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Four-Meter Gait Speed Cut-off and Correlation with 6-Minute Walk Test in Adults

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Abstract

In facilities where a track required is not available for gait speed test, a simpler method using a shorter track and test duration is needed. One of such methods is the 4-meter gait speed. This study aimed to determine the cut off values for 4MGS and its correlation with the 6-minute walk test (6MWT), a more common functional performance test with shorter track and time. Data for this study were collected at the Department of Rehabilitation of Dr. Cipto Mangunkusumo General Hospital during the period of August 2016 to March 2017. The consecutive sampling approach was used to recruit healthy Indonesian adults (n=61) aged 18–50 years into this cross sectional study. The anthropometric and respiratory variables were measured as descriptive data and the cut-off values were determined by calculating the mean 4-meter gait speed (4MGS)-2SD for each gender. The 6MWT was performed afterwards to assess the correlation between 4MGS and 6-minute walk distance (6MWD). Results presented a mean 4MGS value of 2.114±0.309 m/s (male) and 1.908±0.227m/s (female) with the cut-off values for normal gait speed of 1.496 m/s and 1.454m/s for male and female, respectively. Factors affecting 4MGS were body height, body weight, forced vital capacity (FVC), and forced expiratory volume in 1 second (FEV1). The 4MGS is only shown to be weakly correlated with 6MWD (r=0.314, p=0.014). The cut-off values for 4MGS can be used as a reference to assess the normality of gait speed as a parameter of functional mobility in healthy Indonesian adults and should be used in adjunct to 6MWT to represent a comprehensive functional capacity status.

Keywords: Four-meter gait speed test (4MGS), cut-off values, healthy adults, Indonesia, six-minute walk test (6MWT)

Introduction

Walking is an important activity for human. The ability to walk is vital in performing many activities.[1] Therefore, gait speed as a simple measure for walking performance has been proposed as the sixth health vital sign.[2] Although it lacks the ability to measure exercise capacity accurately, it is a good measure of functional mobility as it represents how fast a patient can walk.[3]

Gait speed is commonly measured over a distance of 4, 6, or 10 meters. However, gait speed over 4 meters is increasingly being used as a stand-alone metric as well as a part of the Short Physical Performance Battery (SPPB) due to its short track requirement. In SPPB, walking time ≥ 4.82 s (4MGS ≤ 1.205 m/s) is considered slower than normal. However, the original scoring was made from elderly subjects aged 65 and older.[4] Normative values of 4 meter gait speed test (4MGS) from subjects aged 18–85 years have also been studied before, but in American population.[5] Studies have shown that step length is affected by race;[6] while healthy americans step length was 72 cm and Indonesian adult males was 45.7 and female 42.6 cm therefore the values cannot be used in Asian population.[7]using a crosssectional method. Results: Designed by using the followings: distance, body height, body weight, sex, age, maximum heart rate of six minute walking test and lung capacity (FEV and FVC Such reference values have also not been established in Indonesian population.

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The 6 minute walking test (6MWT) has become the most common submaximal exercise test over the years. It does not only describe walking ability, but also functional capacity since it is a type of submaximal exercise test. The American Thoracic Society (ATS) had recommended a 30-meter track to perform 6MWT, with an output of total distance travelled as 6 minute walk distance (6MWD).[8] However, the track requirement sometimes becomes a barrier of the applicability of this test. Recent hospital attempts in providing buffer areas and setting zones to separate Coronavirus disease 2019 (COVID-19) suspects on hospital grounds, have significantly reduced the amount of working space for practitioners.[9] In such facilities where the track required is not available, a simpler test is required with shorter track and test duration, which are provided by the 4MGS. However, the correlation of 4MGS and 6MWD has not been studied before in Indonesia, but we have to ensure if the patient can't do 6MWT, they can do 4MGS

The main purpose of the study, therefore, was to: (1) determine the cut-off value for 4MGS; (2) evaluate the correlation between 4MGS and 6MWD in healthy Indonesian subjects; (3) evaluate the corelation between the main result and respiratory variables including Forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV_1).

Methods

In this cross-sectional observation study, healthy subjects were recruited in National General Hospital of Dr. Cipto Mangunkusumo, Indonesia by consecutive sampling. All subjects gave informed consent, and the study was approved by the University of Indonesia's Health Study Ethics committee (64/UN2.Ft/ETIK/2016) in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki). The Data collection of this study were conducted at Department of Rehabilitation of Dr. Cipto Mangunkusumo General Hospital during the period of August 2016 to March 2017.

