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Original Research Article

The Acute Effects of Preferred Music on Self-Selected Usual and Maximum Gait Speed on Community-Dwelling Older Adults

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ABSTRACT

Introduction: Slower gait speeds are linked to increased fall risk, frailty, decreased risk of independence, and developing chronic diseases in the older adult population. Previous research highlights the importance of maintaining usual gait speed to decrease mortality and to maintain health status. This study aimed to determine if self-selected music implementation increases gait speeds in community-dwelling older adults, measuring both usual and maximum gait speeds. **Methods:** Thirty participants (mean age 68.8 and standard deviation of 5.3 years) completed a 10-m gait test, one at their usual gait speed and another at their maximum gait speed. The order of music vs. non-music intervention was counterbalanced across the participants. The same two researchers timed the duration that it took for each participant to walk over a 10-m distance using stopwatches and the average time was utilized to compute gait speeds. **Results:** Using a paired sample t test, there was no difference in either usual and maximum gait speeds between music and non-music intervention. When using a two-way repeated measures analysis of variance, there was a significant interaction between music intervention (music vs. non-music) and body mass index (BMI) classifications (normal vs. overweight vs. obese) on usual gait speed, $F(2,27) = 3.73$, MSE = 0.003, $p = .037$. It was found that there was a moderate inverse correlation between BMI ($kg \cdot m^{-2}$) and the difference in usual gait speeds between music and non-music intervention. **Conclusion:** Findings suggest that individuals in normal and overweight BMI classifications may exhibit greater increase in usual gait speed with music implementation compared to walking without music, and participants classified as obese may show no change.

KEYWORDS: Body Mass Index, Gait Speed, Music Intervention.

Introduction

Successful aging is defined as progressing through life with minimal signs and symptoms suggestive of chronic conditions such as cardiovascular disease, hypertension, and diabetes[1]. If a chronic condition is present, maintenance of this primary condition fits successful aging as well. Prevention of developing secondary conditions, such as obesity, psychological illnesses, mental health, pain, fatigue etc, is another component of successful aging that healthcare and rehabilitation professionals work to promote for their patients. The Center for Disease Control[2] predicts that the number of older adults in the US aged 65 years and older will exceed 80.8 million by 2040. Therefore, understanding how this population progresses through the aging process is critical. Usual gait speed is defined as the speed at which one usually walks down the street[3]. Previous research highlights the importance of maintaining usual gait speed as a tool in predicting the mortality and health status of individuals. On average, this population has usual gait speeds[4] between 0.90 and 1.30 ms^{-1} when usual gait speeds of less than 0.82 ms^{-1} are associated with a 23% increased risk of mortality[5]. Similarly, Studenski et al.[6] found that individuals ambulating greater than 1.0 ms^{-1} are expected to live longer, while walking at speeds greater than 1.36 ms^{-1} results in increased survival rates. Slower gait speeds are also linked to increased fall risk, frailty, decreased risk of independence and developing chronic diseases in the older adult population[6-9]. Kyrdalen et al.[8] found that increased fall risk is related to a gait speed less than 1.0 ms^{-1}. Another study confirms increased fall risk and mortality are amplified in older individuals with slower usual gait speeds[9]. Frailty is recognized as increased vulnerability from a decline in the functional capacity associated with aging, indicated by five risk factors: low energy levels, reduced grip strength and ability to perform activities of daily living (ADL), unintentional weight loss of more than 10 pounds, unusual exhaustion, and reduced walking speed. The presence of three or more risk factors is linked to increased mortality, fall risk, hospitalization, and decreased mobility. A study by Castell et al.[10] looked at the early diagnosis of frailty in the primary care setting by analyzing gait speed, finding a high prevalence of frailty in individuals 75 years and older. They determined gait speeds less than 0.8 ms^{-1} as a sufficient method to diagnose frailty. All of the previous literature suggests that the prevalence of frailty, fall risk, and decreased quality of life increases with slower ambulation speeds.

