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ORIGINAL RESEARCH

Association Between Dynapenic Abdominal Obesity and Fall Risk in Older Adults

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Background: In recent years, dynapenic abdominal obesity has received more and more attention. This article aimed to explore the relationship between dynapenic abdominal obesity and fall risk in older adults.
Methods: In this cross-sectional study, according to waist circumference (≥90 cm for men and ≥85 cm for women) and handgrip strength (<28 kg for men and <18 kg for women), 551 older adults were divided into four groups: dynapenic abdominal obese (D/AO), dynapenic nonabdominal obese (D/NAO), nondynapenic abdominal obese (ND/AO) and nondynapenic nonabdominal obese (ND/NAO). Fall risk was measured by the Tinetti performance-oriented mobility assessment (POMA). Binary logistic regression was used to explore the relationship between D/AO and fall risk.
Results: D/AO was related to POMA score (odds ratio [OR]=3.39; 95% confidence interval [CI]: 1.47–7.81; P=0.004) after adjusting the confounding variables. However, D/NAO (OR=1.51; 95% CI:0.69–3.32; P=0.302) and ND/AO (OR=1.48; 95% CI:0.74–2.99; P=0.272) were not associated with POMA score.
Conclusion: This study suggests that older adults with D/AO have a higher risk of falls. Therefore, it is necessary to strengthen the attention to D/AO and relevant interventions should be implemented.
Keywords: dynapenic abdominal obesity, fall risk, older adult

Introduction

The global population is aging. At present, about 11% of the world's population is over 60 years old, and it is expected that this proportion will rise to 22% by 2050.[1] As we all know, balance and gait disturbance is common in older people and is the potential cause of falls.[2,3] Tinetti performance-oriented mobility assessment (POMA), which includes balance and gait subscales, is widely used to assess a patient's fall risk.[43] Among older adults, falls are the main cause of accidental injuries and injury-related deaths, consuming a lot of medical resources.[4,5] Therefore, fall risk assessment need to be taken seriously in older adults.

At present, the prevalence of overweight and obesity worldwide is increasing and almost a third of the world's population is classified as overweight or obese.[6] Obesity is related to functional limitation, disability and poorer quality of life.[7] In older adults, the proportion of body fat, especially abdominal fat, increases with age. Therefore, based on height and weight, body mass index (BMI) cannot accurately measure the changes in body fat.[8,9] Waist circumference is considered to be a substitute for measuring fat distribution. It is widely used to diagnose abdominal obesity and may be a better measure of obesity in older adults.[9]

With age, human muscle strength and muscle mass decrease. Previous studies have suggested that age-related muscle mass decrease is the main cause of insufficient muscle strength,[10,11] but recent studies have shown that muscle mass decrease has a relatively small effect on the loss of muscle strength.[12,13] The relationship between muscle strength and muscle volume is not linear[14] and the decline in muscle strength is much faster than the decline in muscle mass.[15] Studies have shown that physical function is more affected by muscle strength, rather than muscle mass.[16,17] Newman et al[18] pointed out that muscle strength rather than muscle mass was related to mortality. In predicting health-related outcomes

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in older people, muscle strength was better than muscle mass.[19,20] Therefore, dynapenia was proposed to define age-related loss of muscle strength.[21,22]

Previous studies separately explored the effects of abdominal obesity and dynapenia. It was found that abdominal obesity had a greater impact on metabolic disorders,[23] had independent effects on functional limitations and disability,[24–26] and was associated with mortality.[27] And dynapenia increased the risk for functional limitations, disability, and mortality.[22] However, recent studies have found that the simultaneous presence of abdominal obesity and dynapenia have a greater adverse effect. Studies have shown that patients with dynapenic abdominal obese (D/AO) had a higher prevalence of metabolic syndrome,[28,29] a higher risk of falls and fall events,[30–32] a faster decline in walking speed,[32,33] a higher risk of functional decline,[34,35] and a higher rate of disability, mortality and hospitalization.[36–38] Among older women, patients with D/AO were associated with increased risk and fear of falls and reduced dynamic balance.[39]

As we known that falls affect the clinical prognosis of older adults. And D/AO has an important impact on physical function. However, only a few studies have directly investigated the relationship between D/AO and fall risk, and there are no previous studies conducted in Asian population. Therefore, this article tries to explore the relationship between D/AO and fall risk in Chinese people, so as to find potential ways to prevent falls in older people.

