Original Article

Balance Assessment Using Multi-Directional Reach Test in Community-Dwelling Elderly People with Different Body Mass Index

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Objective: To assess ability of balance in community-dwelling elderly people with different body mass index (BMI) using multi-directional reach test (MDRT) test.

Materials and Methods: The cross-sectional study design was used to evaluate the effects of body mass index (BMI) on ability of balance using MDRT in community-dwelling elderly people.

Results: Obese community-dwelling elderly people had the lowest scores in all directions of MDRT when compared with those of normal weight and overweight groups. Furthermore, in overweight group, the scores in all directions of MDRT were significantly reduced compared to those of normal weight group ($p<0.05$). Moreover, the scores of MDRT were negatively correlated with BMI ($p<0.05$).

Conclusion: Obese and overweight community-dwelling elderly people had decreased ability of balance. Additionally, BMI was negatively correlated with the scores of MDRT in community-dwelling elderly people.

Keywords: Body mass index; Multi-directional reach test; Falls; Elderly; Balance

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The incidence of falls is increasing in older adults, which lead to injury including upper and lower limbs fractures, especially fracture of hip[1-3]. In addition, falls could lead to serious health problems in elderly population such as fear of falls, activity limitation, and disability[4,5]. Risk factors of falls include intrinsic and extrinsic factors[6]. The previous studies have reported that intrinsic factors that cause falls are history of medical, physiological change, and abnormality of balance[7,8]. Furthermore, extrinsic factors are environment that caused slipping and tripping[6,9]. Therefore, the evaluation of the ability of balance becomes important for screening the elderly population who have the risk of falls.

There are two main types of balance tests for elderly population, static and dynamic balance tests[10-12]. The single leg stance test and functional reach test are static balance tests[10,11], and time up and go test is the most common dynamic balance test that is used in elderly population[12]. However, these tests could not evaluate all directional ability of balance because falls may occur in all direction such as forward, backward, left-side, and right-side directions. All these reasons led the recent research to use multi-directional reach test (MDRT)[13].

The MDRT test is dynamic balance test[13]. This test can evaluate the ability of balance in all directions including forward, backward, left-side, and right-side directions[13]. In addition, MDRT has high reliability and validity in evaluating the ability of balance in elderly population[14]. Furthermore, a previous study has reported that elderly people had shorter distance in all directions of MDRT than adults, resulting in decreased stability[13]. Currently, the incidences of overweight and obesity are increasing in elderly population[15]. Overweight is the change

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Table 1. Characteristics of the subjects

Variables	Normal weight (n=30; F=20, M=10); means±SD	Overweight (n=30; F=20, M=10); means±SD	Obese (n=30; F=20, M=10); means±SD
Age (years)	72.04±5.41	70.25±5.49	70.58±6.19
Weight (kg)	51.15±5.10	64.74±6.05[a]	76.29±5.86[a,b]
High (cm)	155.02±5.18	155.48±5.45	154.96±5.09
BMI (kg/m^2)	21.00±1.66	26.24±0.87[a]	32.02±1.26[a,b]

F=female; M=male; BMI=body mass index; SD=standard deviation

[a] $p<0.05$ vs. normal weight, [b] $p<0.05$ vs. overweight

from normal weight to obesity and overweight people have higher adipose tissue, resulting in decreased stability of postural control[16]. Therefore, overweight elderly people may have different results of MDRT when compared to normal weight counterparts. Interestingly, the evaluation of the ability of balance using MDRT in different body mass index (BMI) of community-dwelling elderly people has no report. Therefore, the present study aimed to evaluate the effects of BMI on MDRT, and to predict the ability of balance in community-dwelling elderly people.

Materials and Methods

Study design and subjects

The cross-sectional study design was used to evaluate the effects of BMI on ability of balance using MDRT in community-dwelling elderly people. Ninety community-dwelling elderly voluntarily participated in the present study. Elderly people were divided into three groups based on BMI with normal weight at BMI 18.5 to 24.9 kg/m², overweight at BMI 25.0 to 29.9 kg/m², and obese at BMI of 30 kg/m² and more[17]. If the community-dwelling elderly people could walk at least six meters without assistive walking devices, they were recruited as the subjects. Subjects having problems of neurological diseases with imbalance problem, visual and hearing communication, musculoskeletal disease that made them unable to raise arms up to 90°, and history of back or lower limb surgery, scoliosis affecting standing, or walking were excluded. The present study was approved by the Clinical Research Ethics Committee of the University of Phayao, Phayao, Thailand. Approval was granted on April 7, 2021. The IRB code was 1.2/020/64.

Procedures

The community-dwelling elderly subjects required for the present study were 90 individuals. The sample size was calculated using a power of 0.90, power analysis with an alpha of 0.05 and the effect size r of 0.33[13]. The common health data form was used to collect the demographic characteristics of the subjects.

The MDRT was performed by affixing a yardstick 100 centimeters to a tripod that was set parallel to the floor at the height of the subject's acromion process. The MDRT was evaluated in four directions included forward, backward, left-side, and right-side[14]. All subjects were not wearing shoes and instructed to stand on the floor, then lifted an outstretched arm to shoulder height, and the length at the fingertips was recorded as the initial reach data. After that, all subjects were instructed to reach as far as they can and try to keep their hand along the yardstick, without moving their feet or taking a step from floor[14]. The backward direction, all subjects were instructed to lean back as far as they could[14]. The left-side, and right-side direction, all subjects were instructed to lean left side and right side as far as they can. The distance of each direction was calculated from the initial reach to final reach. Three successful trials were recorded for each direction[14].

