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Original Research

Skin tactile perception is associated with longitudinal gait performance in middle-aged and older Japanese community dwellers ☆

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ABSTRACT

Background: Skin tactile perception may indicate frailty in older adults. Although gait performance is crucial for diagnosing frailty, its association with skin tactile perception has not yet been explored.
Objectives: To examine the association between skin tactile perception and changes in step length, cadence, and gait speed in middle-aged and older adults.
Design: A longitudinal study (mean follow-up: 10.8 years)
Setting: Community-based survey
Participants: A total of 1,403 middle-aged and older adults (aged 40–79 years, 53.6 % men) from the National Institute for Longevity Sciences-Longitudinal Study of Aging were included in this study. These participants completed the baseline survey (1997–2000) and at least two follow-up surveys (2000–2012), had no history of cerebrovascular disease, rheumatoid arthritis, or Parkinson's disease, and had complete data with no outliers in skin tactile perception measurements.
Measurements: Skin tactile perception was assessed using a two-point discrimination test. Step length (cm), cadence (steps/min), and gait speed (m/min) were evaluated on an 11-m walkway at a usual speed.
Results: The mean age of participants was 56.4 years. After full adjustment, mixed-effects models with splines revealed that the association between skin tactile perception and gait parameters varied with age. In adults aged 60 and above, we observed non-linear relationships between skin tactile perception and gait parameters. A consistent inflection point around 10 mm in tactile perception was identified across different age groups and gait parameters.
Conclusions: Among community-dwelling middle-aged and older Japanese adults, skin tactile perception was associated with changes in gait parameters, particularly in those aged 60 and above. The 10-mm threshold in tactile perception may serve as a critical indicator for predicting changes in gait performance. Skin tactile perception tests may prove clinically useful for screening patients at elevated risk of impaired gait performance.

1. Background

Frailty, a common geriatric syndrome, is often exacerbated by sensory decline, potentially contributing to functional deterioration in older adults [1]. Notably, somatosensory system impairment may lead to postural instability and an increased risk of falls [2]. Given the rising incidence of falls and fractures (the third leading cause of bed confinement [3]), this issue is particularly concerning, necessitating appropriate countermeasures.

Walking is the most fundamental mode of mobility in daily life. Gait parameters are indicators of walking ability, reflecting muscle strength, balance, and lower limb agility [4]. Frail older adults typically exhibit impairments in gait parameters, such as shortened stride length, decreased gait speed, and cadence [5], not only attributable to impair-

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ments in strength (force-generating capacity of muscles) but also to age-related decline in somatosensory function.

Skin tactile perception is a part of the complex human sensory system. The two-point discrimination test is a valid and straightforward measure of age-related decline in skin tactile perception [6]. Previous cross-sectional studies have suggested that the hand two-point discrimination test can discriminate between robust, frail, and pre-frail status among older adults [1]. However, the association between two-point discrimination and gait parameters remains unclear.

This study hypothesized that skin tactile perception (measured by two-point discrimination) is associated with gait parameters, including step length, cadence, and gait speed. We tested this hypothesis using longitudinal data with follow-up over 14 years.

2. Methods

2.1. Participants

Data for this survey were collected as part of the National Institute for Longevity Sciences-Longitudinal Study of Aging (NILS-LSA), a community-based study. This study assessed normal aging over time using detailed questionnaires, medical checkups, anthropometric measurements, physical fitness tests, and nutritional examinations. The details of the NILS-LSA have been previously reported [7]. The initial NILS-LSA survey involved 2,267 men and women aged between 40 and 79 years, including approximately 280 men and 280 women in each decade of age. The participants were age-stratified by sex and decade and randomly sampled individuals living in Obu City and Higashiura town in Aichi Prefecture, Japan. These participants were followed up every two years from the first (November 1997–April 2000) to the second (April 2000–May 2002), third (May 2002–May 2004), fourth (June 2004–July 2006), fifth (July 2006–July 2008), sixth (July 2008–July 2010), and seventh study waves (July 2010–July 2012). When participants (≤79 years) could not be followed up (due to reasons such as moved to another area, dropped out for personal reasons, or died), new age- and sex-matched participants were randomly recruited from the second to seventh study waves. New participants aged 40 years were recruited during each study wave. All the study waves included approximately 2,300 men and women.