Maximum gait speed is defined as walking as fast as possible safely. Walking at maximum speed has shown to benefit age-related declines in function compared to walking at usual speed[11]. Additionally, maximum walking speed has been linked to improving walking dysfunction commonly seen in individuals who have undergone a stroke. Awad et al.[12] concluded that training maximum walking speeds increases long-distance walking function.

Preferred music is defined as songs within individuals' previously described genre that they would select to listen to while exercising. The study by De Bartolo et al.[13] exhibited more significant results in individuals walking to a genre they enjoyed listening to than music genres they did not particularly enjoy. The same study stated the importance of matching selected music preference tempo to gait speed would have the most significant impact on physical activity levels. Incorporating preferred music into exercising could potentially motivate individuals to push themselves harder and gain more exercise benefits compared to exercising without music.

Gaps in the literature exist around different modalities and interventions that have been identified as efficient ways to combat slow walking speeds. Prior research involving music implementation targeting younger adults required participants to synchronize their stepping rate to the music selection[14]. Those same studies have chosen the song selection for each participant, therefore leaving the preferred music genre as an area that needs further exploration. Other research has suggested that music is an environmental motivator that will encourage older adults to engage in physical activity, therefore decreasing their risk of mortality[15]. Lastly, studies have researched music intervention in relation to usual gait speed but not maximum gait speed[13-16].

This study aims to determine if music implementation increases gait speed in community-dwelling older adults. If the results support that preferred music impacts maximum gait speed, then preferred music could be played at physical activity recreation centers, rehabilitation centers, and hospital settings to incline individuals to pick up their speed of physical activity. Preferred music could be utilized as a form of exercise prescription for clients in order to motivate them to increase the duration or intensity of exercise. Faster gait speed is related to lower mortality risk, so if participants walk faster while listening to self-selected music, this may decrease their mortality risk. If preferred music impacts maximum gait speed, an individual's maximum gait speed with or without music could be used as an assessment tool to assess an older adult individual on their motor abilities and ambulation.

Methods

Participants

The research participants were recruited from a fitness program through a university in the Midwest, along with community members. To initiate this recruitment, a brief explanation of what the participants would have to do was given to fitness program members and the community members. The researchers did not mention the use of music within the brief explanation to limit bias. Participants must be 55 years and older, ambulate without an assistive device, and be able to remove hearing aids if utilized. Activity levels were not taken into account before the volunteers participated in the study. Out of the 42 individuals asked, 30 participants joined the study after screening and eligibility requirements. Participants' age, height, weight, waist circumference, and body mass index (BMI) were recorded during their baseline measurements. After data collection, these characteristics were used to see if significant relationships exist between the participants and their usual and maximum gait speeds. The International Review Board approved the study protocol, and all participants reviewed and signed the consent forms.

Instrumentation

Instruments used in the study include the InBody Bioelectrical Impedance Analysis (BIA) for weight measurement in kilograms and a retractable tape measure used to measure waist circumference recorded in centimeters. The measurement was taken around the abdomen at the level of the umbilicus. Participants found their usual gait speed in the baseline measurement on a Woodway USA treadmill, covering the speed icon. Two treadmills were used for usual gait speed baseline measurements. A previous study measured gait speed using a 4-m and 10-meter length. Both measurements were verified to have excellent test-retest reliability, determined by their intraclass correlation coefficients ranging between 0.96 to 0.98[17]. The same study reviewed the validity of using a stopwatch compared to an automatic timer to record the time elapsed during the measured length. The intraclass correlation coefficients were found to range between 0.99 to 1.00, which concluded that using a stopwatch to measure gait speed was comparable to utilizing an automatic timer[17]. The researchers used handheld stopwatches manufactured by Learning Resources to time the 10-m distance. Participants wore Apple wired earbuds in all six trials to administer music, and the cell phone was positioned in a belt waist pack around the lumbar region. All participant characteristics and measurements were entered into an Excel spreadsheet.

