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DOI: https://doi.org/10.3399/BJGPO.2025.0162

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Received 06 August 2025
Revised 11 October 2025
Accepted 12 November 2025

TITLE PAGE

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Slow walking speed and risk of cardiovascular events in Type 2 diabetes: a systematic review

Abstract

Background

Cardiovascular disease (CVD) is the main cause of mortality in type 2 diabetes (T2DM) and detection of CVD risk is a key part of routine care. Slow walking speed is strongly correlated with CVD events in the general population.

Aim

To see if this applies in people with Type 2 diabetes.

Design and Setting

Systematic review of studies of people with Type 2 diabetes

Method

We searched studies in which usual walking speed was recorded, and participants were followed up for subsequent fatal and non-fatal cardiovascular events. (PROSPERO CRD42024578164)

PubMed Central, Web of Science, Cochrane Register of Controlled Trials and Google Scholar were searched in December 2024. Studies were screened by two independent reviewers. Studies reporting walking speed or comparable indices and CVD outcomes in T2DM were included. Study quality was assessed using the Newcastle-Ottowa Scale. Heterogeneity of study populations prevented meta-analysis.

Results

Out of 1281 studies identified, 53 full-texts were retrieved and four were included, all of good quality. These involved 132,967 individuals with diabetes from USA, UK and Japan. Mean study follow-up was 3-14 years. All four studies assessed walking speed by self-reported questionnaire and reported significant associations between reduced walking speed and increased CVD risk with risk/hazard ratios ranging from 1.18-5.88.

Conclusions

This is the first systematic review to indicate an association between reduced walking speed and increased CVD incidence in T2DM. This association is seen across diverse populations and settings. Further research in T2DM could explore whether increasing walking speed reduces CVD risk.

Keywords

Walking speed, cardiovascular events, Type 2 diabetes, systematic review

How this fits in;

- Reduced walking speed is associated with increased risk of cardiovascular events in the general population, but we do not know if this applies to people with Type 2 diabetes.
- We conducted a systematic review following PRISMA guidelines of studies of people with Type 2 diabetes in which usual walking speed was recorded and participants were followed up for subsequent fatal and non-fatal cardiovascular events.
- All four included studies showed significant associations between reduced walking speed and increased CVD risk with risk/hazard ratios ranging from 1.18-5.88 after adjustment for other CVD risk factors.
- All the included studies used self-perceived walk speed. Further research in people with diabetes is needed to validate different walk speed measures and assess their feasibility in clinical practice.

Introduction

The incidence of diabetes mellitus is increasing substantially worldwide. Over the past three decades, the global burden of diabetes has rapidly increased from 30 million in 1985 to 382 million in 2014 with a projected further increase to 642 million by 2040 (1). Cardiovascular disease (CVD) is approximately twice as common in people with Type 2 diabetes compared to no diabetes and is the main cause of death in this group (2,3). This figure has not changed significantly despite advances in treatment (4). Although routine care of diabetes focuses on prevention of CVD, current risk prediction tools lack reliability and individual discriminatory power (5,6) and there is a need to add factors to increase precision. The excess CVD risk of diabetes is not fully accounted for by adding diabetes to current models as a binary covariate, as is the case currently. Walking speed is increasingly recognised as an important independent predictor of CVD risk. Adding walk speed into general models might also explain some of this excess risk within people with type 2 diabetes(7).

In general population cohorts, self-reported brisk habitual walking pace is associated with reduced risk of cardiorespiratory and cancer outcomes (8) and all-cause mortality (9). Conversely, slow walking speeds (below 1.0 m/s) are strongly associated with increased mortality (10). Indeed, the strength of association has been referred to as the "sixth vital sign", after blood pressure, respiratory rate, pulse, temperature and oxygen saturation (11). However, it is not clear if slow walking speed is also predictive of CVD events in people with

Type 2 diabetes as diabetes has complications that may affect walk speed (12). Diabetes-induced complications such as neuropathy, myopathy and vasculopathy may interfere with the walk speed/CVD relationship, altering the correlation with CVD risk. It is therefore necessary to study diabetes-specific populations to establish the presence of the walk speed CVD relationship and estimate an effect size.

We conducted a systematic review of studies that investigated the association between walking speed and future risk of fatal and non-fatal CVD events in people with Type 2 diabetes.