The NILS-LSA followed the principles of the Declaration of Helsinki and Ethical Guidelines for Epidemiological Research in Japan. This study was approved by the Ethics Committee of the National Center for Geriatrics and Gerontology (No. 1665-2). Written informed consent was obtained from all participants.

Among the 2,267 participants from the first study wave (baseline survey), those who also participated in at least two subsequent waves (from the second through seventh waves, 2000–2012) were selected (n = 1,703). We excluded individuals with a history of cerebrovascular disease, rheumatoid arthritis, or Parkinson's disease at baseline (n = 207), those with any missing data on two-point discrimination and covariates at baseline (n = 16), those with any missing data on gait parameters at both baseline and follow-up (n = 49), as well as those whose data on two-point discrimination were less than the 0.5 percentile of the total range or greater than 20 mm (the maximum distance set in advance) (n = 28). Consequently, the final population analyzed consisted of 1,403 participants (aged 40–79 years; 53.6 % men; 8,448 cumulative observations).

2.2. Skin tactile perception

Skin tactile perception was assessed using a two-point discrimination test on the thenar eminence of the non-dominant hand.

The test was conducted under controlled conditions to minimize potential distractions and ensure standardized testing procedures. Participants were comfortably seated with their forearms resting on a low table, elbows bent at approximately 90°, and wrists and palms facing upwards, supported by a small pillow. This position was intended to stabilize the participant's body and facilitate tactile stimulation. The examiner was positioned directly before the participant, maintaining a suitable distance to avoid inadvertent contact.

With the participant's eyes open, the examiner explained the procedure and demonstrated the nature of tactile stimuli using a pair of sensory needles (Yuhu-seiki, Inc.) applied to the thenar eminence of the participant's hand. After this initial demonstration, the participant was instructed to close their eyes.

Using the same sensory needles, the examiner then proceeded to administer tactile stimuli on the thenar eminence of the participant's non-dominant hand. The stimuli consisted of one or two points of contact, with the distance between the two points progressively decreasing from 20 mm. During the explanation phase, a single-point stimulus was immediately applied following the two-point stimulus to reinforce the understanding that the stimuli could vary.

After each stimulus presentation during the test, the participant was asked a consistent question: "Did you feel one point or two points?" The examiner carefully recorded the smallest distance (accurate to one decimal place) between the two points at which the participant could accurately perceive the two-point stimulus.

2.3. Step length, cadence, and gait speed

Gait parameters were evaluated on an 11-m straight walkway, including 1 m for acceleration and deceleration, at a usual speed [8]. Before starting the tests, a physician asked the participants about their health conditions. Participants with severe pain, physical injury, or orthopedic or cardiovascular diseases were excluded from the tests.

Step length (cm), cadence (steps/min), and gait speed (m/min) during normal gait were investigated using a walking analysis system (YW-3; Yagami Co., Aichi, Japan). Light sensors were used at the start and end points to record the time to walk 10 m. Usual gait speed was measured by recording time taken to walk 10 m, and this was evaluated through three trials. Simultaneously, step length and cadence were recorded. The analysis used data from the trial in which the three measures (step length, cadence, and gait speed) were first successfully observed together.

2.4. Other measurements

Height and weight were measured in a fasting state to the nearest 0.1 cm and 0.1 kg, respectively, with participants wearing light clothing and no shoes. Body mass index (BMI; kg/m^2) was calculated as weight in kilograms divided by the square of height in meters. Medical history (yes or no, including hypertension, ischemic heart disease, dyslipidemia, and diabetes mellitus), smoking status (current, former, or never), and educational level (years) were collected using a self-administered questionnaire. Medical doctors and trained staff confirmed responses to self-reported questionnaires. Physical activity over 24 h was evaluated through the metabolic equivalent of task scores (METs-h/d) acquired from participant interviews. Trained interviewers used a semi-quantitative assessment method [9].

