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นิพนธ์ต้นฉบับ
ORIGINAL ARTICLE

ค่าจุดตัดของการทดสอบการเดิน 6 นาที เพื่อระบุความเสี่ยงต่อการหกล้มของผู้สูงอายุในชุมชน

รุ่งนภา อินทรักษ์[1,2], จิตติมา แสงสุวรรณ[3], สุกัลยา อามตฉายา[1,2] และทิวาพร ทวีวรรณกิจ[1,2*]

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บทคัดย่อ

การมีอายุที่เพิ่มมากขึ้นมักสัมพันธ์กับความบกพร่องด้านความทนทานของร่างกายและส่งผลให้เกิดความเสี่ยงต่อการหกล้มในผู้สูงอายุ ดังนั้น การตรวจประเมินความสามารถทางกายตั้งแต่แรกเริ่มในผู้สูงอายุที่มีความเสี่ยงต่อการหกล้มจึงมีความสำคัญอย่างยิ่ง การทดสอบการเดิน 6 นาที เป็นการทดสอบที่นิยมใช้ประเมินความทนทานของร่างกาย อย่างไรก็ตาม ไม่มีการรายงานค่าจุดตัดที่จำเพาะในการระบุความเสี่ยงต่อการหกล้ม การศึกษานี้จึงมีวัตถุประสงค์เพื่อระบุค่าจุดตัดของการทดสอบการเดิน 6 นาที เพื่อระบุความเสี่ยงต่อการหกล้มในผู้สูงอายุ โดยศึกษาในอาสาสมัครที่มีอายุตั้งแต่ 65 ปีขึ้นไป ซึ่งแบ่งออกเป็นกลุ่มที่มีอายุระหว่าง 65-74 ปี และกลุ่มที่มีอายุ 75 ปีขึ้นไป อาสาสมัครได้รับการสัมภาษณ์ข้อมูลพื้นฐาน และคัดกรองความเสี่ยงต่อการหกล้ม โดยใช้การทดสอบการยืนต่อส้นเท้า (น้อยกว่า 10 วินาที) และประวัติการหกล้มในระยะเวลา 6 เดือน อย่างน้อย 2 ครั้ง รวมถึงประเมินความสามารถด้านความทนทาน โดยใช้การทดสอบการเดิน 6 นาที การศึกษานี้มีอาสาสมัครที่ตรงตามเกณฑ์คัดเข้า จำนวน 255 ราย แบ่งออกเป็นกลุ่มที่มีอายุระหว่าง 65-74 ปี จำนวน 187 ราย และกลุ่มที่มีอายุ 75 ปีขึ้นไป จำนวน 68 ราย ผลการศึกษาพบว่า ค่าจุดตัดในการระบุความเสี่ยงต่อการหกล้มในผู้สูงอายุคือระยะทางน้อยกว่า 320 เมตร (กลุ่มที่มีอายุระหว่าง 65-74 ปี ค่าความไวร้อยละ 73.12 และความจำเพาะร้อยละ 52.13) และ 295 เมตร (กลุ่มที่มีอายุ 75 ปีขึ้นไป ค่าความไวร้อยละ 70.83 และความจำเพาะร้อยละ 65.91) โดยมีพื้นที่ใต้เส้นโค้งอยู่ในเกณฑ์ที่ยอมรับได้ (0.71 และ 0.74 ตามลำดับ) การศึกษานี้เสนอแนะว่าการทราบค่าจุดตัดที่จำเพาะ สามารถช่วยบุคลากรทางการแพทย์ในการระบุความเสี่ยงต่อการหกล้มในผู้สูงอายุอย่างทันท่วงที เพื่อวางแผนการป้องกันและส่งเสริมภาวะสุขภาพในผู้สูงอายุได้

คำสำคัญ: การทดสอบการเดิน 6 นาที, ความเสี่ยงต่อการหกล้ม, ผู้สูงอายุ

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[1] สาขาวิชากายภาพบำบัด คณะเทคนิคการแพทย์ มหาวิทยาลัยขอนแก่น
[2] กลุ่มวิจัยการพัฒนาความสามารถทางกายและคุณภาพชีวิต มหาวิทยาลัยขอนแก่น
[3] ภาควิชาเวชศาสตร์ฟื้นฟู คณะแพทยศาสตร์ มหาวิทยาลัยของแก่น
* ผู้รับผิดชอบบทความ

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ORIGINAL ARTICLE

Cut-off score of the 6-minute walk test for determining risk of fall in community-dwelling elderly

Roongnapa Intaruk[1,2], Jittima Saengsuwan[3], Sugalya Amatachaya[1,2] and Thiwabhorn Thaweewannakij[1,2*]