The inclusion criteria were male or female aged 18–50 years with normal body mass index (BMI) according to World Health Organization.[10] The exclusion criteria were those with cardiorespiratory, musculoskeletal, or neuromuscular disorders. History taking, physical examination, electrocardiography, and spirometry were performed before the subjects were deemed healthy. The minimum sample size required was 27 subjects for each gender, calculated with the formula for obtaining two-sided one sample mean, confidence level set at 95% ($Z\alpha$=2.58), mean difference of 0.087 m/s and Standard Deviation (SD) of 0.23 m/s.[11]

In light of uniformity with previous studies,[12] anthropometric data will be obtained, which includes body height (in centimetre – cm) and body weight (in kilograms–kg). Additionally the respiratory variables will also be obtained to allow correlation analyses and provide better comparison towards the previous studies in non-healthy individuals.[11] These respiratory variables include forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV_1), both of which were measured by using spirometry according to the guidelines

The main outcomes in this study were 4MGS and 6MWD. The 4MGS was performed on a 6-meter track, one meter each at both ends for acceleration-deceleration and four meters for gait speed recording between the acceleration-deceleration tracks. The subjects were asked to walk at their comfortable speed. Timing with a stopwatch began when either one of the subject's feet crossed the starting line of the 4-meter track or stopped when the same foot completely crossed the 4-meter line as shown in Figure 1. The test was performed twice and repeated without rest. The fastest time would be taken to calculate the 4MGS for each subject. 4MGS does not cause fatigue so it was done first.

The 6MWT was performed with a different observer to avoid observer bias, and performed last to avoid exhaustion during 4MGS data collection. The subjects walked on a 15-meter track, instead of a 30-meter track as recommended by ATS. It has been studied before that the 6MWD between both tracks are not significantly different;[13] therefore, the former track was used. The track was flat with 60-cm width divided in the middle, one side to walk from the starting line and the other side to walk towards the starting line. Subjects were free to choose which side to start the walk. All subjects were instructed to walk with an intensity equivalent to Borg Rating of Perceived Exertion scale of 12–13. Six minute walk distance (6MWD) is the total distance performed by the patient during the test, measured by calculating how many laps the patient had walked plus the additional distance they walked before they were stopped by the examiner.

In this study, gender affects step length.[14] Comparison between genders was performed

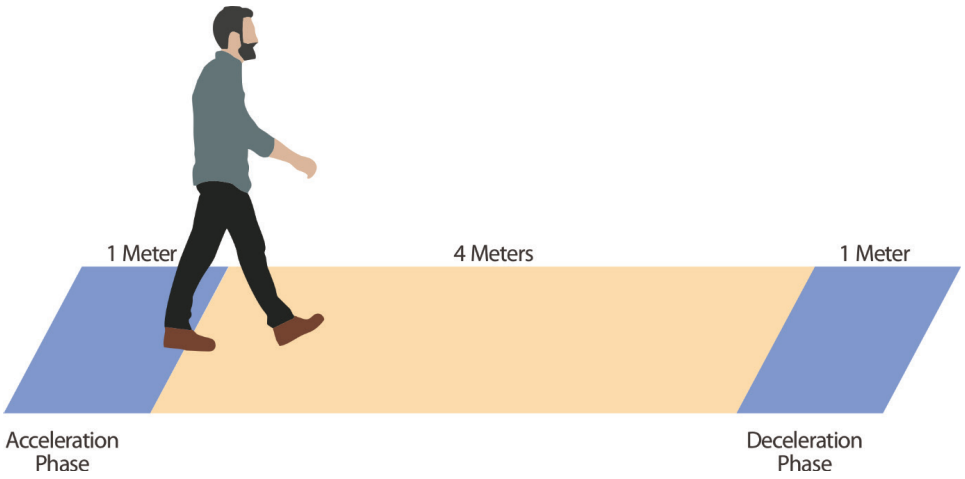

Figure Meter Gait Speed Observation Track
The six meter track was used in this study, providing one meter acceleration track, and ending with one meter deceleration track. This would allow subjects to reach adequate speed during the four meter observation, and provide better representation of four meter gait speed.

in descriptive data, along with the main outcomes of the study in order to obtain cut-off values. On the other hand, correlation were done in between 4MGS with anthropometric, respiratory, and 6MWD in both genders allow better representation in target population of healthy Indonesian adults. Only complete data was included in the study thus missing data were not included in the final inclusion, this study is however, a cross sectional observation, therefore missing data is not expected.