2.5. Statistical analysis

All continuous variables are presented as the mean ± standard deviation (SD), and categorical data are presented as percentages. The Kruskal-Wallis rank sum test was used to evaluate mean differences for continuous variables, and the Pearson's Chi-squared test was used to examine proportional differences for categorical variables by 5 groups of age at baseline (40−<50, 50−<60, 60−<70, and 70−79 years).

The associations between skin tactile perception and gait parameters (step length, cadence, and gait speed) were analyzed using mixed-effects models with splines. These are particularly valuable for the present study for several reasons. Firstly, they can capture potential non-linear

relationships between two-point discrimination threshold and gait performance, allowing a more nuanced understanding of the complex interactions. The mixed-effects component is well-suited to handle the longitudinal data structure, accounting for individual differences and repeated measurements over time. Furthermore, the spline functions can help identify critical turning points, such as where the impact of the two-point discrimination threshold on gait performance begins to change significantly. This method simultaneously considers both fixed effects (like age and sex) and random effects (individual variations), providing a more comprehensive analysis. Lastly, it enables a more accurate estimation of change patterns over a follow-up period, offering insights into long-term trends and variations in the relationship between tactile perception and gait performance [10,11].

Based on the results of model fit for each gait parameter, the mixed-effects models with splines included natural splines of skin tactile perception (at baseline; continuous) with different degrees of freedom (2 for step length and 3 for both cadence and gait speed) (Supplementary Table 1), centered age (at baseline and centered at 60 years; continuous), and skin tactile perception × centered age interactions. This allowed for a non-linear relationship between skin tactile perception and gait parameters, which can vary with age at baseline. The models were adjusted for baseline information on the quadratic term for centered age (continuous), sex (categorical), follow-up duration (continuous), height (continuous), BMI (continuous), and quadratic terms for BMI (continuous), smoking status (current smoker, or others; categorical), total physical activity (continuous), educational level (≤9 years, 10–12 years, and ≥13 years; categorical), and medical history (yes or no for each disease; categorical). We also included random intercepts and random slopes for individual deviations.

To detect inflection points using predicted values from the fixed effects of a mixed-effects model with splines, we follow these steps: (1) Define a set of centered age values (-20, -10, 0, 10, 19) (i.e., baseline age at 40, 50, 60, 70, 79 years) to represent different age groups in the analysis. These values correspond to age deviations from the mean age in our sample. (2) Generate a sequence of predictor values covering the range of skin tactile perception for each of the centered age values. (3) Use the fitted model to predict gait parameters across this sequence of predictor values for each centered age value (calculated based on the following values: quadratic term for centered age, sex [male], follow-up duration [mean value: 10.8 years], height [mean value: 159.5 cm], BMI [mean value: 22.9 kg/m^2], quadratic term for BMI, educational level [10–12 years], smoking status [non-current], total physical activity [mean value: 33.3 METs-h/d], and medical history [none of the mentioned diseases]). (4) Calculate the first and second derivatives of the predicted gait parameters with respect to the predictor of skin tactile perception for each centered age group. The first derivative represents the slope of the curve, while the second derivative represents the rate of change of the slope. (5) Identify the inflection points as the locations where the second derivative changes sign (crosses zero) for each centered age group. (6) Employ a bootstrapping technique to estimate confidence intervals around the identified inflection points to ensure robustness and account for uncertainty.

All statistical analyses were performed using R (version 4.4.1, R Foundation for Statistical Computing, Vienna, Austria) [12]. The significance level was set at a two-sided *P*-value of <0.05.

3. Results

3.1. Baseline characteristics

The mean age (SD) and follow-up duration (SD) were 56.4 (10.0) years and 10.8 (2.6) years, respectively. Table 1 presents participants' baseline characteristics grouped by centered age at baseline.

