ORIGINAL ARTICLE

Combined diabetes and arthritis are associated with declined gait speed

Aqeel M. Alenazi [1] · Mohammed M. Alshehri [2] · Bader A. Alqahtani [1] · Ahmad D. Alanazi [3] · Saad M. Bindawas [4]

Abstract

This study investigated the association of combined arthritis and diabetes, diabetes only, and arthritis only compared with neither with gait speed in the general population. This cross-sectional study included data from the second wave of Midlife in the United States-2 (MIDUS 2) project 4: Biomarker Project, 2004–2009. The MIDUS 2 biomarker project included 1255 individuals aged between 34 and 84 years. Participants were categorized into four groups: combined arthritis and diabetes, diabetes only, arthritis only, or neither. The main outcome measure was gait speed measured by the 50-ft walk test. Covariates included age, gender, body mass index (BMI), depression symptoms, and number of chronic conditions/symptoms. A total of 1255 participants were included with mean age 54.52 ± 11.71, of those 713 (56.8%) participants were females. The results showed that combined arthritis and diabetes was significantly associated with a greater decline in gait speed ($B = -0.11$, 95% confidence interval (CI) [-0.17 to -0.6], $p < 0.001$). Arthritis and diabetes were independently significantly associated with decreased gait speed ($B = -0.072$, 95% CI [-0.10 to -0.043], $p < 0.001$), ($B = -0.064$, 95% CI [-0.12 to -0.012], $p = 0.015$), respectively. Combined arthritis and diabetes was associated with a greater decline in gait speed compared with diabetes only, arthritis only, or neither group.

Key Points
• *Combined arthritis and diabetes were associated with declined gait speed.*
• *Gait speed did not differ between people with arthritis compared with people with diabetes.*
• *We recommended including gait speed assessment in regular clinical visits to capture gait speed declines for further health assessments.*

Keywords Arthritis · Diabetics · Walking speed

Introduction

Arthritis and diabetes are common chronic coexisting conditions [1]. Arthritis is a leading cause of disability and characterized by joint pain and stiffness [2]. Although the most common form of arthritis is osteoarthritis, other forms include rheumatoid arthritis and gout lupus [1]. In the USA, the prevalence of arthritis was estimated to be 22.7% among adults [1], whereas the prevalence of diabetes was estimated to be 17% among adults aged over 25 years and older [3]. A recent report has shown that arthritis affects approximately 47.1% of adults with diabetes, and arthritis-attributable activity limitation was estimated to be 52.5% in people with diabetes [1]. Individuals with diabetes are 1.7 times more likely to have arthritis after adjustment for age [1]. This coexistence between arthritis and diabetes could be attributed to shared risk factors such as age, obesity, and physical activity level [4, 5]. Another important risk factor that was independently associated with each condition is slow gait speed [6–8].

Gait speed is considered the sixth vital sign and a determinant factor for mortality and disability [9–12]. Measuring gait speed is an easy test to administer in clinical practice. In addition, gait speed is a quick, inexpensive, and reliable measure

✉ Aqeel M. Alenazi
aqeelalenazi.pt@gmail.com; Aqeel.alanazi@psau.edu.sa

1 Department of Health and Rehabilitation Sciences, College of Applied Medical Sciences, Prince Sattam Bin Abdulaziz University, Alkharj, Saudi Arabia

2 Department of Rehabilitation Science, Jazan University, Jazan, Saudi Arabia

3 Department of Physical Therapy, Majmaah University, Majmaah, Saudi Arabia

4 Department of Rehabilitation Science, King Saud University, Riyadh, Saudi Arabia

for physical functions [10]. Therefore, previous research has linked slow gait speed to chronic diseases [6–8, 12]. Specifically, a decline in gait speed was associated with arthritis and diabetes separately [6–8]. Individuals with diabetes showed slower gait speed when compared with healthy adults [8, 13]. Furthermore, people with hip or knee arthritis had slower gait speed when compared with people without arthritis [6, 7]. However, the influence of coexisting arthritis and diabetes on gait speed is unknown.