Procedure

To begin, baseline measurements were collected in a laboratory. Collecting baseline measurements, signing consent forms, choosing preferred music genre to exercise to, and filling out a health history questionnaire took each participant 15 minutes to complete. Baseline measurements included height, weight, and waist circumference. Participants also walked on a treadmill for five minutes with the speed icon covered, and estimated their usual gait speed by increasing and decreasing speed as necessary until they reached their self-selected usual walking speed. All baseline information was recorded in an Excel spreadsheet. Participants were then asked to sign up for a timeslot when the second session could be completed. The following week, they performed usual gait speed and maximum gait speed measurements on an indoor track, taking a total of 10 minutes. A coin was flipped to determine if the participant would start with or without music implementation first. Headphones were worn by participants during all six trials. Trials one and two were omitted due to the learning effect. During trial one, participants were asked to walk at their usual walking speed, as if they were walking down the street. They began at the designated starting point and each participant walked 14 meters, with a two meter acceleration zone and two meter deceleration zone at the end. The same two researchers timed the 10-m between the acceleration zone and deceleration zone. The averages were taken from each of the two researchers' stopwatches. During trial two, the participants were asked to walk as fast as they could in a safe manner. They walked 14 meters total, with 10-m recorded by researchers. Times were recorded and entered into an Excel spreadsheet that calculated the average maximum speed. The procedures of trial one and two were repeated twice in the same order of usual gait speed followed by maximum gait speed for a total of six trials. The music intervention was implemented either during trials three and four or trials five and six. To determine the song used for each participant's music intervention, researchers used the participant's preferred genre and asked them their favorite song to exercise to. Spotify was the chosen platform to administer the music implementation.

Statistical Analyses

All analyses were performed with two-way repeated measures ANOVA, descriptive statistics, sample t-tests, and frequency analyses.

Results

Usual and Maximum Gait Speeds between Non-Music and Music Interventions

Out of the 30 participants that signed up to participate in the study, all completed the study. Table 1 presents the participant characteristics including self-selected treadmill walking speed at baseline by BMI classifications. A frequency analysis was used to identify the number of participants in each of the continuous variables. Using an alpha level of 0.05, the paired sample t-test did not indicate a significant increase from non-music usual gait speed (6.20 ± 0.72 mph) and music usual gait speed (6.14 ± 0.80 mph; t = 0.95, p = .348). Using an alpha level of 0.05, the paired sample t-test did not indicate a significant increase from non-music maximum gait speed (4.80 ± 0.72 mph) and music maximum gait speed (4.80 ± 0.81 mph; t = 0.12, p = .906).

Impact of Body Mass Index Classifications on Gait Speeds

Usual gait speed. Using an alpha level of 0.05, the two-way repeated measure ANOVA indicated a significant interaction between intervention (music vs. non-music) and BMI classifications (normal vs. overweight vs. obese) on usual gait speed, $F(2,27)$ = 3.73, MSE = 0.003, p = .037. There was no main effect of music intervention on usual walking speed, $F(1,27)$ = 3.55, p = .070. No main effect was found for BMI, $F(2,27)$ = 1.66, MSE = 0.08 , p = .210. Table 2 presents means and standard deviations of gait speed in ms^{-1} across all participants categorized into three BMI classifications. Simple effect paired samples *t* tests were used to compare usual gait speed between music and non-music for each BMI category. A Bonferroni adjusted alpha of .0167 was used to determine significance for each paired samples *t* test. None of the paired samples t tests indicated significant difference in usual gait speed between music and non-music interventions ($p < .0167$).

Maximum gait speed. In terms of maximum gait speed, a two-way repeated measures ANOVA indicated a significant interaction between music intervention (music vs. non-music) and BMI (normal vs. overweight vs. obese), F (2,27) = 4.22, MSE = 0.01, p = .025. There was no significant main effect for music intervention on maximum gait speed, F (1,27) = 0.62, p = .440. No main effect was examined for BMI, F (2,27) = 1.55, MSE = 0.22, p = .230.