As age increased, participants demonstrated an increase in the distance measured by the two-point discrimination test, indicating a decline in skin tactile sensitivity. Concomitantly, there was a decrease in height among older participants. The prevalence of hypertension, ischemic heart disease, and diabetes mellitus showed a positive correlation with advancing age. Additionally, the proportion of individuals with an educational level of 9 years or less was higher in older age groups. Conversely, the percentage of current smokers decreasing as age increased.

With respect to gait performance, both step length and gait speed demonstrated a negative association with age, with older subjects displaying progressively shorter step lengths and reduced gait speeds.

3.2. Associations between skin tactile perception and gait parameters

Figures 1 - 3 show the predicted relationships between skin tactile perception and step length, cadence, and gait speed after 10.8 years (mean follow-up time) from baseline. The association between skin tactile perception and gait parameters, specifically cadence and gait speed, exhibits distinct patterns across middle-aged and older adult populations. Among middle-aged individuals (aged 40 and 50 years), the correlation between skin tactile perception and cadence and gait speed was negligible. However, a more complex relationship emerges for older adults, particularly those over 70 years of age. Initially, there is a rapid decline in both cadence and gait speed as skin tactile perception values

Table 1
Baseline characteristics of study participants according to age at baseline (n = 1,403).

	Age at baseline				
	40–<50 (n = 436)	50–<60 (n = 430)	60–<70 (n = 343)	70–79 (n = 194)	*P*-value[a]
Two-point discrimination test (mm), mean (SD)	9.6 (2.4)	10.1 (2.6)	10.6 (2.9)	11.4 (2.8)	<0.001
Age (years), mean (SD)	45.1 (2.9)	54.4 (2.8)	63.7 (2.7)	73.0 (2.6)	<0.001
Men, %	52.1	53.3	55.7	54.1	0.788
Height (cm), mean (SD)	162.1 (8.7)	160.3 (8.1)	158.2 (8.2)	154.6 (8.7)	<0.001
Body mass index (kg/m^2), mean (SD)	23.1 (3.0)	23.1 (2.8)	22.8 (2.8)	22.5 (2.9)	0.119
Medical history (yes), %					
Hypertension	8.3	18.6	29.7	38.1	<0.001
Ischemic heart disease	3.9	7.9	9.3	20.6	<0.001
Dyslipidemia	9.6	17.7	16.6	21.1	<0.001
Diabetes	2.5	5.1	8.7	8.8	<0.001
Current smoker, %	28.9	22.6	21.3	15.5	0.002
Total physical activity (METs-h/d), mean (SD)	33.8 (3.8)	33.9 (3.9)	32.8 (3.7)	31.7 (3.3)	<0.001
Education ≤9 years, %	6.9	26.7	42.3	49.5	<0.001
Step length (cm), mean (SD)	70.3 (6.6)	70.0 (7.7)	67.6 (7.5)	65.2 (8.4)	<0.001
Cadence (steps/min), mean (SD)	121.5 (11.6)	121.6 (11.5)	121.6 (11.3)	119.9 (12.3)	0.392
Gait speed (m/min), mean (SD)	83.8 (10.4)	83.1 (10.4)	80.7 (10.3)	75.6 (11.1)	<0.001

[a]Estimated using Kruskal-Wallis rank sum test for continuous variables and Pearson's Chi-squared test for categorical variables.