Methods

Participants

This was a cross-sectional study. The 551 participants were selected from inpatients and outpatients in the geriatric department of Zhejiang Hospital in China from October 2014 to July 2019, who had completed a comprehensive geriatric assessment (CGA). The CGA was performed by a professional geriatric assessment team. The inclusion criteria were as follows: (1) Aged 65 years or older; (2) Ability to walk independently (walking aids such as cane were allowed); (3) Able to understand and communicate in Chinese. The exclusion criteria were as follows: (1) severe acute infection, uncontrolled malignant tumor, severe heart, lung or kidney disease, Parkinson's disease or Parkinson's syndrome, cerebellar disease, acute cerebrovascular disease, delirium, terminal illness; (2) severe vision or hearing impairment; (3) severe cognitive impairment (Mini-Mental State Examination (MMSE) score ≤10 points). This study was in compliance with the Declaration of Helsinki and was approved by the medical ethics committees of Zhejiang Hospital. Each subject signed a written informed consent.

Classification of the Groups

Waist circumference was measured at the level of umbilicus. According to the unique standards of abdominal obesity in Asia, abdominal obesity is defined as WC≥90 cm for men and WC≥85 cm for women.[40,41] And handgrip strength was measured using a dynamometer (the Camry EH101 Electronic Hand Dynamometer). Participants did it three times with their dominant hand, and the best result of the test was recorded. According to Asian Working Group for Sarcopenia (AWGS), low muscle strength is defined as handgrip strength <28 kg for men and <18 kg for women.[42] According to the grouping criteria of waist circumference and handgrip strength, the participants were divided into four groups: D/AO, D/NAO, ND/AO and ND/NAO.

Fall risk Assessment

The fall risk was measured with POMA, which includes balance and gait subscales.[43] The balance subscale includes nine components: sitting balance, arises, attempts to arise, immediate standing balance, standing balance, nudged, eyes closed, turning 360°, and sitting down, with a maximum score of 16 points. And the gait subscale consists of seven components: initiation of gait, step length, step symmetry, step continuity, path, trunk, and walking stance, with a maximum score of 12 points. The total score is the sum of the two subscale scores with a maximum score of 28. The total score is associated with different levels of fall risks, from low risk (>24) to medium or high risk (0–24).

Covariates

The covariates included in this analysis constitute a broad range of factors related to fall risk.[3] The demographic data were collected including: age, gender, education level, marital status, BMI, smoking, drinking, hearing, vision, comorbidity, polypharmacy and orthostatic hypotension. The oldest old was defined as 80 years old and over.[44] So the cut-off point for age here was 80 years old. BMI was calculated by weight/height^2. The World Health Organization recommends that the definition of overweight is BMI ≥ 25 kg/m^2.[45] Comorbidity was referred to the clinical diagnosis of 5 or more diseases.[46] Polypharmacy was defined as the patient taking 5 or more oral prescription drugs.[47] Orthostatic hypotension was defined as a at least 20 mmHg drop in systolic blood pressure or 10 mmHg drop in diastolic blood pressure within 3 minutes of standing position in the orthostatic test.[48] The history of falls in the past year, fear of falling and walking aids were also recorded. A fall is a sudden, involuntary, or unintentional change in body position, falling to the ground or a lower surface.[49] Furthermore, the gait speed (m/s) was calculated using a four-meter gait speed test. Slow gait speed was defined as <1 m/s.[42]

In addition, the 15-item Geriatric Depression Scale (GDS-15) was used to screen for the symptoms of depression in older people, and the sum of score≥6 points was considered to have depressive symptoms.[50] Cognitive function was assessed using the MMSE and the score ≤24 was considered to have cognitive impairment.[51] Nutritional status was assessed by the Mini Nutritional Assessment-Short Form (MNA-SF), and patients with the score≤11 points was considered to be at risk of malnutrition.[52]

Statistical Analysis

Statistical analysis was performed using SPSS 23.0 software. All the data was expressed as a percentage or constituent ratio and the chi-square was used to determine the significant difference among the four groups. In addition, binary logistic regression conducted with 2 models was used to analyze the relationship between D/AO and POMA score, expressed in odds ratios (ORs) and 95% confidence intervals (CIs). Model 1 was not adjusted for covariates and Model 2 was adjusted for age, sex, marital status, education, BMI, smoking, drinking, hearing, eyesight, orthostatic hypotension, comorbidities, polypharmacy, walking aids, history of falls, fear of falling, four-meter walk, MMSE scores, GDS-15 scores, MNA-SF scores. Two-tailed tests were used for all significance tests, and P <0.05 was considered a significant difference.

