Gait Seed and Sagittal Abdominal Diameter: The Results from the Handan Eye Study

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Abstract

Background

The sagittal abdominal diameter (SAD) is more precise than body mass index (BMI) for predicting adverse events in elderly. While physical function and BMI is related, the relationship is uncertain. BMI and gait speed (GS) is related and have a U-shaped distribution. The objective was to examine the relationship between GS and SAD in men and women aged 50 years and older.

Methods

This was a cross-sectional analysis. Data from the Handan Eye Study (HES), a Chinese prospective longitudinal study with participants randomly selected from the Yongnian county. Usual GS was measured over a 4 meters-track. SAD was categorized by interquartile: <18.0cm; 18.0-19.79cm; 19.8-21.89cm; $\geq$ 21.9cm. Unadjusted and adjusted analyses of covariance were performed to estimate the gender-specific means (and 95% CI) of GS (in m/s) according to SAD categories.

Results

The current analyses were performed in 2852 participants. Mean age was 56.16 years for women and 56.54 years for men. The unadjusted means of GS were 0.995 (95% CI 0.972-1.019) m/s in SAD Q1 participants, 0.991 (95% CI 0.968-1.014) m/s in SAD Q2, 0.986 (95% CI 0.964-1.007) m/s in SAD Q3 and 0.961 (95% CI 0.937-0.985) m/s in SAD Q4 individuals in women. The similar trend presented in men [Q1: 0.993 (95%CI 0.969-1.016) m/s; Q2: 0.980 (95%CI 0.956-1.004); Q3: 0.944 (95%CI 0.918-0.970); Q4: 0.948 (95%CI 0.923-0.973)]. After adjustment for age, the reported trends between GS and SAD in categories were largely confirmed in women, but not in men.

Conclusions

Age and gender should be considered when we explore the relationship between GS and SAD in elderly.

Background

Ageing and its associated social problems have turned into a common concern in many countries. Physical function decline is the main component of ageing and also is critical risk factor for adverse events of ageing such as mortality, fall, disability, hospitalization [1]. Gait speed (GS) is a generally utilized estimation to assess to evaluate the physical function. Besides, GS has been viewed as a good predictor for death, cognitive impairment, depression and Alzheimer's disease in elderly [2].

Obesity is a prevalent disease in industrialized countries and has shown to significantly predict negative outcome. Other than clinical comorbidity, it is associated with subclinical conditions such as inflammation and oxidative damage. Body mass index (BMI) is a typical index to explore and classify obesity and be perceived as a marker in a few conditions such as systemic diseases, well-being and frailty, etc. In recent years, lots of studies uncovered that sagittal abdominal diameter (SAD) was a better indicator of cardiovascular disease, hypertension and diabetes than BMI and waist circumference [3, 4]. Previous studies have explored the relationship between BMI and GS, which demonstrated U-shaped relationship [5, 6], but not all studies affirmed reliably. No study has yet explored this relationship between SAD and GS in 50 years and older in a Chinese rural area.

Since BMI and GS are related and have a U-shaped distribution, we hypothesize that SAD (a better predictor than BMI) may also be associated with GS. Therefore, the purpose of this study is to explore whether SAD and GS are associated or not and to indicate their correlation types among village-dwelling older adults aged 50 years and older.

Methods

Data source and study population

The Handan Eye Study (HES) is a population-based longitudinal study in Handan, Hebei Province, China. In 2006-2007, 6830 subjects of 7557 individuals (response rate:90.4%) participated in the baseline study. In 2012-2013, 5394 subjects (85.3 %) of the survivors took part in the follow up study. GS test was performed in subjects aged 50 years or above. A detailed description of the methodology used for the HES can be found in previous publications [7, 8]. Beijing Tongren Hospital Ethics Committee (TREC2006-22) approved the HES according to the principles embodied in the Declaration of Helsinki and all participants provided written informed consent.

The data used in this study were collected from the HES follow-up study because SAD measurement was conducted only in the follow-up study. A comprehensive questionnaire, laboratory tests, an extensive eye examination procedure and an anthropomorphic procedure which included standing height, weight, SAD, waist circumference, hip circumference and blood pressure were undergone by trained nurses and examiners.

Sagittal Abdominal Diameter

SAD was measured using a portable sliding-beam caliper (Holtain Ltd, Crymych, UK). Participants rested on a lightly padded bed in a flexed position when the examiner marked the level of the iliac crests. The examiner lowered the caliper upper arm, lightly touching the abdomen. The SAD was recorded in duplicate to the nearest 0.1 cm [9].

Gait Speed

Participants performed the 4-meter gait speed (GS) test according to standardized instructions [10]. Participants were asked to walk a distance of 4 meters at their usual pace, starting from a still position. Start the timer with the first footfall after the 0-m line and stop the timer with the first footfall after the 4-m line. GS was operationalized as the ratio between distance and time, and expressed in meters by seconds (m/s).

Other Variables

A detailed interviewer-administered questionnaire which included socio-demographics, self-reported chronic diseases and living behaviors such as smoking, drinking was used. Diabetes and hypertension were defined according to self-report from participants (previously diagnosed).