Coexisted arthritis and diabetes may contribute to adverse outcomes because both could be associated with slow gait speed and limited mobility. Difficulty in walking was associated with incident diabetes and serious diabetes complications [14, 15]. However, the quantification of the difficulty in walking using gait speed measure has not been studied. Our previous work found an association between diabetes and slow gait speed in people with knee osteoarthritis, independent of pain [16, 17]. Yet, this study included only individuals with knee osteoarthritis and cannot be generalized to the general population. Thus, it is essential to examine the association of arthritis and diabetes independently and in combination with gait speed in the general population. Therefore, the purpose of this study was to examine the association of combined arthritis and diabetes, diabetes only, and arthritis only compared with neither with gait speed in the general population. We hypothesized that a greater decline in gait speed would be associated with combined arthritis and diabetes.

Materials and methods

Study design

This study was a cross-sectional analysis of data from the second wave of Midlife in the United States-2 (MIDUS 2) project 4: Biomarker Project, 2004–2009, a multisite longitudinal study [18]. The purpose of this project was to add a comprehensive biological assessment to the physical and mental health to investigate the role of behavioral, psychological, and social factors in understanding age-related samples. Eligibility criteria for project 4 were if the participants completed the MIDUS 2 project 1 phone interview and self-administered questionnaire, and if the participants were in the MainRDD (not including city oversamples), twin or African American samples, and if the participants lived in the continental USA. All eligible participants were assigned to one of the three data collection sites including the University of California Los Angeles, University of Wisconsin, or Georgetown. Informed consent was given to each participant and each MIDUS site obtained institutional review board approval.

Participants

The MIDUS 2 biomarker project included 1255 individuals aged between 34 and 84 years from two subsamples: the longitudinal survey sample ($n = 1054$) and the Milwaukee sample ($n = 201$) [18]. For the current analysis, participants were divided into four groups; combined arthritis and diabetes, diabetes only, arthritis only, or neither.

Measures

Participants were divided into four groups based on their self-reported diabetes or arthritis using the following two questions: have you ever had any of the following conditions/illnesses? Diabetes/Arthritis. The participants were categorized to diabetes if they answered yes for diabetes, arthritis if they answered yes to arthritis, combined diabetes and arthritis if they answered yes for both questions, and no diabetes and no arthritis if they answered no to both questions. Previous research has reported the validity and reliability of self-reported diabetes and arthritis using self-reported questionnaires [19–21].

Normal gait speed was measured using the average gait speed of two 50-ft timed walk tests. The participants were instructed to walk in a hallway to a designated location at the other end and turn around. The distance was 25 ft with marked starting and turn around points. Each participant was given this instruction "at your usual speed, just as if you were walking down the street to go to the store." Two trials were given, and the average was calculated for this analysis. Walking speed was computed by converting and dividing the distance (to meters) by the time (s) needed to complete the tests.

Covariates included age, gender, body mass index (BMI), depression symptoms using the Center for Epidemiologic Studies Depression Scale (CESD), and number of chronic conditions/symptoms. Depression symptoms were categorized as yes when the participants' scores on the CESD ≥ 16 [22].

Statistical analyses

Descriptive statistics were presented using means for continuous variables and counts for categorical variables. Multiple linear regression analysis was used to examine the association between groups (combined arthritis and diabetes, diabetes only, and arthritis only versus no diabetes and no arthritis) and gait speed. The reference category for groups was set as no diabetes and no arthritis. Two models were created. Model 1 was adjusted for age and gender, and model 2 was adjusted for age, gender, BMI, depression symptoms, and number of chronic conditions/symptoms. All analyses were performed

using SPSS for Macintosh, version 25.0 (SPSS Inc., Chicago, IL). The significance level was set at 0.05 alpha.

Results

A total of 1255 participants were included with a mean age of 54.52 ± 11.71, of those 713 (56.8%) participants were females, 82 participants had combined arthritis and diabetes, 446 participants had arthritis only, 73 participants had diabetes only, and 654 had no arthritis and no diabetes. Participants' characteristics for all groups are presented in Table 1. The mean gait speed for combined arthritis and diabetes group was 0.90 m/s, for arthritis only group was 0.97 m/s, for diabetes only group was 0.99, and for no arthritis and no diabetes group was 1.10 m/s. Age, BMI, gait speed, and a number of comorbid conditions were significantly different between groups ($p < 0.0001$). The total number of symptoms/conditions was also significantly and independently associated with gait speed ($p < 0.05$).