Abstract

Advancing age usually relates to poor functional endurance which lead to risk of fall in elderly. Therefore, an early detect functional ability in those with risk of fall should be concerned. The 6-minute walk test (6MWT) is commonly used to assess functional endurance. However, none of the studies reported on a specific cut-off score of the 6MWT for determining risk of fall. This study aimed to identify the cut-off score of the 6MWT for determining risk of fall in elderly. The participants who aged at least 65 years were classified into the age of 65-74 years and 75 years and older. They were interviewed their demographic characteristics and screened risk of fall using the tandem stand test (less than 10 seconds) and history of two or more falls within the past 6-months and investigated their functional endurance using the 6MWT. There were 255 eligible participants. Of the 187 participants were elderly aged between 65-74 years and 68 participants were aged 75 years and older. The findings reported the cut-off scores of less than 320 m (aged 65-74 years: 73.12% sensitivity and 52.13% specificity) and 295 m (aged 75 years and older: 70.83% sensitivity and 65.91% specificity) to represent risk of fall in elderly, with the acceptable area under the curve (0.71 and 0.74, respectively). The findings suggested that the specific cut-off score could assist health practitioners to early detect the elderly with risk of fall, in order to plan an appropriate prevention and promote health status in these individuals.

Keywords: 6-minute walk test, Risk of fall, Elderly

[1] School of Physical Therapy, Faculty of Associated Medical Sciences, Khon Kaen University.

[2] The Improvement of Physical Performance and Quality of Life Research Group, Khon Kaen University.

[3] Department of Rehabilitation Medicine, Faculty of Medicine, Khon Kaen University.

[*] Corresponding author: (e-mail: thiwth@kku.ac.th)

Introduction

An advancing age usually relates to functional decline that affects capability to conduct daily activities independently and may increase the number of dependent elderly[1, 2]. These obvious phenomena may affect especially in slow gait speed and poor physical endurance [3, 4]; unfortunately, it leads to frailty and risk of fall in these individuals [5].

Evidences supported that elderly who aged at least 65 years were reported with high incidence of fall, in which it manifestly increased in those aged 75 years and older [6-8]. Falls are a serious health problem in elderly which their occurrence lead to negative impacts on physical, psychological, and socioeconomic consequences [9-12]. All these consequences of falls place heavy demands on healthcare systems [13]. Therefore, an early detect functional ability in those with risk of fall should be concerned in order to plan an appropriate prevention and promote health status [1, 14].

Evidence supports that the ability to walk for longest distance is a feasible physical performance measure[15], which can be qualified using the 6-minute walk test (6MWT) [16]. The 6MWT is commonly used to assess exercise tolerance and aerobic endurance in patients with cardiorespiratory disease[16]; furthermore, it has been also used as a measure of functional endurance in elderly[1]. Bean and colleagues (2002) found that the 6MWT is the best characterized as a performance-based measure of ambulatory capability. This test is used to predict the impairment of leg muscle strength which related to ability to perform walking task. As a result of decreased aerobic endurance in elderly, who were able to walk with a shorter distance, may cause a decrease in functional capacity and increase susceptibility to falls [16, 17]. Previously, the 6MWT was reported with an acceptable reliability and validity when were conducted in elderly (ICC = 0.87-0.95, r = 0.52-0.73, respectively) [5, 18]. There was reported different reference value of the ability to perform the 6MWT in Thai elderly among aged groups [19]. However, none of the studies reported on a specific cut-off score of the 6MWT for determining risk of fall in community-dwelling elderly among aged groups (65-74 years and 75 years and older), in which the findings may assist health practitioners to identify risk of fall and plan an appropriate intervention for these individuals.

Material and Methods

Study design and population

The study was cross-sectionally conducted in elderly who lived in rural and semi-rural communities in northeastern of Thailand. Participants were the elderly who aged at least 65 years, both male and female with a body mass index (BMI) between 18.5 and 29.9 kg/m^2. They were screened their demographic characteristics and risk of fall. The risk of fall in this study was defined as the elderly who had balance impairment (unable to take full tandem stand test for 10 seconds) and/or having history of two or more falls within the past 6 months[14, 21]. Additionally, the participants also needed to understand simple commands of the test in order to complete the protocol of the study. However, they were excluded if they had any signs or symptoms that might affect the study; for examples, the inflammation of lower extremity joints and muscles with pain more than 5 out of

10 scores on a verbal numerical rating scale (VNRS), sequelae of neurological disease (e.g., stroke and Parkinson's disease), dizziness, visual and auditory deficits that cannot correct using glasses or hearing aids, acute illness or injury, unstable heart disease (e.g., angina), and uncontrolled hypertension. The study protocols and consent procedures were approved by the Khon Kaen University Ethics Committee for Human Research (HE602302).