Methods

The systematic review protocol was registered prior to the review (PROSPERO CRD42024578164). We followed the PRISMA guidelines with the additional (SWIMM) reporting guidelines for systematic reviews without metanalysis (13).

Data Sources and Searches:

A systematic literature search was conducted in PubMed Central, Web of Science, Cochrane Register of Controlled Trials, and Google Scholar from inception until 12 December 2024. We used keywords: walking speed, diabetes, cardiovascular and their associated synonyms and terms (Supplementary box 1). Citations from identified publications were screened to check for further potential studies.

Study inclusion criteria

- prospective and retrospective studies that investigated the incidence rate of fatal or non-fatal CVD events in individuals with type 2 diabetes and included walking speed as a primary or secondary predictor variable.
- Subtypes of incident CVD events included: coronary heart disease, myocardial infarction (MI), angina, cerebrovascular events, heart failure, major adverse cardiovascular events.

Exclusion criteria

- Studies solely on Type 1 diabetes or gestational diabetes mellitus
- Studies using accelerometry to provide measures of walking activity in terms of intensity, step count or distance, but not including walking speed.
- Studies not available in English

Study Selection

Two independent authors (PO, RB) screened titles and abstracts for eligibility, followed by selected full-texts. Where different studies reported on the same cohort, the study closest to the inclusion criteria was selected. Any disagreements about eligibility were resolved through discussion between reviewers.

Data Extraction and Quality Assessment

Study data were extracted by one investigator (RB) and cross-checked by an independent reviewer (PO). Data included author, year of publication, country, diabetes type, sex distribution, mean age (range), study design, cohort name, mean length of follow-up in years, number of participants, total cases of fatal and non-fatal CVD, method of walking speed assessment and CVD outcome effect measure with 95% CI. Cardiovascular disease covariates included in multiple regression models were also documented.

Study quality was assessed using the Newcastle-Ottowa Scale (Appendix-Table 2) (14) by two independent assessors (RB and PO). Differences were resolved by discussion.

Analysis

Meta-analysis was not possible due to important differences between study populations, such as single gender studies and differences in walk measures and cardiovascular outcomes. Instead, individual study outcome data were examined for effect size, methods and context, and areas of between study agreement highlighted.

Results

Literature Search Results

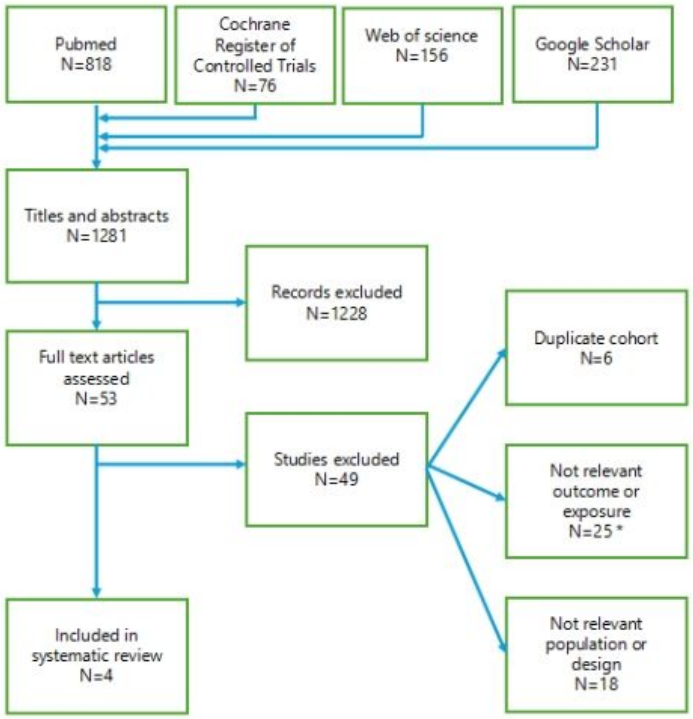

Figure 1. PRISMA flow chart of included and excluded studies; *25 studies excluded on the basis of not relevant predictor variables, including physical activity, step counts and grip strength.

Overview of included studies

In total, 1,281 potential publications were identified (Figure 1). From these, 53 full texts were retrieved, and four studies met the inclusion criteria. In each of the included studies, people with diabetes were identified where CVD events were the primary outcome and walking speed was recorded at baseline. These four studies were published between 2001 and 2023 and included 132,967 individuals with diabetes from the USA, UK and Japan (Appendix-table 1).