Statistical analysis

The demographic data were analyzed by using descriptive statistics. The one-way ANOVA test was used to compare MDRT in different BMI groups. Pearson's correlation test was used to investigate the correlation between the BMI and scores of MDRT. All statistical analyses were conducted using IBM SPSS Statistics software, version 22.0 (IBM Corp., Armonk, NY, USA). A p-value of less than 0.05 was set to denote significance.

Results

There were ninety community-dwelling elderly subjects who voluntarily participated in the present study. The characteristics of the community-dwelling elderly subjects are shown in Table 1. Most of the subjects were female. The average age was not different among the tested groups, but BMI was different among the groups.

Table 2. The score of MDRT on different BMI in community-dwelling elderly people

Variables	Normal weight (n=30; F=20, M=10); means±SD	Overweight (n=30; F=20, M=10); means±SD	Obese (n=30; F=20, M=10); means±SD
Forward (cm)	17.00±6.21	12.87±4.78[a]	9.47±3.09[a,b]
Backward (cm)	12.27±4.26	10.37±3.51[a]	8.30±1.58[a,b]
Left-side (cm)	13.40±4.23	10.33±4.65[a]	7.80±2.55[a,b]
Right-side (cm)	13.40±4.77	9.67±3.92[a]	7.43±2.43[a,b]

F=female; M=male; BMI=body mass index

[a] p<0.05 vs. normal weight, [b] p<0.05 vs. overweight

Table 3. The correlation between BMI and scores of MDRT in community-dwelling elderly people

Variable	Forward	Backward	Left-side	Right-side
BMI (kg/m^2)	r=–0.535, p<0.01	r=–0.484, p<0.01	r=–0.499, p<0.01	r=–0.559, p<0.01

BMI=body mass index

All community-dwelling elderly subjects completed all directions of the MDRT. The results are presented in Table 2. The obese community-dwelling elderly subjects had significantly reduced MDRT when compared with those of normal weight and the overweight community-dwelling counterparts ($p<0.05$). In addition, overweight community-dwelling elderly subjects had significantly decreased MDRT when compared with those of normal weight groups ($p<0.05$).

The correlation between BMI and scores of MDRT in all directions are shown in Table 3. The BMI was negatively correlated with the scores of all directions of forward, backward, left-side, and right-side (r=–0.535, –0.484, –0.499, and -0.559, respectively).

Discussion

The major findings in the present study pointed out that the obese community-dwelling elderly subjects had the lowest scores of MDRT in all directions when compared with the normal weight and the overweight groups. In addition, the overweight elderly subjects had reduced scores of MDRT in all directions, compared to the normal weight counterparts. Furthermore, BMI was negatively correlated with the scores of MDRT in all directions. Therefore, these results suggested that the obese and the overweight community-dwelling elderly people had decreased ability of balance using MDRT, which led to limits of stability. Previous studies have revealed that aged people with overweight and obesity had functional limitation and disability[18-20]. Furthermore, the balance was associated with body composition and obesity induced reduction of muscle mass, resulting in muscle weakness, and leading to increased risk of falls[21]. That finding is consistent with the current study as the results showed that the obese and the overweight groups had reduced ability of balance using MDRT, compared to the normal weight group.

Interestingly, overweight phase was the change from normal weight to obesity and had increased adipose tissue, resulting in decreased stability of postural control[16]. Furthermore, individuals with overweight had alterations in gait pattern due to increased activity of ankle muscles, resulting in reduced walking velocity and increased base of support[22]. These findings indicated that individuals with overweight had increased risk of falls, compared to normal weight people.

There are many well-known tests to evaluate the falls such as static and dynamic balance tests[10-12]. Previous studies have reported that BMI was associated with static and dynamic balance tests[23-25]. In addition, the higher BMI individuals had decreased physical performance including loss of muscle mass and reduced muscle strength of lower limbs, resulting in poor ability of balance[26,27]. Therefore, these findings suggested that overweight and obese individuals had decreased static and dynamic balance. However, these static and dynamic balance tests could not indicate the directions of falls. Currently, MDRT is the first test that is used to evaluate the limits of stability in directions of forward, backward, left-side, and right-side[14]. A previous study has found that elderly people had lower scores of MDRT in all directions than adults, then their results suggested that

MDRT could be used to evaluate the ability of balance and postural control in elderly people[13]. However, the information of ability of balance using MDRT on different BMI in elderly people have no report. The current study is the first study to compare the ability of balance using MDRT on different BMI in Phayao community-dwelling elderly people. The present study results showed that the community-dwelling elderly people who had higher BMI had decreased ability of balance, resulting in limited stability in all directions. Therefore, the present study indicated that MDRT could be used to evaluate the ability of balance in individuals with different BMI.

Conclusion

The obese and overweight community-dwelling elderly people had decreased ability of balance using MDRT. These results suggested that obese and overweight community-dwelling elderly people had limited of stability in all directions.

What is already known on this topic?

The MDRT can evaluate the ability of balance in all directions including forward, backward, left-side, and right-side, indicating the limitation of the stability. A previous study has reported that elderly subjects have the lowest scores of MDRT in all directions, resulting in decreased ability of balance.

What this study adds?

This study supports that BMI is correlated with ability of balance in community-dwelling elders by using MDRT.

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Conflicts of interest

The authors declare that they have no competing interests.

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