Simple effect paired samples *t* tests were used to compare maximum gait speed between music and non-music for each BMI category. A Bonferroni adjusted alpha of .0167 was used to determine significance for each paired sample *t* test. None of the paired samples t tests indicated significant difference in maximum gait speed between music and non-music interventions ($p < .0167$).

A Pearson Product Moment Correlation analysis revealed a moderately negative correlation between BMI and changes in usual walking speed (r = -.446, p = .014). Indicating that individuals with a greater BMI have the smallest difference in usual gait speed between non-music and music intervention.

Table 1. Participant Characteristics by Body Mass Index

	Normal (n = 10)	Overweight (n = 8)	Obese (n = 12)	Total (N = 30)
Age (years)	68.8 ± 4.9	68.8 ± 3.4	68.8 ± 6.7	68.3 ± 5.3
Waist Circumference (cm)	81.6 ± 10.1	82.6 ± 28.7	114.3 ± 11.3	94.9 ± 23.2
Height (cm)	166.3 ± 7.5	173.5 ± 11.0	172.2 ± 11.7	170.6 ± 10.4
Weight (Kg)	62.8 ± 7.8	80.4 ± 9.7	103.0 ± 17.4	83.5 ± 21.6
Self-Selected Treadmill Speed (ms^{-1})	1.22 ± 0.25	0.95 ± 0.29	1.08 ± 0.33	1.09 ± 0.31

Comparison between BMI classification between age, waist circumference, height and weight of the participants. Values are mean ± SD.

Table 2. Usual and Maximum Walking Speed by Intervention (non-music vs music) and Body Mass Index

	Normal (*n* = 10)	Overweight (*n* = 8)	Obese (*n* = 12)
Non-music usual	1.70 ± 0.22	1.54 ± 0.12	1.64 ± 0.20
Music usual	1.75 ± 0.21	1.60 ± 0.11	1.61 ± 0.27
Non-music max	2.21 ± 0.34	1.99 ± 0.24	2.153 ± 0.34
Music max	2.33 ± 0.43	1.99 ± 0.26	2.10 ± 0.36

Note. Comparison between BMI classification to music and no music intervention on usual and maximum gait speed in miles per hour. Values are mean ± SD.

Discussion

The purpose of this research study was to investigate the impact of music intervention on usual and maximum gait speed. The researchers' hypothesized that implementing preferred music would increase usual and maximum gait speed. The hypothesis was not supported by our results. This study is unique because each participant chose their preferred song for the music intervention.

Descriptive statistics

Several previous studies and their findings align with our study in terms of descriptive statistics. Malatesta et al.[18] examined the effects of treadmill and overground walking on preferred walking speed in older adults aged 66-80 years (72.2 ± 4.0). Similarly, Pippi et al.[19] studied the impact of BMI, physical activity, and sitting time levels on health-related outcomes in a group of overweight obese adults with and without type 2 diabetes with the women aged (51.9 ± 9.5) and men aged (54.6 ± 8.3).

Statistical analyses

Although data analyses that were run for this study did not find a relationship between usual and maximum gait speed on music intervention, an interaction between BMI classification and change in gait speed with music intervention was identified. This relationship supports previous research.

Treadmill vs. overground gait speed

When analyzing treadmill gait speed and overground gait speed, our findings align with Malatesta et al.[18], who concluded that older adults tend to walk slower on a treadmill compared to when walking above ground. Our data supports that finding by showing an average treadmill walking speed of 1.09 meters per second (ms^{-1}) and above ground walking speed of 1.64 ms^{-1}. These differences between gait speeds could be due to the familiarity level that each participant had with walking on a treadmill prior to data collection[20]. When determining whether treadmill walking, as a mode of physical activity for older adults, is comparable to overground walking, Marsh et al.[20] found that walking velocities were significantly slower on the treadmill compared with overground. Results also suggested a more favorable attitude and level of enjoyment in the overground group compared to treadmill training, which could also explain the differences.