Study design and population

The studies varied substantially in their designs and the populations studied. Tanesescu, Hu and Boonpor were prospective cohort studies (15,16,17), while Ueno was a retrospective study based on health insurance data (18). Mean follow-up also varied: 3 years in Ueno, 11 years in Boonpor and 14 years in Hu and Tanesescu.

Tanesescu (15) recruited 2803 male health professionals over the age of 30 years with T2DM in the USA. Hu (16) also focussed on health care professionals in the USA but instead recruited 5125 female nurses across 11 states with all types of diabetes. Boonpor (17) included 11,974 white Europeans with T2DM from the UK Biobank, a large-scale publicly accessible biomedical database. Finally, Ueno (18) retrospectively analysed health insurance data of 113,065 Japanese participants with all types of diabetes, following them up from their initial health check to first CVD event or study end. All four studies excluded participants with a previous history of CVD.

Walking speed measures

All four studies relied on self-report to categorise walking speeds, using different and unvalidated scales. In Hu (16), participants were asked to report if their usual walking pace was "*easy, average, brisk or very brisk"*. Tanesescu (15) asked participants to categorise their walking as "*casual, normal, brisk or striding"*. Ueno asked participants to assess their walking speed in relation to others of the same age and sex and report if they walked faster than their peers. Finally, Boonpor (17) asked participants to rate their walking pace as "*slow, steady/average or brisk"*. Tanesescu (15) and Hu (16) reported performing an objective validation test of the self-reported walking speed on a subset of participants.

CVD outcome measures

All studies reported fatal and non-fatal CVD events and stroke. Boonpor and Ueno also reported heart failure, and Ueno reported angina. Outcomes were collected from medical records and death certificates using international standardised definitions. Where medical records were absent or unavailable, participants were contacted individually. Completeness of follow-up data was not clearly reported in the included studies.

Analysis

All four studies reported incident CVD events, Hu and Tanesescu reporting risk ratios and Ueno and Boonpor hazard ratios. Studies consistently adjusted their models for age, sex (in the studies recruiting both men and women), smoking and BMI. There were some differences in the other demographic and health variables included in the models, which are outlined in Appendx-Table 1. In Ueno and Hu only CVD events occurring at least 1 year and 2 years respectively after entry into the study were counted. This reduced the risk of bias due to reverse causality. For similar reasons, Tanesescu excluded men who reported significantly reduced physical activity in the 2 years prior to study recruitment.

Associations between walking speed and CVD events

All four studies reported significant associations between self-reported walking speed and CVD events after adjustment for confounding variables. The direction of effect was consistent across studies, with slower walking speeds being associated with an increased risk of subsequent CVD events, but effect size varied substantially between studies. Tanesescu(15), a study including male healthcare workers in the USA, found the strongest association with a more than 5 times risk of CVD events in the slowest walking group compared to the fastest (RR 5.88, 95% CI 2.05 to 16.90) and although confidence intervals are wide, the findings are consistent with an at least doubling of the risk. Risk/hazard ratios for the remaining studies were smaller (1.18 to 2.13) but were consistent with a significantly increased risk of CVD events in the slowest walking group. In Tanesescu, where walking was analysed in 3 groups, the p value for the trend suggests a dose-response relationship (p=0.001).

Two studies (Ueno and Boonpor) reported hazard ratios for specific CVD outcomes, including myocardial infarction, stroke, heart failure and angina (Ueno only), which further confirmed the significant association between slower walking and increased cardiovascular risk (Appendix-Table 1).

Discussion

Summary

All four studies included in this systematic review found a significant association between slower walking speed and increased risk of subsequent fatal and non-fatal cardiovascular disease in people with Type 2 diabetes. There was a range of effect sizes. Although there were only four studies, these were of good quality and the association was seen across diverse populations, settings and time periods from 1976 to 2020.

Strengths and limitations

This is the first systematic review to examine studies of walking speed as a correlate of future CVD incidence in type 2 diabetes. The prospective design of three of the four included studies, large sample sizes, long follow up time and confirmation through medical records contributed to the quality of evidence. All studies excluded participants with a previous history of CVD and three studies excluded participants with a recent decline in walk speed or who had experienced a CVD event early in the study, to reduce bias from possible reverse causation. We formally assessed risk of bias of included studies using a recognised tool for

observational studies (Appendix- Table 2) (12). The populations included a range of ages and genders across three continents.