The results in table 2 showed that combined arthritis and diabetes was significantly associated with decreased gait speed ($B = -0.11$, 95% confidence interval (CI) [-0.17 to -0.6], $p < 0.001$). Arthritis only was significantly associated with decreased gait speed ($B = -0.072$, 95% CI [-0.10 to -0.043], $p < 0.001$). Finally, diabetes only was significantly associated with decreased gait speed ($B = -0.064$, 95% CI [-0.12 to -0.012], $p = 0.015$).

Discussion

The purpose of this study was to examine the association between gait speed and combined arthritis and diabetes, diabetes only, arthritis only, and no arthritis nor diabetes among the general population. The findings support our hypothesis that a greater decline in gait speed would be associated with

combined arthritis and diabetes compared with the other groups. The current study showed that adults with combined arthritis and diabetes were significantly associated with decreased gait speed. The results remained significant even after adjusting for all covariates such as age, gender, BMI, depression symptoms, and a total number of symptoms/conditions. In addition, both arthritis only and diabetes only were significantly associated with decreased gait speed. To the best of our knowledge, this is the first study to examine the relationship of combined arthritis and diabetes with gait speed.

In our study, the overall gait speed estimates for adults with arthritis only and diabetes only were decreased by 0.072 and 0.064, respectively, after adjusting for all covariates. Our findings were consistent with previous results that have demonstrated an independent association between diabetes, arthritis, and gait speed. In a cross-sectional study, Brach and colleagues have reported a decline of 0.06 m/s in gait speed in patients with diabetes [23]. Although some covariates have been controlled for in this study, other factors such as lower extremity strength have not been controlled which may explain the trivial change in gait speed [23]. Similarly, previous longitudinal studies found that arthritis was significantly associated with decreased in gait speed in adults with arthritis after adjusting for all covariates [24, 25]. These studies also showed that gait speed was significantly and independently associated with age, gender, BMI, and depression symptoms. In our study, we found that the total number of symptoms/conditions was also significantly and independently associated with gait speed which could explain the amount of change in gait speed after the adjustment.

In the current study, we examined the association between groups and gait speed using two models to explore the influence of other covariates on gait speed such as BMI and other comorbidities. The first model included age and sex as very common covariates in people with either arthritis or diabetes [26–29]. Older age has been associated with cellular function decline that has been linked to both arthritis and DM [26–28]. Previous studies have shown that women have a higher

Table 1 Participants' characteristics

	All sample	No arthritis and no diabetes	Diabetes only	Arthritis only	Combined arthritis and diabetes	*p* value
Participants, *n* (%)	1255	654 (52.11)	73 (5.82)	446 (35.54)	82 (6.53)	
Age, years (SD)	54.52 (11.71)	51.16 (10.67)	54.33 (10.56)	58.45 (11.73)	60.13 (11.93	< 0.0001
Female, *n* (%)	713 (56.8)	360 (55.0)	38 (52.1)	268 (60.1)	47 (57.3)	0.33
BMI, kg/m²	29.77 (6.63)	28.56 (5.85)	31.85 (8.09)	30.42 (6.87)	33.93 (7.11)	< 0.0001
Depression symptoms, yes, *n* (%)	212 (16.9)	97 (14.8)	17 (23.3)	82 (18.4)	16 (19.5)	0.16
Number of chronic conditions	4.10 (2.97)	2.74 (2.24)	4.36 (2.21)	5.45 (2.94)	7.40 (2.81)	< 0.0001
Gait speed, m/s	1.04 (0.23)	1.10 (0.22)	0.99 (0.21)	0.97 (0.23)	0.90 (0.25)	< 0.0001

The results based on chi-square for categorical data or one-way ANOVA/Kruskal-Wallis test for continuous data

Table 2 Linear regression analyses for gait speed measured by 50-ft walk test

Groups	Model 1 ($n = 1236$)			Model 2 ($n = 1236$)		
	B	SE	p value	B	SE	p value
Combined diabetes and arthritis	− 0.19	0.027	< 0.0001	− 0.11	0.028	< 0.0001
Diabetes only	− 0.11	0.27	< 0.0001	− 0.064	−.026	0.015
Arthritis only	− 0.11	0.14	< 0.0001	− 0.072	0.15	< 0.0001
No diabetes and no arthritis	Reference			Reference		
R^2	0.11			0.19		

