	Y	Y	7
He et al. (2018)	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	6
Gomeñuka et al. (2019)	Y	Y	Y	Y	N	Y	N	Y	Y	Y	Y	8
Gomeñuka et al. (2020)	Y	Y	Y	Y	N	Y	N	Y	Y	Y	Y	8

Legend: 1—eligibility criteria; 2—random allocation; 3—concealed allocation; 4—baseline comparability; 5—blind subject; 6—blind clinician; 7—blind assessor; 8—adequate follow-up; 9—intention-to-treat analysis; 10—betweengroup analysis; 11—point estimates and variability; Y—criterion is satisfied; N—criterion is not satisfied; Σ—total awarded points.

Selection and characteristics of studies

A search of electronic databases and scanning the reference lists yielded 986 studies. Lastly, a total of 15 full-text studies were included in the systematic review. The study selection process is shown in Figure 1.

These 15 studies included in the systematic review are presented in Table 2. Scientific studies selected for detailed analysis usually had one experimental and one control group. The oldest research in this review is from 2006 (Audette et al., 2006; Kimura et al., 2006), and the most recent research was published in 2020 (Gomeñuka et al., 2020). The total number of respondents is 611, and the number of respondents is quite different in all papers. The smallest number of respondents was 17 (Rogers, Rogers, Fujita, Islam, & Takeshima, 2017), while the largest number of respondents was 67 (Song et al., 2013). The youngest respondents were 58.5±6.90 years

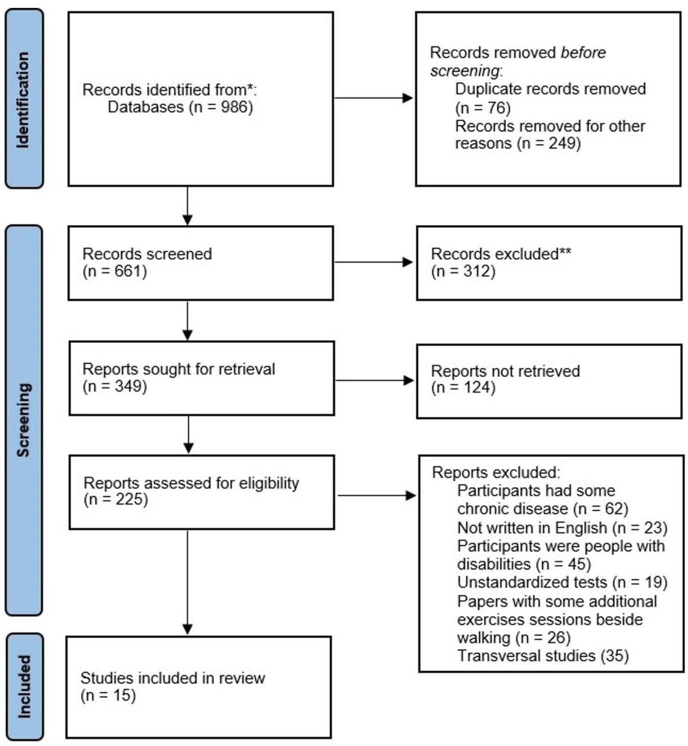

FIGURE 1. Shematic represantation of the search strategy for studies

old (Mikalački et al., 2011), while the oldest were 74.8±1.7 years old 45 (Prakhinkit, Suppapitiporn, Tanaka, & Suksom, 2014). The vast majority of studies measured body composition, maximal oxygen consumption, muscle strength, and blood pressure. The duration of the program in most papers was 12 weeks, based on which it can be concluded to what extent different walking models affect the fitness components. The shortest experimental treatment was 8 weeks (Gomeñuka et al., 2019; Gomeñuka et al., 2020; Rogers et al., 2017), and the longest treatment was 52 weeks (Ružić et al., 2011). The highest frequency was five times a week (Kimura et al., 2006) while the lowest frequency was twice a week (Chen, Hsieh, Tseng, Ho, & Nosaka, 2017; Kubo et al., 2008). In all other papers, the frequency was three times a week. The most common forms of walking were Nordic walking (Gomeñuka et al., 2019; Gomeñuka et al., 2020; Hagner, Hagner-Derengowska, Wiacek, & Zubrzycki, 2009; He et al., 2018; Mikalački et al., 2011; Song et al., 2013) and normal walking (Audette et al., 2006; Gomeñuka et al., 2019; Gomeñuka et al., 2020; Kimura et al., 2006; Rogers et al., 2017; Song et al., 2013; Yoo, Jun, & Hawkins, 2010). A smaller number of studies have recorded some other models of walking, such as fast walking, stair climbing, economical walking, Buddhist walking meditation, and dog walking (Chen et al., 2017; He, Wei, & Can, 2018; Magistro, Liubicich, Candela, & Ciairano, 2014; Prakhinkit et al., 2014; Ružić et al., 2011). All papers investigated the effect of walking on fitness in the elderly.