Statistical analysis

The data are presented as the means and standard deviations for continuous variables and as frequencies and percentages for categorical variables. All analyses were independently conducted for men and women to evaluate the gender differences for SAD. SAD was categorized by interquartile. Unadjusted and adjusted analyses of covariance were performed to assess the gender-specific means (and 95% CI) of GS (in m/s) as indicated by SAD categories. After having provided results from the unadjusted analyses, age-adjusted models were performed. Spearman correlation coefficients were utilized to clarify the associations between SAD and GS. P-values < 0.05 were considered statistically significant and 95% confidence intervals (95% CI) are provided. All analyses were performed using SPSS, version 24.0 (SPSS Inc., Chicago, IL, USA).

Results

Among the 5394 participants enrolled in the HES follow-up study, 3297 were aged 50 years or older. We choose the sample because SAD only performed in the HES follow-up study and GS test in elderly aged 50 years or above. The current analyses were performed in 2852 (86.5%) participants,

after exclusion of 445 (13.5%) individuals with missing data for the main variables of interest (GS or/and SAD).

Table 1 shows that the excluded 445 were older (72.5 ± 3.67 versus 58.33 ± 4.77), had a lower hip

circumference (100.72 ± 10.03 cm versus 101.88 ± 9.83 cm) and higher hypertension (10.6% versus 8.4%). There were no significant differences in BMI, waist circumference, systolic blood pressure, diastolic blood pressure, SAD and the status of diabetes, smoking, alcohol drinking between the two groups.

Table 2
Main characteristics of the study sample according to gender

	Women (N=1559)	Men (N=1293)	P
Age (years)	56.16±4.72	56.54±4.81	0.039
Systolic BP (mmHg)	146.02±22.00	145.98±21.76	0.960
Diastolic BP (mmHg)	82.39±12.16	82.57±11.91	0.693
BMI (kg/m ²)	25.48±3.83	25.61±3.97	0.341
Waist circumference (cm)	89.10±11.50	89.78±11.54	0.124
Hip circumference (cm)	102.13±9.75	101.59±9.94	0.150
SAD (cm)	20.31±3.12	19.85±3.06	0.000
4m gait speed (m/s)	0.98±0.23	0.97±0.23	0.045

Table 1
Comparison of subjects included and non-participated from GS data analysis

	Included (N=2852)	Non-participates (N=445)	p
Age (years)	58.33±4.77	72.50±3.67	0.000
Female	89.6%	90.9%	0.217
Systolic BP (mmHg)	145.65±21.99	144.16±26.51	0.523
Diastolic BP (mmHg)	81.99±12.10	82.04±13.26	0.956
BMI (kg/m ²)	25.54±3.89	25.60±3.90	0.866
Waist circumference (cm)	89.41±11.52	89.46±11.34	0.93
Hip circumference (cm)	101.88±9.83	100.72±10.03	0.031
SAD (mm)	201.00±30.96	199.32±30.89	0.301
Diabetes			
Yes	9.9%	10.0%	1.000
No	90.1%	90.0%	
Hypertension			
Yes	8.4%	10.6%	0.041
No	91.6%	89.4%	
Smoking			
Yes	10.2%	8.1%	0.099
No	89.8%	91.9%	
Drinking			
Yes	9.6%	9.9%	0.93
No	90.4%	90.1%	

Table 2 shows the main characteristics according to gender. The mean age of the 2852 participants [1559 women (54.7%) and 1293 men (45.3%)] was 56.16 years for women and 56.54 years for men ($p = 0.039$). Women had lower SAD ($p = 0.000$) and GS ($p = 0.045$) compared to men. No difference between men and women was reported for BMI, systolic blood pressure, diastolic blood pressure, waist circumference and hip circumference.

The relationship between the GS and SAD categories in analyses of covariance is presented in Table 3. The unadjusted means of GS were 0.995 (95% CI 0.972-1.019) m/s in SAD Q1 participants, 0.991 (95% CI

0.968-1.014) m/s in SAD Q2, 0.986 (95% CI 0.964-1.007) m/s in SAD Q3 and 0.961 (95% CI 0.937-0.985) m/s in SAD Q4 individuals in women. The similar trend presented in men [Q1: 0.993 (95%CI 0.969-1.016) m/s; Q2: 0.980 (95%CI 0.956-1.004); Q3: 0.944 (95%CI 0.918-0.970); Q4: 0.948 (95%CI 0.923-0.973)]. After adjustment for age, the reported trends between GS and SAD in categories were largely confirmed in women, but not in men.

GS and SAD were dramatically significantly correlated ($r=-0.072$, $P = 0.00$). Linear trends between SAD and GS were reported for women and men.