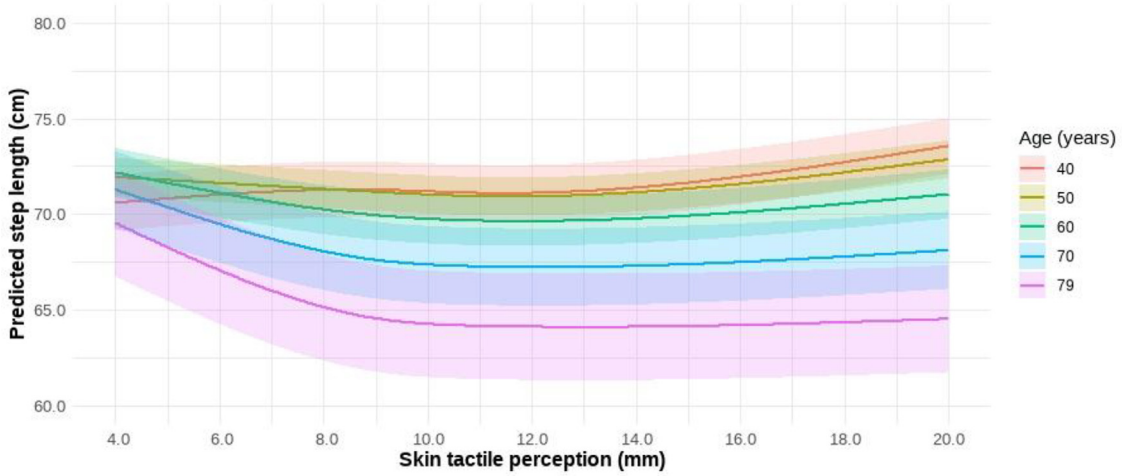

Fig. 1. Predicted relationships between skin tactile perception and step length with their 95 % confidence intervals after 10.8 years (mean follow-up time) from baseline. Analysis was completed using mixed-effects models with splines, adjusted for baseline information on quadratic term for centered age (continuous), sex (categorical), follow-up duration (continuous), height (continuous), BMI (continuous), quadratic terms for BMI (continuous), smoking status (current smoker, or others; categorical), total physical activity (continuous), educational level (≤9 years, 10–12 years, and ≥13 years; categorical), and medical history (yes or no for each disease; categorical). Estimated step length was calculated based on the following values: quadratic term for centered age, sex (male), follow-up duration (mean value: 10.8 years), height (mean value: 159.5 cm), BMI (mean value: 22.9 kg/m^2), quadratic term for BMI, educational level (10–12 years), smoking status (non-current), total physical activity (mean value: 33.3 METs-h/d), and medical history (none of the mentioned diseases).

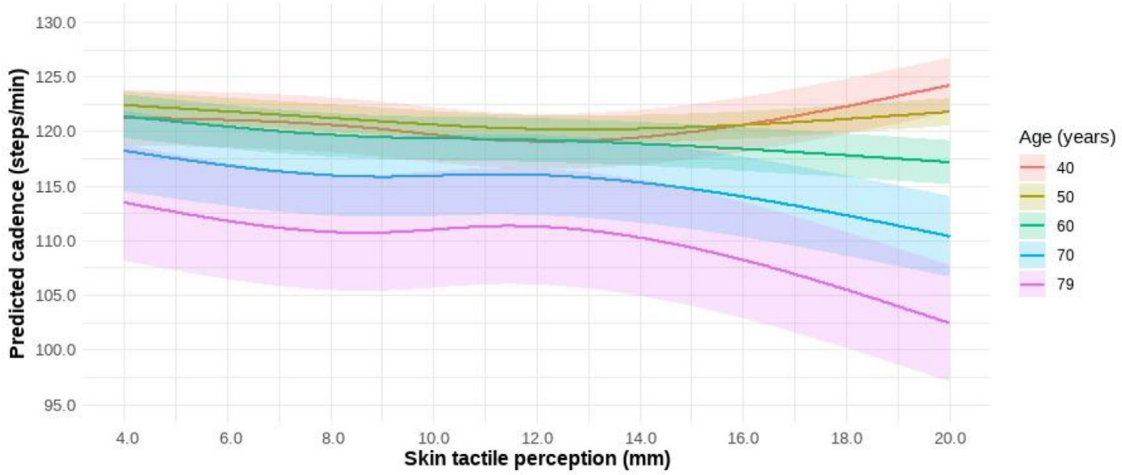

Fig. 2. Predicted relationships between skin tactile perception and cadence with their 95 % confidence intervals after 10.8 years (mean follow-up time) from baseline. Analysis was completed using mixed-effects models with splines, adjusted for baseline information on quadratic term for centered age (continuous), sex (categorical), follow-up duration (continuous), height (continuous), BMI (continuous), quadratic terms for BMI (continuous), smoking status (current smoker, or others; categorical), total physical activity (continuous), educational level (≤9 years, 10–12 years, and ≥13 years; categorical), and medical history (yes or no for each disease; categorical). Estimated cadence was calculated based on the following values: quadratic term for centered age, sex (male), follow-up duration (mean value: 10.8 years), height (mean value: 159.5 cm), BMI (mean value: 22.9 kg/m^2), quadratic term for BMI, educational level (10–12 years), smoking status (non-current), total physical activity (mean value: 33.3 METs-h/d), and medical history (none of the mentioned diseases).