Table 2. Review of studies

FIRST AUTHOR AND YEAR	SAMPLE OF PARTICIPANTS			EXPERIMENTAL TREATMENT				VARIABLES	RESULT	CONCLUSION
	n	Sex	Age (yrs)	Dur. (week)	Freq. (week)	Training volume (min)	Exercise intensity			
Audette et al. (2006)	19	W	71.4±4.5	12	3x	40	50–70% of max heart rate	Normal walking, VO2max, HRV, Flexibility, single leg balance, strength	WK↔ VO2max, flex; WK↕SLB, Str	The results of this study indicate an improvement in VO2max and flexibility with the help of normal walking, while the results of tested strength and balance show no improvement with the influence of the treatment.
Kimura et al. (2006)	8 22	M W	71.6±7.8	12	5x	30	80% of max heart rate	Normal walking, body composition, VO2, basal metabolism, Salivary and Blood variables	WK↕BC WK↕Vo2	There was no major change between treatments before and afterwards in weight, as well as significant changes in VO2. Peak VO2 was 1143.4 ± 236.9 and 1176.2 ± 264.2.
Kubo et al. (2008)	35	M, W	68.4±5.6	24	2x	15-40	walk at a self-selected, comfortable pace	Normal walking, body composition, muscle thickness for knee, strength	WK↔BC WK↔Str WK↔MTK	The results of this research suggest that walking at a free pace affects the hypertrophy and strength of the muscles of the lower limbs in the elderly.
Hagner et al. (2009)	53	W	62.5±5.43	12	3x	90	average pulse rate between 100 and 140 bpm	Nordic walk, body composition, blood sample	NW↔BC NW↔BMI	The results of this study showed that Nordic walking can improve body composition and reduce body mass index. It also affected the parameters of the blood count.

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FIRST AUTHOR AND YEAR	SAMPLE OF PARTICIPANTS			EXPERIMENTAL TREATMENT				VARIABLES	RESULT	CONCLUSION
	n	Sex	Age (yrs)	Dur. (week)	Freq. (week)	Training volume (min)	Exercise intensity			
Yoo et al. (2010)	21	W	70.9±2.7	12	3x	45	60% of heart rate reserve	Normal walking, strength, balance, agility, aerobic endurance, body composition, bone metabolism	WK↔Str WK↔AE WK↔BC	The results revealed significant changes in upper limb strength. Leg strength, aerobic endurance and body composition are improved with walking.
Mikalački et al. (2011)	60	W	58.5±6.90	12	3x	15-55	50% to 90% of maximal heart rate	Nordic walking, HRR, BPS, BPD, FITIND, VO2max, BMI	NW↔HRR, BP; NW↔FITIND, VO2max	In this study, a three-month treatment with Nordic walking reduced the resting pulse values and blood pressure, while it improved values of the fitness index and VO2max.
Ružić et al. (2011)	29 30	M M2	72.5±7.7	52	3x	15 30	x	Dog walking, normal walking, functional cardiac capacity	DW↔FCC WK↔FCC	The results indicate a significant improvement in the functionality of heart capacity in both tested groups, which indicate the importance of regular daily physical activity.
Magistro et al. (2013)	26 37	M W	72.0±4.5	16	3x	75	40%–45% of max heart rate	Ecological walking, aerobic endurance, lower limb strength, balance and mobility	EW↔AE EW↔LLS EW↔Bal EW↕Mob	The results of the study showed that ecological walking improves aerobic endurance by 25%, as well as lower limb strength (33%) and balance (13%). While the improvement in flexibility did not show statistical significance (6%).
Song et al. (2013)	67	W	67.8±2.5	12	3 x	30-50	x	Nordic walking normal walking grip strength sit to stand test, total cholesterol triglyceride HDL cholesterol body composition	NW↔BMI NW↔BF% NW↔BM NW↔BS WK↔BMI WK↔BF%	In this study, the results show that NW and WK improve body mass index results, reduce body fat percentage. It also affects weight loss.
Prakhinkit et al. (2014)	45	W	74.8±1.7	12	3x	30	40%–50% heart rate reserve	Buddhism walking meditation, normal walking, physical fitness, body composition, muscle strengths, blood pressure, flexibility, strength	BWM↔PF BWM↔Flx BWM↔Str BWM↔BP	A Buddhist-based walking meditation that included arm swing exercises, was effective in improving impaired functional fitness and vascular dysfunction, which affected depression in older people.