The Statistical Program for the Social Sciences (SPSS) 20.0 was used for all analysis. Continuous variables were presented with means and standard deviation. The cut-off values were obtained by subtracting mean 4MGS with 2 SD for each gender[15] Pearson's correlation coefficient was used to quantify the association between 4MGS and 6MWD, as well as other factors. Between gender differences were assessed using unpaired t-test or Mann-Whitney for non-parametric data.

Results

This study have recruited 61 subjects, with 28 males and 33 females as seen in Table 1, no missing data was found. It could be observed that the mean age for males were 26.25 (±4.55) years, while females were 27.54 (±4.91) years. Males were seen to be taller with 171.37 (±6.33) cm, as compared to females 157.04(±5.52) cm. Similar trend were also seen in body weight, males tend to be heavier with 67.35(±7.49) kg, while females 53.56 (±6.76) kg. Body mass index seem similar for these subjects with males being 22.75 (±1.70) kg/m^2, and females 21.74(±1.90) kg/m^2. Finally,

Table 1 Subject Characteristics

Variables	Male (n=28)	Female (n=33)	p-value
Age (years)	26.25(±4.55)	27.54(±4.91)	0.302
Height (cm)	171.37(±6.33)	157.04(±5.52)	0.554
Weight (kg)	67.35(±7.49)	53.56(±6.76)	0.467
Body mass index (kg/m^2)	22.75(±1.70)	21.74(±1.90)	0.667
4 meter gait speed (m/s)	2.114(±0.309)	1.908(±0.227)	0.609

*All data are presented in mean (SD), and tested with independent sample t-test

Table 2 Summary of Cut-off Point Interpretations

Variable	Cut-off Values	Interpretation
Male	≥1.496 m/s	Normal
	<1.496 m/s	Poor
Female	≥1.454 m/s	Normal
	<1.454 m/s	Poor

4MGS was also compared between gender, and it was shown that males were slightly faster as compared to females, accruing to 2.114 (±0.309) m/s against 1.908 (±0.227) m/s respectively. All of these descriptive values were shown not to be statistically different between the gender, all with p>0.05.

The main results of this study could be seen in Table 2, where gait speed here was calculated by measuring the time in seconds for 4 meter travelled, and cut-off was obtained by deducting 2 SD from the mean values. Good values for males were those who achieved gait speed faster than 1.496 m/s, while females with slightly lower anthropometric values have lower cut off of 1.454 m/s.

Correlation coefficient values against are presented in Table 3, with mean values of all 61 subjects. Both anthropometric and respiratory variables seem to correlate significantly. Although respiratory values tend to have stronger correlation as compared to the former, these correlation are still classified as weak. When gait speed was compared to 6MWD with a mean of 556.44 (±73.31) meter, the correlation was weak with correlation coefficient of 0.314 but it was statistically significant (p=0.014).

Discussion

This study has highlighted the cut-off value for 4MGS, which is 1.496 m/s for Indonesian males, and 1.454 for females. It could also be seen that gait speed weakly correlates with anthropometric parameters such as body height and weight; and respiratory parameters which includes FVC and FEV_1. Eventually with all these parameters being correlated, 4MGS was seen to weakly correlate with 6MWD.

Over the years, gait speed successfully illustrate a general condition and is able to predict several clinical outcomes, hence making it the sixth vital sign.[2] It is essential for clinicians to realize that differences of 0.1 m/s will have a significant impact to general survivability, that it was mentioned for every additional health problem in a patient would lead to a reduction of 0.023 m/s in gait speed after adjusting to other factors.[2,16] Therefore, accuracy of gait speed recording must be given attention, especially for shorter tracks. Their correlation to the widely accepted 6MWT should be commended, these are evidences that shows how essential is gait speed examination in subjects with severe comorbidities such as advanced lung disease.[11,17]

Since this study had highlighted the 4MGS cut-off for Indonesian, these results notably differ with the large scale study in United States. Bohannon et al. had reported various values of mean gait speed, stratified for males and females in different age groups from 18-85 years old.[12] It seemed natural that gait speed is reduced in the elderly, accruing for 1.18(±0.20) m/s in 18-29 year old male, as compared to 0.97(±0.20) m/s in 80-85 year old. In females too, the same trend is seen, with 1.11 (±0.20) m/s for the younger 18-29 year old group, and geriatric females with