Results

A total of 551 people were included in the study, including 105 people with D/AO, 79 with D/NAO, 194 with ND/AO and 173 with ND/NAO. As can be seen in Table 1, the four groups had differences in age, gender, marriage status, BMI, comorbidities, polypharmacy, walking aids, history of falls, fear of falling, four-meter gait speed, MMSE scores, MNA-SF scores and POMA scores (all with P<0.05). And there were no significant differences in education level, smoking history, alcohol drinking history, hearing, eyesight, orthostatic hypotension or GDS-15 scores (all with P>0.05).

Then, binary logistic regression analysis was performed between fall risk (POMA score≤ 24) and D/AO (Table 2). Model 1 without adjusting covariates was a crude model and it was showed that D/AO (OR: 11.39, 95% CI: 6.31–20.58; P<0.001), D/NAO (OR: 6.14, 95% CI: 3.42–11.03; P<0.001) and ND/AO (OR:1.58, 95% CI: 1.02–2.47; P=0.043) were all associated with increased fall risk. Model 2 found that only D/AO (OR:3.39, 95% CI: 1.47–7.81; P=0.004) was associated with increased fall risk adjusted for age, sex, marital status, education, BMI, smoking, drinking, hearing, eyesight, orthostatic hypotension, comorbidities, polypharmacy, walking aids, history of falls, fear of falling, four-meter walk, MMSE scores, GDS-15 scores, MNA-SF scores.

Discussion

This article found that D/AO was associated with increased fall risk in older adults, and the result remained unchanged even after adjusting for confounding variables. It suggests that the coexistence of decreased muscle strength and central obesity may have more important clinical application value in older people.

Previous studies have found that abdominal obesity is related to falls.[53] The possible mechanism is that the weight center of obese people is farther from the ankle joint. Therefore, compared with people of normal weight, they need a larger corrective ankle joint torque to offset the greater gravitational torque.[54] And dynapenia is the age-associated loss

Table 1 Characteristics of Older Adults According to Abdominal Obesity and Dynapenia Status

	Dynapenic Abdominal Obese (n=105)	Dynapenic Nonabdominal Obese (n=79)	Nondynapenic Abdominal Obese (n=194)	Nondynapenic Nonabdominal Obese (n=173)	P-value
Age (80 or more years old), n (%)	90 (85.7)	60 (75.9)	104 (53.6)	73 (42.2)	<0.001
Sex (female), n (%)	52 (49.5)	28 (35.4)	98 (50.5)	55 (31.8)	0.001
Marital status (married), n (%)	64 (61.0)	56 (70.9)	150 (77.3)	141 (81.5)	0.001
Education (senior high school or above), n (%)	57 (54.3)	49 (62.0)	104 (53.6)	104 (60.1)	0.436
BMI (≥25kg/m^2), n (%)	52 (49.5)	0 (0.0)	108 (55.7)	7 (4.0)	<0.001
Current or former smokers, n (%)	24 (22.9)	19 (24.1)	52 (26.8)	46 (26.6)	0.861
Current or former drinkers, n (%)	15 (14.3)	17 (21.5)	51 (26.3)	45 (26.0)	0.085
Hearing (Loss), n (%)	57 (54.3)	46 (58.2)	92 (47.4)	72 (41.6)	0.051
Eyesight (Loss), n (%)	66 (62.9)	47 (59.5)	112 (57.7)	87 (50.3)	0.183
Orthostatic hypotension, n (%)	28 (26.7)	17 (21.5)	40 (20.6)	35 (20.2)	0.599
Comorbidities (≥5 diseases), n (%)	81 (77.1)	56 (70.9)	123 (63.4)	97 (56.1)	0.003
Polypharmacy (≥5 drugs), n (%)	65 (61.9)	47 (59.5)	98 (50.5)	69 (39.9)	0.001
Walking aids, n (%)	49 (46.7)	29 (36.7)	28 (14.4)	16 (9.2)	<0.001
History of falls, n (%)	34 (32.4)	26 (32.9)	38 (19.6)	33 (19.1)	0.008
Fear of falling, n (%)	73 (69.5)	52 (65.8)	94 (48.5)	55 (31.8)	<0.001
Four-meter walk (<1m/s), n (%)	94 (89.5)	67 (84.8)	113 (58.2)	65 (37.6)	<0.001
MMSE (≤ 24 score), n (%)	55 (52.4)	39 (49.4)	58 (29.9)	41 (23.7)	<0.001
GDS-15 (≥ 6 score), n (%)	19 (18.1)	13 (16.5)	27 (13.9)	16 (9.2)	0.161
MNA-SF (≤ 11 score), n (%)	40 (38.1)	57 (72.2)	31 (16.0)	73 (42.2)	<0.001
POMA (≤ 24 score), n (%)	85 (81.0)	55 (69.6)	72 (37.1)	47 (27.2)	<0.001