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FIRST AUTHOR AND YEAR	SAMPLE OF PARTICIPANTS			EXPERIMENTAL TREATMENT				VARIABLES	RESULT	CONCLUSION
	n	Sex	Age (yrs)	Dur. (week)	Freq. (week)	Training volume (min)	Exercise intensity			
Chen et al. (2017)	30	W	60–82	12	2x	60	88.6 ± 7.8 bpm	Descending stair walking, body composition, HR, BPS, BPD, balance, strength, BM, FPF	DSC↔BC DSC↔BPS, BPD; DSC↔BAL DSC↔BM DSC↔Str	The results of the study indicate improved results in blood pressure, body composition, balance and muscle strength with the help of continuous stair climbing.
Rogers et al. (2017)	17	W	63-70	8	3x	20-30	x	Normal walking, body composition, strength,	WK↔BC WK↔Str	The results of the study show that walking for 20 to 30 minutes, three times a week, for two months, can improve body composition and muscle strength.
He et al. (2018)	46	x	55–60	12	3x	60	45%-55% of max heart rate	Brisk walking, blood pressure, VO2max	BW↔BP BW↔VO2max	Brisk walking can reduce size increase in blood pressure during exercise of different intensities and may reduce the risk of acute cardiovascular diseases in elderly patients with essential hypertension. It also affects VO2max
Gomeňuka et al. (2019)	33	x	68±3.9	8	3x	15	55%-65% of max heart rate	Nordic walking, normal walking, body composition, Skinfolds, balance, WAI/HEI, blood pressure, dynamic stability, VO2max	NW↔BC NW↔Bal NW↔VO2max; WK↔BC WK↔Bal WK↔VO2max	The results showed that NW and WK can improve balance, body composition (lower percentage of subcutaneous fat), as well as maximum oxygen consumption.
Gomeňuka et al. (2020)	33	x	64-70	8	3x	60	70 to 105% of the max heart rate	Normal walking, Nordic walking, body composition, WAI/HEI, speed, EMG, cardiorespiratory, functional mobility	NW↔CR WK↔CR NW↔ULS, LLS; W↔LL NW↔FM WK↔FM	It can be concluded that NW is an effective training technique as WK for sedentary older people who need an increase on their cardiovascular endurance. Also, after training in walking with and without canes, older people increase optimal walking speed and the speed of energy consumption has changed.

Legend: n- number of respondents; M- man gender; W- woman gender; x- how many times a week; ↔ - correlation of results; ↕- without correlation of results; WK- normal walking; NW- nordic walking; EW- economical walking; BWM- a walking meditation based on Buddhism; VO2max- maximum oxygen con-sumption; BS - basal metabolism; HRV, HR- Heart rate; BPS- systolic blood pressure; BPD- diastolic blood pressure; BP- blood pressure; SLB- balance on one leg; Str.- muscle strength; MTK- knee muscle hypertrophy; BC- body composition; BMI- body mass index; AE- aerobic endurance; DW- walking the dog; FFC- functional cardio capacity; HRR- resting heart rate; FITIND- Fitness index; LLS- lower limb strength; ULS- upper limb strength; Bal- balance; Mob.- mobility; BF%- percentage of adipose tissue; BM- body mass; PF- Physical fitness; Flex- flexibility; DSC- climbing stairs; CR- cardiovascular system; FM- ffunctional mobility; bpm- the number of heart beats per minute.

Discussion

The aim of the study was to investigate, by searching the available literature, how different walking models affect the fitness of the elderly and which type of walking will yield the best results on specific health-related fitness parameters of elderly individuals. In all the studies, which this systematic research included, the association between walking variables and the fitness of the elderly was proven. Research that analyzed Nordic walking showed that the significance of the positive impact on body composition results, such as a reduction in body mass index, was confirmed (Gomeñuka et al., 2019; Gomeñuka et al., 2020; Hagner et al., 2009; Kubo et al. al., 2008; Mikalački et al., 2011; Song et al., 2013), decrease in fat percentage (Gomeñuka et al., 2019; Song et al., 2013), decrease in body weight (Song et al., 2013), as well as an increase in muscle percentage (Chen et al., 2017; Rogers et al., 2017). Variables that showed fitness were drastically improved compared to the initial measurement. Maximal oxygen consumption improved (Audette et al., 2006; Gomeñuka et al., 2019; He et al., 2018; Kimura et al., 2006; Mikalački et al., 2011), and blood pressure (He et al., 2018; Mikalački et al., 2011; Prakhinkit et al., 2014; Ružić et al., 2011). The programs also showed improvement in balance (Chen et al., 2017; Gomeñuka et al., 2019; Magistro et al., 2014), flexibility and mobility of muscles and joints (Magistro et al., 2014; Prakhinkit et al., 2014), while the improvement of muscle strength was proven by the largest number of papers (Audette et al., 2006; Gomeñuka et al., 2020; Prakhinkit et al., 2014; Rogers et al., 2017; Yoo et al., 2010).