increase. This decline plateaus when skin tactile perception reaches approximately 10 mm. Subsequently, as skin tactile perception increases to 12 mm, a second phase of decline in both cadence and gait speed is observed.

The relationship between skin tactile perception and step length demonstrated a different pattern. While the association between these factors remained negligible in middle-aged individuals, it showed subtle variations among older adults. Among older individuals, step length initially decreased with increasing skin tactile perception. However, once skin tactile perception reached 10 mm, step length stabilized, showing minimal further change despite continued increases in tactile perception thresholds.

The detected inflection points are presented in Table 2. The results demonstrate that the mean inflection points for all age groups (40–79 years) cluster around 10 mm (ranging from 9.52 to 10.78 mm) for all three gait parameters (step length, cadence, and gait speed).

4. Discussion

In this longitudinal study, we investigated the association between skin tactile perception at baseline and subsequent change in gait parameters among community-dwelling Japanese middle-aged and older adults. Our findings reveal that the longitudinal associations between skin tactile perception and step length, cadence, and gait speed ex-

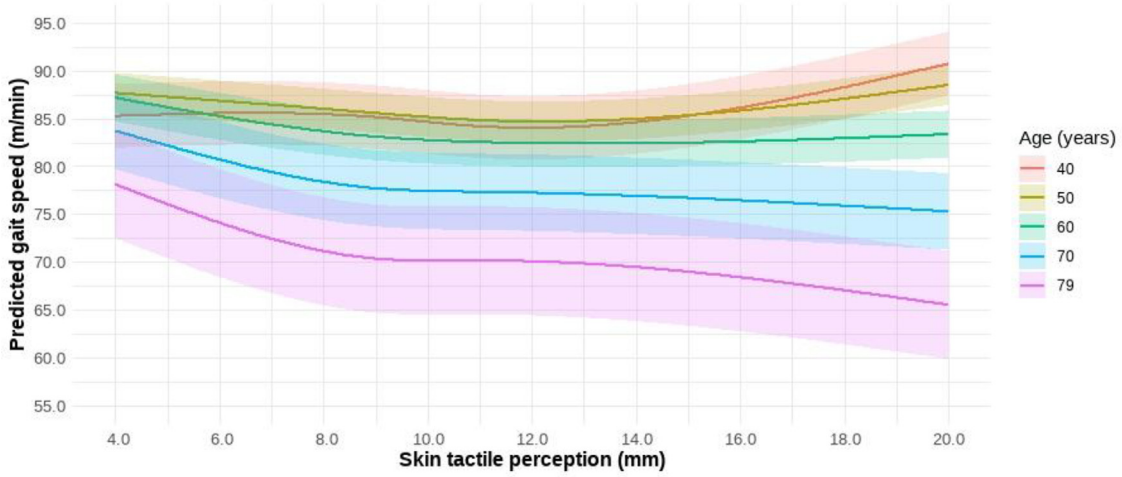

Fig. 3. Predicted relationships between skin tactile perception and gait speed with their 95 % confidence intervals after 10.8 years (mean follow-up time) from baseline. Analysis was completed using mixed-effects models with splines, adjusted for baseline information on quadratic term for centered age (continuous), sex (categorical), follow-up duration (continuous), height (continuous), BMI (continuous), quadratic terms for BMI (continuous), smoking status (current smoker, or others; categorical), total physical activity (continuous), educational level (≤9 years, 10–12 years, and ≥13 years; categorical), and medical history (yes or no for each disease; categorical). Estimated gait speed was calculated based on the following values: quadratic term for centered age, sex (male), follow-up duration (mean value: 10.8 years), height (mean value: 159.5 cm), BMI (mean value: 22.9 kg/m^2), quadratic term for BMI, educational level (10–12 years), smoking status (non-current), total physical activity (mean value: 33.3 METs-h/d), and medical history (none of the mentioned diseases).

