



Correlation between the 2- and 6- minute Walk Test in Healthy Children Aged 7-10 Years

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ABSTRACT

Introduction: The 2- and 6-minute walk tests are used to assess walking ability, but the 2-minute walk test is not commonly known.

Objective: The purpose of the research was to investigate the correlation between the 2- and 6-minute walk tests in healthy children.

Methods: A Cross-sectional study was carried out on healthy children whose age ranged from 7 to 10 in the first through third grades of primary schools in Chiang Mai province, Northern Thailand. Each participant also completed a 2- and 6-minute walk test on two separate test days by a week. Pearson's correlation coefficient (r) was calculated for the relationship between 2- and 6-minute walk test.

Results: In 2- and 6-minute walk tests, the mean walking distance was 203.6 meter from the 2-minute walk test and 559.79-meter from 6-minute walk test. A significant positive correlation was found between 2- and 6-minute walk tests, $r = 0.99$, $p = 0.001$ of all participants.

Conclusion: These data suggest that the 2- and 6-minute walk tests in healthy children have fairly strong positive correlation. Our findings support the 2-minute walk test is a suitable alternative timed walking test for functional capacity testing in children.

Keywords: 2-minute walk test; 6-minute walk test; correlation; children

Introduction

Walking is the principal means by which most humans go from one location to another under their strength.[1] If people are to function autonomously in the group, they must be able to walk a significant distance—more than 300 meters, according to Shumway-Cook et al.[2] Timed walk tests have been used to evaluate ambulatory endurance since the inception of the 12-minute walk test in the 1970s.[3] The 6-minute walk test (6MWT) was suggested by the American Thoracic Society (ATS) for this purpose[4] and has been used with the pediatric population.[5] Nonetheless, the 2-minute walk test (2MWT) may be used as an alternative assessment. Both 2- and 6- minute walk tests were used to measure self-paced walking ability and functional capacity. However, the 2-minute walk test has a shorter distance than the 6-minute walk

test. Which is suitable for person with disability of walking.[6]

The current situation of respiratory infections causing children to be affected after infection that affects activities. Therefore, the 2MWT is another option for physical capacity evaluation. Aside from taking less time than the 6MWT, the 2MWT is rarely exceeded during incidental bursts of walking.[7] Furthermore, the distance walked in 2 minutes is substantially linked with the distance reached in 6 minutes ($r = 0.968$)[7], and the walking pace during the 6MWT is constant between 1 and 6 minutes.[8] However, some children who are willing to walk for 2 minutes continuously "give up" before 6 minutes.[7] Although 2MWT is suitable for children, correlation with 6MWT has not been reported in Thailand. The purpose of this research was to investigate the

correlation between the 2- and 6-minute walk tests in healthy children.

Methodology

A cross-sectional study was conducted on healthy children from the first through third grades of primary schools in Chiang Mai province. The participants were randomly chosen; each school's administration chose healthy pupils at random whose parents agreed to their child's involvement and provided informed consent. The sample size calculation was calculated from the program G-Power version 3.1, which references a sample population based on research by Bohannon et al.[7] By setting Power equal to 0.80, and alpha level equal to 0.05, found that there should be a total number of not less than 26 cases in each group (effect size=1.032). For this reason, a total of 30 participants collected data. And the children have the ability to walk more than 60 meters. On the other hand, children with underlying disorders, particularly cardiovascular, respiratory, or neuromuscular problems, a history of severe sickness within the two weeks prior to selection, a history of taking medication that could impair the walk test.[9] Conditions that have a major impact on walking capacity and an inability to gain informed consent were also excluded.

The record form included date of birth, underlying conditions, age, gender, weight and height. The data was collected between April and May 2022. The chosen children were questioned by researchers and evaluated by physicians to establish their eligibility as subjects. A stadiometer and digital weighing scale were used to measure height and weight in the standard position. Using a conventional tape, leg length was measured from the anterior superior iliac spine (ASIS) to the medial malleolus in the upright posture.[10]

Before any performance-based assessments were conducted, participants' basic demographics (age, gender, height, body mass, etc.) were assessed. The participant sits in a chair near the start of the walking course while receiving instructions from the training handbook. The examiner gave one demonstration, then each participant took an out-and-back practice round before taking one trial of the actual examination. Participants were instructed to wear comfortable clothing and proper shoes and to refrain from excessive exercise for at least two hours prior to the test. They were required to rest for at least 10 minutes in a chair at the starting line before beginning the test. During the waiting time, participants' respiration rates, pulse rates, and blood pressure were monitored, and they were asked to score their baseline fatigue or dyspnea using the Borg CR10 scale (0 = no exertion at all and 10 = maximal exertion).[10] Each participant also completed a 2- and 6-minute walk test on order with two separate test days by a week. The exams were held between 8.30 a.m. and 11.30 a.m. at a location designated on the grounds.