Study protocols

The eligible participants were investigated their functional endurance using the 6MWT. They were instructed to walk as far as possible in 6 minutes around 6 × 4 meters rectangular walkway with their selected speed [19]. The tester walked alongside them for safety. During the test, the participants were able to rest as need without stop timing. In addition, they were given standardized encouragement at 1, 3, and 5 minutes during the test which "You are doing a good job" (minute 1), "You are halfway done" (minute 3), and "You have 1 minute to go" (minute 5) [20]. Then, the distance to complete the test in 6 minutes was recorded in meters.

During administration of the test, a tester was always beside a participant without interruption to ensure participant's safety and accuracy of the tests. Furthermore, the participants had to wear appropriate shoes which were prepared by the researchers and they were assessed blood pressure and heart rate for safety and ensuring enough rest.

Statistical analysis

The data were analyzed by the SPSS for Windows (SPSS Statistic version 17.0, IBM Corporation, 1 New Orchard Road Armonk, New York 10504-1722, USA, serial number: 5068054). The descriptive statistics (mean, standard deviation, 95% confidence intervals, and the percentage) was applied to explain characteristics of participants and the findings. The independent sample t-test (for continuous variable) and the Chi-square test (for categorical variable) were used to compare the differences of demographic characteristics between elderly with and without risk of fall. Finally, the receiver operating curve (ROC) was used to utilize the cut-off score, sensitivity, specificity, and area under curve (AUC). A level of significant difference was set at less than 0.05.

Results

Six hundred and ten participants interested to participate the study; however, 355 of them were excluded in a screening phase due to they were missing the inclusion criteria and unavailable to participate the study. Finally, there were 255 eligible participants which were divided into the age of 65-74 years (187 participants) and the age of 75 years and older (68 participants) **(Figure 1)**.