Table 3
Results from unadjusted and adjusted analyses of covariance presenting means (and 95% confidence intervals) of 4-meter gait speed according to sagittal abdominal diameter (SAD) categories, stratified by gender

	Age unadjusted 4m gait speed	Age adjusted 4m gait speed
Women (n = 1554)		
Q1, SAD<18.0cm (n = 377)	0.995 (0.972;1.019)	0.976 (0.954;0.999)
Q2, SAD18.0-19.79cm (n = 411)	0.991 (0.968;1.014)	0.961 (0.940;0.983)
Q3, SAD19.8-21.89cm (n = 393)	0.986 (0.964;1.007)	0.936 (0.915;0.957)
Q4, SAD≥21.9cm (n = 373)	0.961 (0.937;0.985)	0.907 (0.887;0.928)
P	0.177	0.000
Men (n = 1291)		
Q1, SAD<18.0cm (n = 326)	0.993 (0.969;1.016)	1.024 (1.002;1.047)
Q2, SAD18.0-19.79cm (n = 322)	0.980 (0.956;1.004)	1.008 (0.986;1.030)
Q3, SAD19.8-21.89cm (n = 320)	0.944 (0.918;0.970)	1.005 (0.981;1.028)
Q4, SAD≥21.9cm (n = 323)	0.948 (0.923;0.973)	1.023 (0.998;1.049)
P	0.013	0.000

Discussion

In this cross-sectional analysis of persons aged 50 years and older, we found that GS follows a linear pattern across SAD categories. Compared to those in the lowest quartile of SAD (<18cm), participants in the highest quartile (>21.9cm) were more likely to have lower GS. These relationships are independent of age in women, but not in men.

BMI is utilized to confirm in case subjects are overweight or obese disregarding the distribution of body fat. High BMI is related with hypertension, diabetes mellitus and cardiovascular diseases. Abdominal

adiposity is likewise a risk factor for the development of dyslipidemia, hypertension CVDs and glucose intolerance. Aggregating proof proposes that visceral adipose tissue is more emphatically identified with metabolic risk factors than subcutaneous adipose tissue. WC and SAD are utilized as abdominal obesity markers, yet WC doesn't recognize visceral from subcutaneous adipose tissue, and consequently can't precisely reflect levels of visceral adipose tissue. SAD gives a superior intra-abdominal or visceral obesity estimate than WC.

Our study revealed that the unadjusted means of GS decreased with increase of SAD. It presented a linear pattern both in men and in women and was confirmed by recent evidence. A few reports have shown that fatty infiltration of muscle is a significant part of low muscle strength and that abdominal obesity can lessen muscle strength through inflammatory and endocrine mechanisms [11–13]. Aging is associated with increased the inflammatory activity. Raised CRP levels have been related with incident mobility limitations in subjects with and without diabetes [14]. A new report found that WC was firmly associated with mobility disability and with activities of daily living disability and showed that obesity was associated with functional decline after some time [15].

We also found that the trend was largely confirmed in women, but not in men after adjustment for age. It is notable that ageing leads to reduction of functional ability and increase of visceral adipose tissue. Past studies have shown that body fat will redistribute and subcutaneous fat tissue will move to visceral adipose tissue with age [16]. The difference is partly explained by menopausal status. Several alterations in fat deposits occur with the advent of the menopause, leading to a change in the distribution of body fat. Postmenopausal women had a higher prevalence of central obesity [17].

The strengths of our study included that it provided the relationship between SAD and GS in a Chinese rural and village settings. However, there are some limitations in our study. First, the participants were recruited among persons aged 50 years and older living in rural areas. This may introduce a representativeness bias for external validation of our results. Second, non-participants were older and had more hypertension which could lead to selection biases. Third, no conclusion in regard to the cause or consequence can be drawn, due to the cross-sectional approach.

Conclusions

A linear relationship between gait speed and SAD is here demonstrated. After age adjustment, the relationship exists in women, not in men. It may provide complementary information in the comprehensive assessment of older persons. Age and gender should be considered when we explore the relationship between physical function and visceral adipose tissue in elderly.

Abbreviations

SAD: Sagittal abdominal diameter; BMI: Body mass index; GS: Gait speed; CI: Confidence interval; HES: Handan Eye Study; CVD: Cardiovascular disease; CRP: C-reactive protein

Declarations

Acknowledgement

The authors acknowledge the contribution of the study participants and the HES group involved in data collection.

Authors' contributions

JPL analyzed the data, participated in the manuscript writing and revision, finalized the results, and made the tables and figures. XRL and NLW provided critical comments on the design and the results and conceived the study ideas. KC provided comments on data sources and the manuscript. JH and YZ involved data collection, management and result interpretation. All authors participated in the discussion and contributed to the final manuscript. All authors read and approved the submission of the final manuscript to BMC Geriatrics.

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Availability of data and materials

Final analysis data will be available to the researchers upon request via email at

tydljp@126.com or by mail to Dr. Ningli Wang, Beijing Tongren Eye Center, Beijing Tongren Hospital, Capital Medical University, Beijing Ophthalmology & Visual Science Key Laboratory, Beijing Institute of Ophthalmology, No.1. Dong Jiao Min Xiang, Dongcheng District, Beijing, 100730, China.

Ethics approval and consent to participate

All the participants gave informed written consent, and the survey was approved by the Beijing Tongren Hospital Ethics Committee (TREC2006-22).

Consent for publication

Not applicable.

Competing interests

The authors declare no conflicts of interest in the present study.

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