Two-minute walk test

The 2MWT was completed on a 50-foot (15.2-meter) out-and-back course. A stopwatch, measuring tapes, cones, marking tapes, a chair, record sheets, and a clipboard were used in the setup. Before the participant came, the examiner marked a 50-foot course with 10-foot intervals in a broad, flat, open area such as a hallway, with a cone at either end. A chair was strategically positioned near the start of the route. Participants were told to walk as quickly as they could until they were told to stop (without anyone walking with them). They were also urged not to worry if they needed to slow down or rest, but that if they did, they should resume walking as soon as they were ready. They were told after 1 minute, "you are doing great; you have 1-minute remaining." Participants came to a halt after 2 minutes of walking.[9] The examiner placed a piece of tape behind the participant's heel to note where the participant stopped and measured the distance from the tape to the last lap. Finally, the examiner recorded the distance on the record sheet. The test, including instructions and practice, took about 4 minutes to conduct.

Six-minute walk test

The 6MWTs were carried out in accordance with the American Thoracic Society (ATS) recommendations [11]. The technician who administered the 6MWTs was advised about the standard protocol and instructed to utilize it. A conventional 30-meter tape was used to measure the five 30-meter walking courses on long, level, straight, and hard ground. Every meter of the walking paths was labeled. The starting and turnaround points were also delineated. Each lap covered a total distance of 60 meters.

The test was timed for six minutes using a regular stopwatch. The technician utilized standard terms of encouragement during the testing to motivate the participants in the same way. When the six minutes were up, the individuals were instructed to stop walking and the technician recorded the total distance from the test. The same technician monitored the participants' respiratory rate, pulse rate, and blood pressure before asking them to rate their post-walk Borg CR-10 scale. Dizziness, chest discomfort, leg or thigh pain, and syncope were all reported as post-walk symptoms. The participants were applauded and given a drink of water before being sent back to their classes by walking. Ethical review and approval were approved by the Institutional Review Board of the Faculty of Medicine of Chiang Mai University (IRB number 511/2021).

Statistical analysis

The descriptive characteristic was used to represent participant characteristics and distance from walking tests. Shapiro-Wilk test was used to confirm normal distribution of data. Pearson's correlation (r)

was used to assess the correlation coefficient between 2- and 6- minute walk tests. All analyses were carried out in SPSS version 26 (significant at alpha 0.05).

Results

A total of 30 participants were investigated during the study; 50% were males (Table 1). The comparison of baseline characteristics has similarities between male and female ($p>0.05$). The Borg scale was grade 0 for all participants prior to the assessment of the 2- and 6-minute walk tests. As shown in Table 1.

Table 1 Male and female characteristics (mean $\pm$ SD)

	n=30	Male (n=15)	Female (n=15)
Age (year)	7.96 $\pm$ 0.71	8 $\pm$ 0.75	7.93 $\pm$ 0.7
Weight (kg)	17.06 $\pm$ 1.31	17.13 $\pm$ 1.18	17 $\pm$ 1.46
Height (m)	1.29 $\pm$ 5.1	1.28 $\pm$ 5.1	1.30 $\pm$ 4.7
BMI (kg/m ²)	10.21 $\pm$ 0.63	10.39 $\pm$ 0.51	10.04 $\pm$ 0.71
Leg length (cm)	64.64 $\pm$ 1.17	64.3 $\pm$ 1.14	64.99 $\pm$ 1.13
2 MWD (m)	203.6 $\pm$ 17.4	205.4 $\pm$ 20.07	201.8 $\pm$ 14.9
Borg-post	2(1,3)	2(1,3)	2(1,3)
6 MWD (m)	559.79 $\pm$ 50.97	605.06 $\pm$ 58.82	594.51 $\pm$ 43.16
Borg-post	5(4,7)	5(4,6)	6(4,7)

Continuous variables (age, height, weight, leg length, and BMI-Body Mass Index) are given as mean values with their standard deviations (SD). Borg scale is present with median and interquartile range (IQR1,3).
n: number of participants; MWD: minute walk distance; kg: kilogram; m: meter; cm: centimeter.