Note: All data were analyzed by the chi-square test.

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Table 2 Association Between Fall Risk and Dynapenic Abdominal Obesity

	Model 1		Model 2	
	OR (95% CI)	**P-value**	**OR (95% CI)**	**P-value**
Nondynapenic Nonabdominal Obese	1	–	1	–
Dynapenic Abdominal Obese	11.39 (6.31–20.58)	<0.001	3.39 (1.47–7.81)	0.004
Dynapenic nonabdominal Obese	6.14 (3.42–11.03)	<0.001	1.51 (0.69–3.32)	0.302
Nondynapenic Abdominal Obese	1.58 (1.02–2.47)	0.043	1.48 (0.74–2.99)	0.272

Notes: Model 1: crude model; Model 2: adjusted covariates for age, sex, marital status, education, BMI, smoking, drinking, hearing, eyesight, orthostatic hypotension, comorbidities, polypharmacy, walking aids, history of falls, fear of falling, four-meter walk, MMSE scores, GDS-15 scores, MNA-SF scores.

of muscle strength,[21] which is an important contributor to balance and gait problems, causing the occurrence of falls.[55] Our research found that D/AO, D/NAO and ND/AO were all associated with increased fall risk. However, when the confounding variables were controlled, only D/AO was related to increased fall risk. This may be related to the characteristics of our subjects, and it was also showed that D/AO had a greater impact on fall risk.

Falls have caused a heavy economic burden on society.[4] Previous articles have attempted to explore the relationship between D/AO and falls. Gadelha et al[30] found that in a total of 201 older women, D/AO was more closely related to falls than either dynapenia or abdominal obesity alone, and was independently associated with an increased incidence of falls. And Máximo et al[31] analyzed the data from 1046 community-dwelling participants and discovered that there was a stronger association between D/AO and a single fall. The above results are consistent with our study.

In addition, studies have tried to explore the relationship between D/AO and falls-related phenotype. Pereira et al[39] found that D/AO was associated with increased risk and fear of falls and reduced dynamic balance in 217 older women. Zhang et al.[32] found that D/AO exhibited worse gait speed and increased the risk of fall events in older adults.Our article found that D/AO was related to increased fall risk in Chinese older adults. Fall risk was assessed by POMA, which includes balance and gait subscales. It suggested that D/AO may have poorer balance and gait, which may provide a potential direction for prevention of falls in older adults.

This article has some advantages. Firstly, the data measuring method in the article is easy, which is convenient for clinical implementation. Secondly, we grouped D/AO, D/NAO, ND/AO and ND/NAO according to Asian demographic standards, which is more in line with the characteristics of Chinese people. Also, this study has some limitations. First of all, this is a cross-sectional study and we cannot determine the causal relationship between D/AO and fall risk. Second, our subjects were selected from inpatients and outpatients in the same hospital, and the differences between inpatients and outpatients were not analyzed, which affected the generalizability of our results. Therefore, prospective studies with more representative subjects are needed to further explore the relationship between D/AO and fall risk.

Conclusions

This article found that older adults with D/AO had a higher risk of falls. Therefore, D/AO in older adults should be taken seriously and corresponding intervention measures such as increasing muscle strength and controlling abdominal obesity should be taken, which will help prevent falls in older people.

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Disclosure

The authors report no conflicts of interest in this work.

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