Music intervention

Despite insignificant results between gait speed and music intervention, a past study found significance in gait speed in individuals who listened to music they enjoyed[13]. Our study allowed the participants to self-select a song of their choice; however, our results do not support that self-selected music is significant when discussing increases in gait speed. Another study found that music increased walking speed and motivation when the song choice was more activating than relaxing[16]. Researchers in our study did not require participants to self-select a fast song, but a song they preferred to walk to. Due to in control of the selected music tempo, participants could have chosen a slower song, explaining why a relationship was absent between music intervention and gait speed.

BMI Classification and Gait Speed

When analyzing changes in self-selected gait speed, our data supports findings by Mendes et al.[21], Hardy et al.[22], Stenholm et al.[23], Sallinen et al.[24], and, resulting in individuals with a higher BMI have slower gait speeds.

Mendes et al.[21] examined usual gait speeds across all four BMI classifications. On average, participants classified as having a normal BMI, overweight BMI and obese BMI walked between 0.95 ms^{-1} and 0.99 ms^{-1} ,0.89 ms^{-1} and 1.01 ms^{-1}, and 0.72 ms^{-1} and 0.94 ms^{-1} respectively. Our results found that participants classified as having a normal BMI, overweight BMI, and obese BMI walked at an usual speed of 1.71 ms^{-1}, 1.54 ms^{-1}, and 1.64 ms^{-1}. With the exception of our overweight BMI results, our data and Mendes et al.[21] data show decreases in usual gait speed with increases in BMI. Hardy et al.[22] stated that older adults in the overweight BMI classification performed worse in various physical performance assessments in which walking speed was included. Similarly, Stenholm et al.[23] found that walking limitations were observed in women classified as overweight, obese, and severely obese. Walking limitations in men were observed in participants that were classified as obese and severely obese. Sallinen et al.[24] found individuals with the slowest maximum gait speeds had the highest BMI, supporting our results as well. Due to slower gait speeds in populations who are obese, motivators that may increase physical activity and gait speed across older adults of all BMIs impact individuals on a personal, social, and environmental level. Physical and health benefits, ease of performing activities of daily living, reducing pain and injury, mental health and social benefits, and organized exercise opportunities all motivate older adults to perform in exercise, possibly increasing gait speed to decrease mortality rate[25].

Our sample size was reasonable when compared to previous research on gait speed and BMI. While our 14-meter walking distance was adequate, we did not see significant results. Music implementation may not impact participants' acute walking speed but may rather impact longer distance walking speed. A limitation in the study is the variety of the participants' chosen song. The song's tempo was not programmed to be a faster cadence than their usual walking speed. A participant chose their favorite song to exercise to, but the song could have been a slow cadence, unintentionally influencing the participant to walk slower. Other limitations include the population selected for research and the lack of control of physical activity participants before data collection. The majority of the participants in the research study participated in a community fitness program and were active. The results were not representative of a community dwelling older adult population, but an active older adult population. Future studies should report physical activity levels of the participants before participating within the study. Also, participants' data collection took place while they were exercising. Their level of fatigue was not recorded and could have influenced their gait speed.

Conclusion

Our research found a relationship between BMI and impact of music implementation on walking speed; people with normal weight and overweight BMIs were impacted by music more that people who are obese. Our study contributes to data on how music can motivate populations to exercise and increase activity. Aside from music, there are other motivational tools to increase gait speed in people of all classifications, such as group exercising programs or accountability partners. Since our study suggested an insignificant impact on acute maximum and usual gait speed with music implementation, further studies to determine if music implementation impacts usual and maximum gait speeds over a long distance is needed. Further studies could research the relationship between high cadence music selection, preferred music, and music genre to see if the type and selection of music impacts walking speed. Further studies could also compare walking speeds of community dwelling and active community dwelling older adults, and the importance of physical activity to keep walking speeds elevated to reduce mortality rate.

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