Table 2. Pearson correlation coefficients (r) between 2- and 6- minute walk tests in children

Pearson correlation (r)	2MWD	6MWD	age	weight	height	Leg length	Borg scale-post (2MWT)	Borg scale-post (6MWT)
2MWD (r) (p-value)	1	0.99 ^b 0.001*	0.90 ^b 0.001*	0.56 0.001*	0.40 0.02*	0.44 0.01*	0.02 0.88	-0.3 0.85
6MWD		1	0.89 ^a 0.001*	0.538 0.002*	0.38 0.03*	0.42 0.02*	0.02 0.90	-0.04 0.81
age			1	0.51 0.004*	0.28 0.12	0.33 0.06*	0.14 0.44	0.05 0.76
weight				1	0.56 0.001*	0.54 0.002*	0.20 0.27	0.17 0.35
height					1	0.92 ^b 0.001*	0.11 0.54	-0.08 0.66
Leg length						1	0.13 0.48	-0.49 0.79
Borg scale-post (2MWT)							1	0.10 0.59
Borg scale-post (6MWT)								1

*Indicates statistical significance ($p < 0.05$), ar=0.7-0.89, br=0.9-1.00, Minute walk distance (MWD).

The relationship between 2- and 6- minute walk distance (MWD)

There was a strong and significant positive correlation between 2MWD and 6MWD ($r = 0.99$, $p = 0.001$). Correlations calculated for the four variables and 2MWD, also showed the significance ($p < 0.05$). In 2MWD they were, $r = 0.56/0.01$ (weight), $r = 0.40/0.02$ (height), and $r = 0.44/0.01$ (leg length) respectively. As shown in Table 2.

Discussion

The primary finding of this study is that the 2MWT and 6MWT are highly correlated. A correlation is dominant in the relationship between the 2MWT and 6MWT ($r = 0.99$, $p = 0.001$). These results are

comparable with earlier research on the 2MWT and

6MWT, in previous study (2015-2018) ($r = 0.61-1.00$). [6, 8, 12] According to a general recommendation, $r > 0.75$ indicates good correlation, and $r > 0.90$ is suggested for clinical choices.[9]

Despite the 2MWT and 6MWT's strong relationship, there was a statistically significant increase in walking distance from the children group (203.6 $\pm$ 17.49 m and 559.79 $\pm$ 50.97 m in the 2MWT and 6MWT, respectively). The variation was also observed in children's groups, but most of it was not statistically significant. The results could be explained by small sample size and age range is not wide enough.

For healthy youngsters, the 6MWT is recognized as a valid and reliable functional walk test.[10] It is

feasible and useful, simple to implement, affordable, safe, and well tolerated by young children. In the previous study, the 6MWT has several factors involved in the result for interpretation including age, gender, weight, and height. Similarly, the 2MWT is most likely dependent on 6MWT.[9] In this study, the 2MWD is positively related to BMI, leg length, and Borg scale. According to Bohannon (2018), provide normative values for the 2MWT for children and adolescents. Gender and age have a significant interaction with 2MWT from regression analysis ($F=2.27$, $p=0.05$). Correlation analysis revealed that age, age-squared, height, and mass were all moderately linked with 2MWT distance ($r=0.30$ to 0.53 , $p<0.01$).[7] Bohannon in 2015 described the norms of the 2MWT for healthy adults. The results of distance covered are correlated with participant's body mass index ($r=0.573$, $p<0.05$).[12]

However, there are several studies suggesting that 2MWT could assess ability of walking in children with neuromuscular disorder (eg. Myotonic dystrophy type 1, Becker muscular dystrophy, Duchenne muscular dystrophy, spinobulbar muscular atrophy, and facioscapulohumeral).[8, 9] The pathology of the disease is a result of a significant decrease in walking distance, which affects the interpretation of 6 MWT. As a result, the 2 MWT is appropriate for assessing children with functional impairments.[9]

Due to the current epidemic of respiratory disease, the functional ability assessment is important to predict the functional level and ability of daily life activity- especially walking. For this reason, the 2MWT is another available alternative assessment and suitable for young children. They have limited endurance and tolerance for long-distance walking, especially in children with long covid-19 symptoms.[13] The limitation of this study was that it was only studied in healthy subjects. Therefore, data cannot be inferred in children with underlying medical conditions. Although the 2MWT takes less time and is more likely to be completed by boys and girls than the 6MWT [7], its utility has been restricted to far due to a lack of norms in Thailand. Therefore, further studies should be done to determine the normative values in children.

Conclusion

The 2MWT and 6MWT have a good relationship in children. In which to measure the 2MWT, individual characteristics should be considered. A walking capacity resulted in an increase in absolute measuring inaccuracy. When evaluating 2MWT and 6MWT data in individual patients in the clinic, practitioners must be mindful of the challenges related to absolute functional capability.

Competing Interests

The authors declare that there is no conflict of interest.

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Author contributions

WC takes full responsibility for the integrity of the data and the accuracy of the data analysis. WC, RM, and SD had access to, and verified, the underlying data. WC, and RM critically evaluated all stages of the research process. All authors designed the study, contributed with conceptual design, analyses, and interpretation of the results, also contributed with drafting the article and critically revising it for important intellectual content, and gave final approval for the version to be submitted.

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