Table 3 Correlation between 4MGS and Other Parameter

	Mean (±SD)	Correlation Coefficient	p-value
4 Meter gait speed (m/s)	1.99(±0.25)	-	Reference
Body height (cm)	163.48(±9.19)	0.307	0.016*
Body weight (kg)	59.74(±9.79)	0.261	0.042*
FVC (liters)	3,104.90(±736.21)	0.334	0.008*
FEV_1 (liters)	2,868.69(±702.33)	0.271	0.035*
6MWD (meters)	556.44(±73.31)	0.314	0.014*

0.95(±0.24) m/s. In direct comparison to the subjects in this study in particular of the 18-29 year old group, Indonesian subjects were faster by 1 m/s for males with 2.114(±0.309) m/s, and 0.8 m/s faster in females with 1.908(±0.227) m/s.[12] In respect to height, the study by Bohannon was taller and heavier for both genders, as compared to Indonesian, which eventually would lead to differences in body mass index. Higher body weight would also impact speed especially in effective energy generation in comfortable walking speed, and thus subsequently translate to slower gait speed. Previously it has been reported that obese individuals do select slower comfortable walking speed for their daily function, as it would minimize pendular energy transduction, energy cost, and their rating of perceived exertion.[18]

Aside from anthropometric differences that might lead to varying results of 4MGS, evidences of racial differences were also shown to correlate with step length.[6] Ryu et al. had reported gait comparisons between Korean and Western people in an attempt to gather local gait reference data. Their study revealed that Korean stride length were significantly lower as compared to Western by 7-25%, and thus walking speed is eventually slower by 14-42%.[6] It was speculated that the main reason for longer stride length was taller stature in Western subjects. Further analyses revealed that Korean subjects had clinically larger knee valgus moment, while all the other moments are inversely smaller as compared to Western.[6] Another study had also shown how racial differences would be exposed to different subset of risk factors, and worsened health status is correlated to slower walking speed.[16]

This study had also shown how gait speed correlates with respiratory parameters, hence a slower speed is expected for pulmonary compromised subjects such as chronic obstructive pulmonary disorder (COPD). It is obvious that COPD subjects require close monitoring, and at times when long endurance walking of 6MWT is not possible to be performed, the 4MGS have been shown to be valid for use in this special population.[11] For COPD subjects, it was shown that 4MGS cut-off of above 1.27 m/s as good with maximum performance, which means subjects were instructed to walk at their maximum speed.[11] On the other hand, this study that uses comfortable walking speed for the 4MGS, which would appropriately enhance its ease of use when practiced in tele rehabilitation setting.[19,20] Moreover, the utilization of healthy subjects in this study had also shown an added benefit of functional capacity screening for the healthy or even asymptomatic subjects of COVID-19.

Even when this study could be applied to adults with similar anthropometric variables, this study has identified age limitations which is due to small number of sample to represent older individuals in the adult age group, as such done previously.[12] Additionally, since only healthy subjects were recruited, no side-by-side comparison with unhealthy subjects could be generated. Another identified limitation is that this study didn't examine individual gait parameters, such as step length, stride length, and total number of steps during the four meter travelled for further analysis. On the other hand, a prominent strength of this study involves performing both 4MGS and the widely accepted submaximal 6 minute walking test to obtain 6MWD, thus a direct comparison could be made during the same visit. Similarly, these values could then be used for patients with similar anthropometric parameters, in particular Asians, such as the Mongoloid race.

Apparently the presentation of various gait speed arrays in between studies then portrayed how future studies are required to analyse significant determinants of effective gait.[12,16,18] We suggest future studies could recruit bigger sample size to determine more variables that could effect 4MGS to enrich the cut of values obtained in this study. In light to these, the authors then suggests future studies could discover cut-off for other races in the local setting, which then allows seamless utilization of the 4MGS tool, especially in the pandemic era.

The cut-off point of 4MGS can be used as a reference value for functional capacity, specified to each gender. Good cut-offs for 4MGS include males walking faster than 1.496 m/s, and 1.454 m/s for females due to anthropometric differences. Although weak, gait speed significantly correlates with anthropometric (body height; weight) and respiratory variables (FVC; FEV_1), as well as 6MWD; hence could be used as a screening, although not replacing the widely accepted submaximal 6MWT. There are growing utilization of the 4MGS test, and it prove to be a solid choice for tele rehabilitation during the pandemic era. Remembering the fact that gait speed is the sixth vital sign, this examination could prove its worth to screen subjects with slower gait speed for further investigation of their cardiorespiratory, neuromuscular, musculoskeletal and metabolic system.

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