Table 2
The bootstrap estimates of age-specific inflection points (for skin tactile perception) and their 95 % confidence intervals (CI) after 10.8 years (mean follow-up time) from baseline.

		Step length			Cadence			Gait speed		
Centered age	Baseline age (years)	Mean	95 % CI		Mean	95 % CI		Mean	95 % CI	
-20	40	9.97	9.19	10.61	9.81	9.07	10.84	9.77	9.19	10.61
-10	50	9.82	8.87	11.12	9.96	8.97	10.80	9.99	8.87	11.12
0	60	10.78	9.34	11.42	10.13	9.39	10.83	10.63	10.33	11.05
10	70	10.55	9.25	10.86	10.04	9.45	10.45	10.48	10.28	10.70
19	79	9.52	8.97	10.41	10.00	9.56	10.30	10.38	10.28	10.44

hibit both similarities and differences. Importantly, these associations are moderated by baseline age. Furthermore, the consistent inflection point observed across age groups and gait parameters suggests that a skin tactile perception threshold of 10 mm may serve as a critical value for predicting changes in gait performance.

In middle-aged individuals, we found no associations between skin tactile perception and changes in step length, cadence, and gait speed. However, in adults aged 60 and above, a more complex association emerged. Step length initially decreased with increasing skin tactile perception up to the 10 mm threshold, beyond which it remained relatively stable. Conversely, skin tactile perception demonstrated non-linear associations with cadence and gait speed, characterized by an initial decline with increasing skin tactile perception up to the 10 mm threshold, a plateau phase up to the 12 mm threshold, and a secondary decline beyond that point. This pattern indicates a complex interplay between sensory input and motor output in the aging population.

The two-point discrimination threshold, a measure of tactile spatial acuity, is widely used to evaluate higher-order perceptual functions in rehabilitation [13]. The two-point discrimination threshold typically increases with age and conditions involving central or peripheral nerve impairment [14,15], as well as non-specific low back pain [16]. The present study excluded participants with a medical history of cerebrovascular disease, rheumatoid arthritis, and Parkinson's disease at baseline before analysis, which may have minimized the effects of neurological impairment and pain. However, conditions such as cervical spondylosis or lumbar disc herniation may have also influenced the association between skin tactile perception and gait function.

Tactile perception is a complex phenomenon that involves multiple cortical regions via the primary somatosensory cortex [17], with the two-point discrimination being primarily considered as a parietal lobe function [15,18]. On the other hand, structural or functional deficits in the parietal cortex have been found to lead to impairments in gait performance, causing shortened step length and increased step width [19]. Therefore, we postulate that our findings may be influenced by the structural and functional integrity of the parietal lobe in our participants, which is a crucial brain region for integrating tactile and motor information. Individuals with higher tactile sensitivity may possess superior spatial acuity and enhanced proprioceptive processing, thereby facilitating motor control and balance coordination during gait. Future studies may require additional neuroimaging data to corroborate the validity of the above hypothesis.

The stronger association of the two-point discrimination test on the thenar eminence with cadence and gait speed compared to step length is an intriguing finding that warrants further discussion. This might be explained by the differential neural control mechanisms underlying these gait parameters. Cadence and gait speed are more closely related to the rhythmic aspects of gait, primarily controlled by central pattern generators in the spinal cord and brainstem [20,21]. These central pattern generators are heavily influenced by sensory feedback, including tactile information [22]. In contrast, step length depends more on lower limb

biomechanics and joint mobility, which may be less directly related to upper limb sensory function [23].