Model 1: adjusted for age and gender

Model 2: adjusted for age, gender, BMI, depression symptoms, and total number of symptoms/conditions

SE, standard error

prevalence of hip and knee osteoarthritis than men [30]. In addition, women have a higher prevalence of diabetes than men at older ages [31]. The second model included in addition to age and sex other comorbidities such as BMI, depression symptoms, and number of chronic conditions. Obesity or higher BMI is associated with diabetes [32] and osteoarthritis [33]. The prevalence of depression symptoms is higher in people with osteoarthritis [34] and diabetes [35]. Therefore, it is essential to control for these factors in the analysis. In the current study, gait speed was decreased from 0.19 in the first model in people with arthritis and diabetes to 0.11 in the second model after adjustments for other additional covariates. These differences between models were consistent with our previous research using a similar approach [17]. Our recent work examined the association between diabetes and gait speed in people with knee osteoarthritis using a similar approach for controlling covariates. This study found that diabetes was associated with a 0.12 decrease in gait speed after controlling for age, sex, and knee composite grade [17]. The second model of this study controlled for age, sex, knee composite grade, BMI, pain while walking, and depression [17]. The amount of decrease in gait speed from the first to the second model in the previous study (from 0.12 to 0.06 m/s) was similar to the current study (from 0.19 to 0.11 m/s) indicating a decrease in gait speed by 0.11 m/s. However, the average age in the previous study was higher than the current study. The current study adds to the literature the negative association of combined arthritis and diabetes on declined gait speed in the general population.

Individuals with both arthritis and diabetes showed the highest amount of decline in gait speed compared with the other groups. The absolute difference in gait speed between combined arthritis and diabetes and no arthritis and no diabetes group was 0.2 m/s, and the adjusted difference was 0.11 m/s. These findings could be explained by the health burden and complications of the coexistence of arthritis and diabetes on gait speed. Previous researchers have reported a decline of 0.10 m/s in gait speed is considered a meaningful

change in older adults [36]. Therefore, our results indicated that there was a meaningful decline in gait speed among people with both arthritis and diabetes.

The results of this study should be interpreted with cautions since this is a retrospective study. The major limitations of this study are the low sample size for some groups and the type of arthritis. Future research using a prospective design is needed to replicate the findings on a larger sample size with arthritis specifications to improve the generalizability. In addition, assessing the gait speed using a highly sensitive measure such as Gaitrite will help in accurately measuring the gait speed. Although self-reported diagnosis of diabetes and arthritis is sensitive enough, using diagnostics criteria of both comorbidities is essential to confirm our findings. Also, we have not controlled the medications as some medications and their interactions may increase the likelihood of slower gait speed in older adults [37, 38]. Thus, future research may include the medication lists to use them as covariates to assess its impact on gait speed. Finally, there are other important variables such as sarcopenia that were not available in the current dataset that could affect the results. Although a previous study found a higher prevalence of sarcopenia in people with rheumatoid arthritis (37.1%) [39], another work found that sarcopenia was not associated with physical functions in individuals with either rheumatoid arthritis or osteoarthritis [40]. Future research should examine whether the association between combined arthritis and diabetes on gait speed is mediated by sarcopenia.

Clinicians may benefit from this study to screen gait speed in order to improve the quality of life and reduce the risk of fall. Previous studies have established the association of slow walking speed with low quality of life and fall risk [41–46]. Increased risk of fall might place people with diabetes and arthritis at a greater risk of fracture. Therefore, we recommend including gait speed assessment in regular physicians' visits to capture gait speed declines for further health assessments.

In conclusion, this study evaluated the association of combined arthritis and diabetes, diabetes only, and arthritis only

compared with neither with gait speed in the general population. The findings showed a greater decline in gait speed is associated with combined arthritis and diabetes compared with the other groups after controlling for common risk factors of gait speed declines. Future research is needed to establish a novel intervention to optimize the gait speed in this population (Table 2).

Data availability The dataset generated during the current study are publicly available and can be obtained through http://www.midus.wisc.edu/midus2/project4/

Compliance with ethical standards

Disclosures None.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This study was approved by the Institutional Review Board (IRB) for three General Clinical Research Centers (at University of California Los Angeles, University of Wisconsin, and Georgetown University).

Informed consent Informed consent was obtained from all individual participants included in the study.

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