Nordic walking is generally accepted as great exercise for improving a wide variety of health-related fitness parameters, and positive results were observed in all gathered papers. Hagner et al. (2009) found that a 12-week Nordic walking program can influence the reduction of BMI ($p<0.05$). The subjects trained 3 times a week for 90 minutes, with an intensity of 100-140 bpm. These results were confirmed by a relatively similar research (Mikalački et al., 2011), which also implemented a program 3x per week for 12 weeks with an intensity of 50-90 HR but with a training duration of 15-55 minutes. It was found that Nordic walking can have an effect on heart rate at rest, blood pressure, and VO2max ($p<0.05$). Besides that, Song et al. (2013) concluded that both Nordic and normal walking can improve BMI and reduce body fat %. Grip strength, sit-to-stand, and arm curl tests also showed significant improvement. In addition, arm curl was significantly increased in the Nordic walking group compared to the normal walking group and the control group, which is expected since the difference between those two programs is the activation of the upper limbs during Nordic walking. The results presented by Gomenuka et al. (2019) showed that Nordic walking and normal walking can improve balance, improvements in the self-selected walking speed (primary outcome, $p=0.011$, $ES=0.42$), static balance ($p<0.05$) and dynamic variability ($p<0.05$) were found in both groups. In accordance with this is research conducted by Gomenuka et al. (2020) proved that Nordic walking, implemented 3x a week, during the 8 weeks, with training duration of 60 min, and intensity of 70-105% of Hrmax, is an effective method for sedentary older people who need an increase on their cardiovascular endurance. The benefits of Nordic walking can also be confirmed in the younger population, where the improvement and increase of all the mentioned variables can be seen (Bullo et al., 2018; Cebula et al., 2017; Jasiński et al., 2015).

The studies that observe the influence of normal walking on the fitness of the elderly proved that it could have an effect on the results after the experimental treatment. In paper of Rogers et al. (2017) during 8 weeks of experiment, with the frequency of 5 times a week, 20 to 30 minutes of training, normal walking positively influenced results of body composition and muscle strength. The results of study (Audette et al., 2006) indicate an improvement in VO2max and flexibility, while the results of tested strength and balance showed no improvement with the influence of treatment. Hypertrophy and strength of muscles of lower limbs can be affected by 24 weeks of normal walking two times a week (Kubo et al., 2008).

Body composition improved, especially in body mass index variables (Gomeñuka et al., 2019; Song et al., 2013), reduced body fat percentage (Gomeñuka et al., 2019; Rogers et al., 2017; Song et al., 2013), and increased muscle percentage (Gomeñuka et al., 2019; Rogers et al., 2017; Song et al., 2013). Motor abilities were improved, and the greatest significance was shown in the increase in strength (Audette et al., 2006; Rogers et al., 2017; Yoo et al., 2010). It has been proven that improvements in balance (Gomeñuka et al., 2019), and flexibility (Audette et al., 2006) results can be influenced, while one study did not show improving body composition and maximal oxygen consumption (Kimura et al., 2006). Research that addressed the impact of normal walking on fitness in younger population had a significant improvement (Karstoft et al., 2013; Silvernail, Milner, Thompson, Zhang, & Zhao, 2013; Villarrasa-Sapiña, Serra-Añó, Pardo-Ibáñez, Gonzalez, & García-Massó, 2017).