Considering the feasibility of the assessment, the present study used hand skin tactile perception as an indicator of tactile perception. However, plantar sensation may be more relevant to gait. Previous studies have reported that impaired plantar sensation induced by ice immersion resulted in significant gait alterations, manifesting as reduced gait velocity and stride length [24,25]. Furthermore, plantar sensory training has been demonstrated to potentially benefit balance ability in older adults, thereby preventing falls [26]. Based on the evidence above in conjunction with our findings, enhancing or maintaining skin tactile perception sensitivity may be advantageous for preventing frailty in older adults and reducing adverse health outcomes such as falls.

With increasing age, skin tactile perception sensitivity tends to diminish, often unnoticed due to a lack of routine assessment in general physical examinations [6]. Our findings have important clinical implications, particularly for fall prevention and rehabilitation in older adults. The identified 10 mm threshold in tactile perception could be an early indicator of fall risk, allowing timely interventions. Although addressing age-related decline in skin tactile perception sensitivity may be challenging, several strategies show promise. Skin tactile perception can improve in warm environments [27], and sensory rehabilitation training may enhance tactile sensitivity. In rehabilitation, incorporating sensory integration exercises, such as using textured insoles providing plantar sensory stimulation, could enhance stability during standing [28,29] and improve foot sensibility and gait speed in older adults with diabetes [30]. The simplicity of tactile perception tests also makes them potential screening tools for gait impairment risk in clinical settings. However, future studies using tactile perception measures of feet are needed to validate these approaches. Investigating the effectiveness of interventions targeting tactile perception in improving gait performance and reducing fall risk could provide valuable insights for clinical practice.

A key strength of this study is its use of longitudinal survey data to establish, for the first time, the association between two-point discrimination and subsequent walking ability in community-dwelling middle-aged and older adults. It suggests that even a simple and feasible assessment of skin tactile perception can provide helpful information for health management. Nevertheless, this study also has limitations. First, the two-point discrimination test was applied for assessing tactile perception. While this test is simple, widely accepted, and feasible for large-scale epidemiological studies, it provides a relatively crude measure of tactile sensitivity. More sophisticated techniques, such as vibration perception thresholds or pressure sensitivity tests, could have provided a more nuanced assessment of tactile function. Second, we used hand tactile perception but not plantar sensation, which is more directly involved in gait. The neural pathways for hand and foot sensation involve different spinal cord levels and potentially different cortical representations, while both are part of the dorsal column-medial lemniscus pathway (also associated with gait performance) [31]. In addition, the sensory receptors in the hands and feet, although similar, may be subject to different environmental factors, usage patterns, and age-related changes. Third, we did not include assessments of lower limb muscle strength or vestibular function, which are essential for maintaining stability while standing and wal kingsa a king. Fourth, as the present study is observational, the observed associations might reflect shared age-related changes in both skin tactile perception and gait performance rather than a direct causal relationship. Fifth, although we adjusted for many confounders in our analysis, residual confounding effects such as drug use could not be excluded. Last, our exclusion criteria of participants may have introduced some degree of selection bias, potentially limiting the generalizability of our findings. Therefore, we anticipate an increasing number of studies that include participants with common age-related health conditions to investigate the association between skin tactile perception (in particular, the use of tactile assessment methods in combination with different body parts) and gait changes, as well as adverse health outcomes in the population. These studies will provide robust evidence for preventing age-related health issues.

5. Conclusions

This longitudinal study provides novel insights into the association between skin tactile perception and gait parameters in middle-aged and older adults. Our findings reveal that the relationship between tactile perception and gait performance is age-dependent and non-linear. While no significant associations were observed in middle-aged individuals, adults aged 60 and above demonstrated complex relationships between skin tactile perception and gait parameters. Notably, we identified a consistent inflection point around 10 mm in tactile perception across different age groups and gait parameters, suggesting this threshold may serve as a critical indicator for predicting changes in gait performance. These results highlight the potential utility of the two-point discrimination test as a simple yet informative tool for assessing fall risk and gait impairment in older adults.

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Conflict of interest

None.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.tjfa.2024.100006.

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