However, there are limitations. Three of the included studies recruited through employment status and therefore may not be fully representative of background populations. Two studies (Hu and Ueno) did not differentiate between type 2 and type 1 diabetes, but due to the approximately 9:1 ratio in prevalence, it is expected that this would not significantly change the results. Two studies (Hu and Tanesescu) were published over 20 years ago and walking speed and habits may have changed over this period. It is unclear why the mean follow-up duration in Ueno was just 3 years when the study ran from between 2005 and 2021.

There is potential for reverse causation by early cardiovascular changes influencing walk speed and later progressing to overt disease, despite studies not counting CVD in the first 1-2 years of each study period. In practice, as the walk speed/CVD relationship is likely to be circular, then the lack of causation does not affect the utility of walk speed as a predictor of CVD

All included studies estimated walking speed by self-assessment questions, without direct measurement, and only in Ueno was assessment of walking speed a primary objective of the study. To date there is no universally standardised questionnaire and studies used constructed questions based on estimating speed compared to peers. However, this is simple to measure and is generally considered to be reliable (19). The assessment of walking speed by different methods prevents direct comparison or conversion to a common denominator metric. Categorisation of walking speed into a binary variable, slow versus normal or brisk, improves effect detection within a study, but only one study, Tanesescu, defined these in objective terms of miles per hour (15). Known differences in usual walking speeds across different age groups and countries affects study external validity. However, the peer comparison nature of self-assessment means it is unlikely that individuals were misclassified within their cohort regardless of actual speed.

Comparison with existing literature

We found that compared with nearly 50 studies examining walking speed and CVD risk in general population cohorts (20), there are relatively few studies in Type 2 diabetes. Indeed, only one study (Ueno) primarily examining walking speed as predictor covariate was identified.

Our review findings in patients with Type 2 diabetes are similar to those of the general population. A recent systematic review of reduced walking speed and fatal and non-fatal events showed a HR of 1.12, 95% CI: 1.09-1.14. (21). This equated to a 12% increased risk of earlier mortality for each reduction of 0.1 m/s in gait speed. In more recent cohort studies using accelerometry, gait speed is calculated indirectly from physical activity intensity. This removal of self-assessment recall bias may show even larger effect sizes in CVD risk (22).

The underlying relationship of walking speed to cardiorespiratory fitness has been well documented (23). Walking speed is increasingly recognised as better reflecting underlying fitness than step count or walking distance (24,25,26). Finally, in the general population, walking speed has been found to increase the predictive power of CVD multi-factor risk scores (27).

Implications for Research and/or practice

Our findings indicate that walking speed in people with Type 2 diabetes is related to future risk of CVD events and CVD mortality. While these studies cannot demonstrate causation, a possible explanation is that slow walking is associated with higher blood pressure, BMI, and impaired muscle function which can be associated with chronic inflammation. All these can increase the risk of CVD. By contrast brisk walking can result in improved insulin sensitivity, glycaemic control and lipoprotein profile (15), and lower BMI and blood pressure, all of which will reduce cardiovascular risk. In clinical terms, advice to patients on the benefits of brisk walking may be more important in people with T2DM who have double the CVD risk and who walk slower than people without diabetes (12).

In general populations, the effect size of slow walking speed is comparable to those of other major CVD risk factors such as smoking and high blood pressure (28). Addition of walking speed to existing CVD scores in general cohorts improves CVD risk prediction (29). Our findings suggest that this might also apply in type 2 diabetes.

If confirmed by further research, walk speed could become an integral part of CVD risk assessment in primary care diabetes management. Assessing walking speed by a simple question might be feasible even in time-pressured clinical settings. GPs could ask: "Compared with other men/women your age, do you walk slower, the same or faster?" with slow walking speed defined as <1m/second. Alternatively, timed set distance walk tests may be feasible such as 10 or 6 metre tests although 3 metres is also validated (30). Interventions

to improve walking speed are known to reduce CVD mortality (31). Clinically recorded measures of walking speed could therefore provide both current CVD risk and inform future exercise interventions.