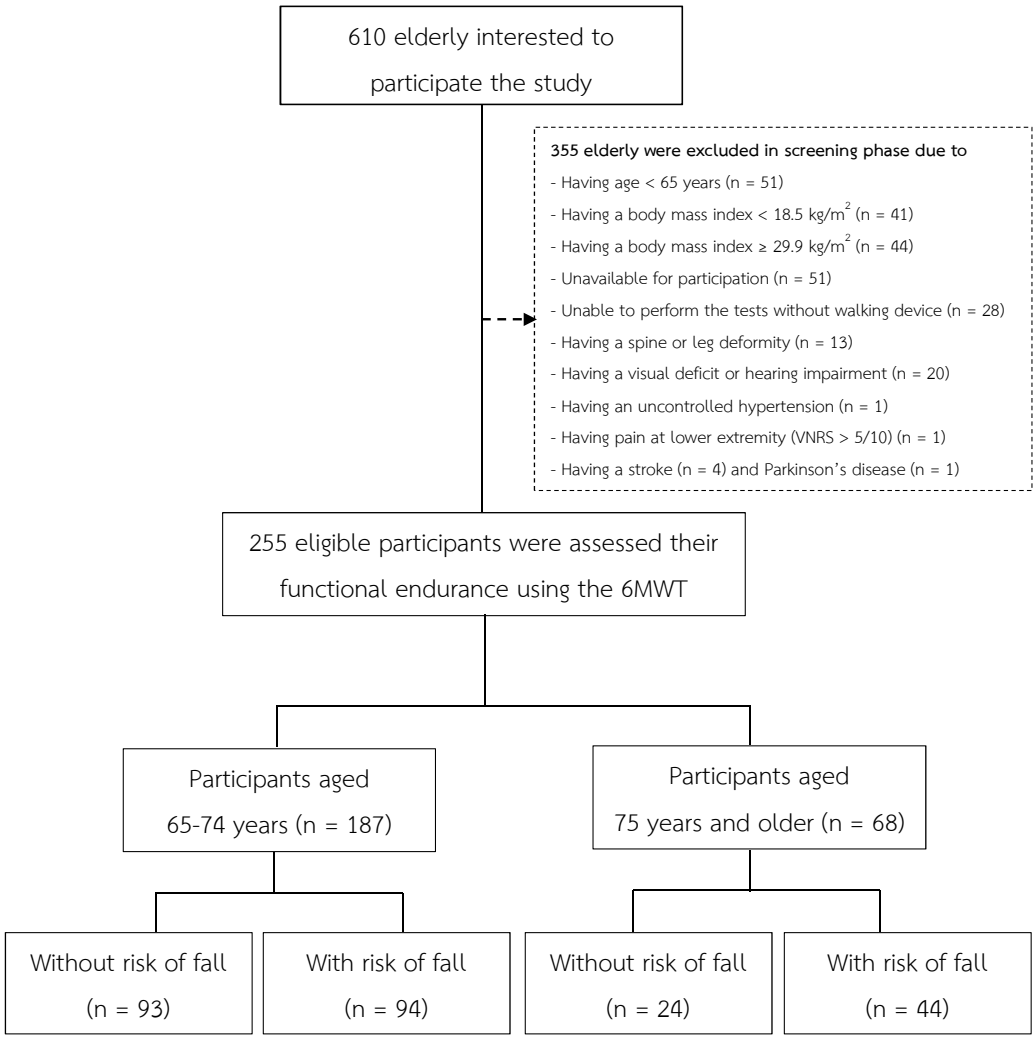


Figure 1 Participants flow chart

Table 1 Demographic characteristics of elderly with and without risk of fall

Variable	65-74 years		*p-value*	75 years and older		*p-value*
	Without risk of fall (n = 93)	With risk of fall (n = 94)		Without risk of fall (n = 24)	With risk of fall (n = 44)	
Gender [female : male] [a]	63 (67.74) : 30 (32.26)	73 (77.89) : 21 (22.11)	0.905	13 (54.17) : 11 (45.83)	35 (79.55) : 9 (20.45)	0.439
Age (year) [b]	69.09 ± 2.73 (68.52 – 69.66)	69.89 ± 3.14 (69.24 – 70.54)	0.055	77.83 ± 2.53 (76.73 – 78.92)	78.97 ± 3.77 (77.83 – 80.12)	0.104
Weight (kg) [b]	55.51 ± 7.63 (53.93 – 57.10)	58.28 ± 7.88 (56.65 – 59.91)	0.017*	57.48 ± 8.29 (53.90 – 61.06)	53.98 ± 7.90 (51.57 – 56.38)	0.56
Height (cm) [b]	154.59 ± 6.68 (153.20 – 155.98)	154.38 ± 6.43 (153.05 – 155.71)	0.826	156.43 ± 7.41 (153.22 – 159.64)	151.36 ± 8.04 (148.92 – 153.80)	0.007*
BMI (kg/m^2) [b]	23.26 ± 3.04 (22.63 – 28.90)	24.45 ± 2.94 (23.84 – 25.96)	0.008*	23.51 ± 3.07 (22.18 – 24.84)	23.55 ± 2.94 (22.66 – 24.45)	0.952
6MWT (m) [b]	357.02 ± 57.95 (345.14 – 368.90)	305.98 ± 71.33 (291.21 – 320.75)	< 0.001*	321.96 ± 54.57 (298.37 – 345.46)	260.17 ± 81.96 (235.25 – 285.09)	< 0.001*

Note: * Indicates statistically significant difference, [a] The data were demonstrated using number of participants (%) and compared using the Chi-square, [b] The data were represented using mean ± standard deviation (95% confidence interval) and compared using the independent sample t-test.

Abbreviations: BMI = body mass index, 6MWT = 6-minute walk test.

Table 2 Cut-off scores of the 6MWT for determining risk of fall

Age range	Cut-off score (m)	Sensitivity (%)	Specificity (%)	AUC
65-74 years	< 320	73.12	52.13	0.71
75 years and older	< 295	70.83	65.91	0.74

Abbreviation: AUC = area under the curve.

The participants who aged 65-74 years with risk of fall were reported shorter time to complete the tandem stand than those without risk of fall (7.33 ± 13.07 sec and 45.59 ± 19.91 sec, $p < 0.001$, respectively). Similar to the participants who aged 75 years and older with risk of fall were also demonstrated shorter time than the other group (6.09 ± 12.09 sec and 41.79 ± 20.39 sec, $p < 0.001$, respectively). However, there were no statistically significant difference of the tandem stand test between age groups who with and without risk of fall ($p = 0.597$ and $p = 0.483$, respectively). Regarding to the experience of multiple falls in the last 6 months, there were 26.60% of elderly who aged 65-74 years, and 34.09% of those who aged 75 years and older. More than a half of multiple falls (56 out of 93 times) caused by intrinsic factor, such as loss of balance, postural hypotension during changing position, and leg muscle weakness. The extrinsic factor included slipping, tripping, stumble over uneven paths, and too-long dress. Furthermore, the participants with risk of fall were reported shorter distances to complete the 6MWT than those without risk of fall (*p-value* < 0.001). Other demographic characteristics were shown in **Table 1**. The cut-off scores of the 6MWT for determining risk of fall in each age range were presented in **Table 2**.