In contrast to previously mentioned papers are results which showed different outcomes of the programs. Kubo et al. (2008) have determined that after 24 weeks of walking training there may even be negative results, specifically an increase in subcutaneous fat. In their work, the respondents had training twice a week for 15-40 minutes. The negative results were probably caused by the intensity of the training because the subjects were allowed to determine their own comfortable pace. Given that respondents without training experience and knowledge probably did not do the training at a pace sufficient to reduce subcutaneous fat. In addition, they determined that such a training program can influence hypertrophy and strength, which can be explained by simply activating people who have not had any activity or training for a long period of time that would maintain muscle hypertrophy. Another work that did not show a positive impact was the one conducted by Kimura et al. (2006). They didn't show any improvement in body composition and VO2max after 12 weeks. The reason might be a big volume of 5x a week with relatively high intensity (80%) which might lead to overtraining. This might occur especially if participants are older and without any activity so they can't adapt to that level of physical activity. Some other papers which implemented not so conventional walking programs also came to a positive conclusion. Audette et al. (2006) showed improvement in VO2max and flexibility ($p<0.08$) compared to the control group with no improvement in strength and balance as it was expected since program did not include exercises which will improve those variables. Two papers (Prakhinkit et al., 2014; Yoo et al., 2010) proved that normal walking (Yoo et al., 2010) and buddhist-based walking meditation that included arm swing exercises (Prakhinkit et al., 2014) with intensity of 40-60% of heart rate reserve, can improve upper limb strength, leg strength, aerobic endurance and body composition. In accordance with this is another work published by Ruzic et al. (2011) which proved that dog walking 15-30 min a day, 3x a week for 52 weeks, can significantly improve the functionality of heart capacity.

Magistro et al. (2014) proved that Ecological walking performed 75 min a day, 3x a week for 16 weeks, with intensity 40-45% HR can improve aerobic endurance by 25%, as well as lower limb strength (33%) and balance (13%; $p<0.05$). Chen et al. (2017) suggested that blood pressure, body composition, balance and muscle strength can be significantly improved ($p<0.05$) with the help of continuous stair climbing after performing it 2x a week for 12 weeks, with training duration of 60 min and with intensity of 88.6±7.8 bpm. He et al. (2018) investigated the influence of 12 weeks, 3x, 60 min, 45-55% of Hrmax, brisk walking can reduce size increase in blood pressure during exercise of different intensities and may reduce the risk of acute cardiovascular diseases in elderly patients with essential hypertension as well as increasing VO2max.

Yoo, Jun and Hawkins (2010) inspected walking with ankle weights can have and proved that significant main effects of time were found for total fat (23.2±6.6 vs. 21.3±5.7 kg, $p<0.01$), leg fat (6.4±0.3 vs. 5.0±1.5 kg, $p<0.01$), and trunk fat (10.9±3.1 vs. 10.0±2.8 kg, $p<0.01$). A significant time × group interaction was found for trunk fat ($p<0.05$, $\eta p2=0.24$). Post hoc tests indicated significant changes in the exercise group for trunk fat (11.9±3.1 vs. 10.4±2.5 kg, $p=0.00$) but not in the control group (9.9±3.0 vs. 9.6±3.1, $p=0.46$).

In modern life, a sedentary lifestyle adversely affects people's health. By correcting the habit and introducing physical activity, such as a different model of walking, into the daily routine, the risk of various heart diseases is reduced, osteoporosis slows down, blood test results of diabetes are improving, the psychological aspect is more stable and the motivation for other activities in the elderly increases.

One of the main limitations of this review is that the selected studies primarily focus on Nordic and normal walking treatments, with limited research conducted on other walking models such as brisk walking, dog walking, stair climbing, economic walking, and Buddhist-based walking. As a result, further experimental studies should be conducted on these different walking models to examine their impact on the fitness of the elderly population. Additionally, this systematic review excluded studies with persons with disabilities, highlighting the need for future research on the impact of different walking models on this population. Moreover, future studies could consider analyzing the results by gender separately or comparing them to identify the potential benefits of different walking models. Despite these limitations, this study makes a significant contribution to the understanding of walking models and their impact on the fitness of elderly individuals.

Conclusion

In conclusion, this systematic research provides strong evidence for the positive effects of Nordic walking, normal walking, and other unconventional walking programs on various health-related fitness variables in the elderly population. Nordic walking has been shown to be an effective exercise for improving body composition, cardiovascular fitness, motor abilities, and balance in the elderly individuals. Normal walking has also been found to positively influence body composition and muscle strength, while improving VO2max, balance, and flexibility. Unconventional walking programs such as dog walking, ecological walking, walking with ankle weights, and continuous stair walking have also shown positive results in improving aerobic endurance, leg strength, upper limb strength, and functionality of heart capacity. However, it is important to ensure proper intensity and volume of training to avoid potential negative outcomes, such as an increase in subcutaneous fat or overtraining. Overall, walking programs can be an effective and accessible way for elderly individuals to improve their physical fitness and overall health.

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Conflict of Interest
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