FUNDING;

No funding source was required for this study.

ETHICS;

Ethical approval was not required for this study.

COMPETING INTERESTS;

The authors declare that they have no competing interests in their contributions to this study.

ACKNOWLEDGEMENTS;

The authors wish to thank Professor Patrick Esser for his support.

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Author Study site Mean follow up period (years)	Population cohort. Study size Mean age	Composition of diabetes group	CVD Outcome measure	Walking speed as primary or secondary exposure	Exposure groups – Study defined group categories of walk speed	Regression model adjustment variables	Fully adjusted Hazard/Risk Ratios.
Hu (2001) USA 14y	The Nurses Health Study- 5125 females, mean age= 50y	All diabetes types	Fatal+ non fatal CVD Events	Secondary	"Brisk" vs "easy/slow"	Age, smoking, alcohol, BMI, menopausal status, Vitamin supplements, hypertension, dyslipidaemia, aspirin use, diabetes duration, diabetes medication	Average (RR 0.52), Brisk (RR 0.47) P=0.001
Tanesescu(2003) USA 14y	Health professionals Follow up study 2803 males 40-75y (average age unavailable)	Type 2 Diabetes	Fatal +non fatal CVD events	Secondary	"Normal / brisk/striding" vs "casual /slow"	Age ,physical activity,alcohol, smoking, family history of CVD, Vit E supplements, diabtes duration, diet ,hypertension,, cholesterol, BMI	Normal RR 0.82, brisk 0.58, very brisk 0.17 (95% CI 0.04 to 0.71; *P*trend 0.001)
Ueno (2023) Japan 3y	Japan Insurance Health cohort-mixed N=113,065 mean age=54y	All diabetes types	Fatal + non-fatal CVD events	Primary	"Normal+fast" vs "slow"	Age sex BMI, hypertension, dyslipidaemia, physical activity, smoking	Total HR 0.85 (0.811-0.883), HF 0.839(791-0.891) ,MI 0.89(0.773-1.024), Angina 0.892 (0.839-0.949), CVA 0.793 (0.726-0.867)
Boonpor (2023) UK 11y	UK Biobank- N= 11974 , mean age=59y	Type 2 Diabetes	Fatal + non-fatal CVD events	Secondary	"Slow" vs "average/brisk"	Age sex, deprivation, education, diet, smoking alcohol, physical activity, diabetes duration, BMI	(HR 1.92 [95% CI 1.64; 2.24]), stroke (HR 1.84 [95% CI 1.33; 2.55]), HF (HR 2.63) [95% CI 2.15; 3.22]) and MI (HR 1.59 [95% CI 1.06; 2.38])

Table 1. Summary of four studies on self-reported walking speed and subsequent cardiovascular events in Type 2 diabetes

	Hu	Tanesescu	Ueno	Boonpor
Representativeness of the exposed cohort – truly or somewhat representative of the average person in the community	Poor Diabetes-all types 100% female nurses <55yrs	Limited (100% male professionals with T2DM)	Good Diabetes-all types. Company workers, single ethnicity	Good T2DM (Single ethnicity)
Selection of non-exposed population – drawn from the same community	Same cohort	Same cohort	Same cohort	Same cohort
Measurement of exposure (walking speed) – secure record or structured interview	2 yearly questionnaires	2 yearly questionnaires	Questionnaire at initial health check	Self-reported question, at structured interview
Outcomes not present at start of study	Diagnoses excluded from self-report questionnaire	Diagnoses and suggestive symptoms excluded from self report questionnaire+ 1yr initial washout period	Diagnoses excluded from health records and 1 year washout period	Diagnoses excluded from health records
Comparability of study and control population on the basis of design or analysis	Same population	Same population	Same population	Same population
Assessment of outcome – independent blind assessment or record linkage	Self report+confirmation from medical records by independent, blinded medical assessor.	Self report+confirmation from medical records	Medical records	Medical records
Sufficient length of follow up for outcomes to occur	Strong (mean 14y)	Strong (mean;14y)	Weak (mean 3y)	Strong (mean10.7y)
Adequacy of follow up of cohort – small numbers lost to follow up or unlikely to introduce bias	Data completeness not specified	Data completeness not specified	Data completeness not specified	Data completeness not specified

Table 2. Newcastle-Ottowa Scale assessment of study quality of cohort studies