Discussions

This study investigated the optimal cut-off scores of the 6MWT for determining risk of fall in community-dwelling elderly, which were categorized into the age of 65-74 years and 75 years and older. The present study reported the cut-off scores of less than 320 m (aged 65-74 years: 73.12% sensitivity and 52.13% specificity) and 295 m (aged 75 years and older: 70.83% sensitivity and 65.91% specificity) represented risk of fall with the acceptable area under the curve (0.71 and 0.74, respectively).

The 6MWT is the best performance-based measure to identify functional endurance which affects the ability to conduct daily activities[16, 21]. It is commonly used as an instrument to assess progression of functional exercise capacity and determine functional limitation in several patients, particularly in elderly people[15, 16, 21]. Although there were some studies reported normative value of the 6MWT in elderly[19, 20], present study was the first study to explore the specific cut-off scores for determining risk of fall in these individuals. The findings showed that advancing age (aged 75 years and older) had a shorter distance within 6 minutes than younger (aged 65-74 years). In addition, they also had a higher risk of fall, which was confirmed by less time to complete the tandem stand test and higher number of falls

within the past 6 months. Present findings reported that more than a half of participants with risk of fall were female gender. Similarly, Thiamwong and coworkers (2008) reported that female gender is one of the significant fall risk factors in elderly; therefore, they rated the score of females as fall risk indicators in the Thai falls risk assessment test (Thai-FRAT)[22]. Evidence supported that female had a higher risk of fall than male because of the effect of menopause[23]. It led to decrease of bone mineral density (BMD) which was reported strong concomitant decline in muscle strength[24]. These conditions were closely related to reduce activity in daily living, then lead to fall in elderly[23, 25].

Regarding to elderly who were unable to walk with long distance, it could be represented low aerobic fitness which led to early muscle fatigue during perform the activity of daily life[26]. The evidence reported that the aerobic fitness can be qualified using O_2 consumption (VO_2 max[26], which occurred in exercised muscles and positive correlated with distance walk[26]; unfortunately, it was decreased with aging process[27]. Therefore, muscle fatigue is a clinically important with risk of fall in these individuals[28]. Furthermore, the evidence supported that walking distance within 6 minutes also correlated to muscle strength in elderly [29]. Similarly, Pang and colleagues (2008) reported that leg muscle weakness related to ability to walk with short distance, which was an important reason to increase risk of fall in elderly [30].

The present findings showed that elderly aged 75 years and older were reported the 6MWT's cut-off score of less than 295 m **(Table 2)**. Previous study reported that the cut-off score of the 6MWT of less than 300 m indicated poor walking ability and mortality rate in chronic heart failure patients[31]. Unfortunately, those with risk of fall might be troubled with walking ability to perform the activity of daily living and increased mortality rate. Additionally, the elderly aged 65-74 years in present study were reported that the distance walk in 6 minutes of less than 320 m indicated risk of fall. Previously, Cote and colleagues (2008) reported that the distance of less than 350 m identified an increase of mortality rate in patients with chronic pulmonary disease (COPD)[32]. The elderly with risk of fall, who were able to walk with short distance, might reflect frailty and poor health status. Moreover, the present study found that the BMI might be a factor-related ability to perform the 6MWT in young elderly (aged 65-74 years). Evidence supports that overweight elderly likely to have a poor physical performance[33]; however, the further investigation of the effect of BMI on ability to perform physical function may show clearer findings.

However, there were some limitations of the study. Firstly, a smaller number of participants who aged 75 years and older might be a reason of wide range of standard deviation of the 6MWT **(Table 1)**. This might occur due to a lack of sample size calculation of the study; however, the power of test was verified and reported of more than 0.80 in each age group. Therefore, further study should state the sample size calculation and recruit a greater number of participants for clearer findings. Secondly, the study design in this study was a cross-sectional design, in which it cannot identify cause and effect relationship of fall. Therefore, further investigation should design as the prospective study for indicating fall risk factors. Finally, the present study did not explore

the correlation between 6MWT and tandem test or frequency of falls, in which the further investigation of this relationship might useful to confirm the importance of declining in functional endurance to susceptible falls in elderly.

Conclusions

The findings suggested the optimal cut-off score of the 6MWT to determine risk of fall in community-dwelling elderly as the distances of less than 320 m (aged 65-74 years) and less than 295 m (aged 75 years and older). The specific values could assist health practitioners to early detect the elderly with risk of fall using ability of functional endurance, in order to plan an appropriate prevention and promote health status in these individuals.

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