Correlation of Anthropometry Characteristics and Six-Minute Walking Test Distance In Children Aged 7-8

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Abstract

Background: The six-minute walk test (6MWT) is a useful test for measuring functional capacity and predicting morbidity and mortality. The 6MWT is not widely used in children because the exact reference data are often not known, and the test requires concentration and co-operation from the participants, which is harder to manage in children. The anthropometry characteristic influences the 6MWT distance.

Objective: This study aimed to investigate the correlation between anthropometry characteristic and 6MWT distance in children aged 7-9 years old.

Methods: This research was an observational analytic study using cross-sectional design that was conducted on August 2013. Weight, height and body mass index were measured according to the Decree of Ministry of Health Republic of Indonesia. The 6MWT was performed according to American Thoracic Society (ATS) in a 15m indoor walkway. The data were analyzed using several tests, including Kolmogorov-Smirnov test for data normality test and Pearson's correlation test.

Results: The average 6 MWT distance in all subjects was 390.45±50.05 meters, with the average 6 MWT distance in subjects aged 7 and 8 were 370.15±45.64 and 410.75±46.47 meters, respectively. Pearson's correlation test showed a positive correlation between height and 6 MWT in allsubjects, but there was no correlation between height, weight and body mass index with 6 MWT distance in each age group.

Conclusion: The anthropometry characteristic was not correlated with the 6MWT distance in children aged 7 and 8 years old.

Keywords: *anthropometry characteristic, children, six-minute walking test*

Introduction

Decreased children's physical activities have become a growing health problem in recent years. Outdoor physical activity has been replaced with many indoor activities. Children's participation in sports begins to decline as they prefer watching television and playing video games. Epidemiological studies suggest that sedentary lifestyle is associated with early onset and progressivity of cardiovascular disease and doubling the risk of premature death [1,2].

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Functional training capacity assessment is necessary to determine human body's physical fitness, particularly cardiovascular, respiratory, metabolic and musculoskeletal systems [3]. The gold standard for determining objective functional capacity is by testing incomplete cardiopulmonary training using either a treadmill or an ergometer bike. The implementation of maximum training test requires facilities, tools and trained people. This makes health centers with minimal facilities difficult to conduct such trainings [4]. The use of a six-minute walking test (6MWT) as a submaximal test has been proved to be an alternative to the functional capacity assessment in adults [5].

The reliability of 6MWT in children aged 5-14 has been demonstrated by studies in China and Belgium

[6,7], by investigating bilateral, knee dominant, knee joint alignment (tibio-femoral angle and Q angle), body mass index, pain and quadriceps muscle activity on the incidence of body swing disorders dynamically in patients with knee osteoarthritis. Some studies also found that 6MWT was easy, safe and cheap, and it could reflect daily activities compared to other types of walking tests [8].

The 6MWT is useful in clinical use, but has not been widely used in pediatric practice due to lack of data reference in healthy children. In addition, this test requires concentration and co-operation of the participants, which is harder to manage in children [3]. Some studies investigateda standard value reference of 6MWT in children as well as the correlation of anthropometric characteristics, including age, sex, weight, height, body mass index (BMI) and heart rate, with 6MWT distance [9].The 6MWT study in 1,455 healthy children aged 7-16 in China suggested the first standard value reference in international literature [10]. Some studies aimingto obtain standard value references of 6MWT have been conducted in various countries, including Austria, United Kingdom, Brazil, Tunisia and Thailand [9]. A study aiming to obtain 6 MTW average distance was also conducted in Indonesia in 2010. The study conducted in Jakarta was only investigating 6 MWT average distance in healthy children aged 9-10 [11]. To date, there has been no data available in Indonesia that examine 6 MWT distance in healthy children outside that age group. Anthropometry characteristics affect 6 MWT results. Therefore, demographic, anthropometric and nutritional differences in different ethnic groups should be taken into account in 6 MWT results. Shorter individual and woman have shorter stride length that subsequently shortens travel distance [12]. Bulgarian children, who are taller and heavier, have a superior cardiopulmonary function compared to Romanian children [13].

Different anthropometric characteristics also appear in ethnic differences. It was found in a study conducted in Malaysia as the results found anthropometric differences in ethnic Malays, Indian and Chinese. Therefore, we were interested in investigating correlation of anthropometric characteristics and 6MWT distance in children aged 7-8.

Methods

This observational analytic study using cross sectional design was carried out from August 2013 at Department of Physical Medicine and Rehabilitation, Dr. Soetomo Teaching Hospital, Surabaya, Indonesia. The subjects were Muhammadiyah 4 elementary school students aged 7-8 who met the inclusion criteria. They were taken using cluster sampling method. One cluster that met the minimum sample size was taken from each stratum.

Subjects must meet the following inclusion criteria: 1) Muhammadiyah 4 elementary school students aged 7-8 whohad no contraindication to undergo 6MWT; 2) Having wide joint motion and level 5 muscle strength on manual muscle testing (MMT) examination. We excluded subjects with following criteria: 1) Having cardiorespiratory, neuromuscular and other diseases affecting gross motor skills and walking capabilities as evidencedby anamnesis and clinical examination; 2) Having been ill in the last two weeks and taking medications that may affect walking ability. On the other hand, the drop criteria was subject who could not complete 6 MWT for any cause.

This research began with subjects declaring their willingness to participate in this study by signing the informed consent and filling in the questionnaire. The subjects were determined in accordance to the inclusion and exclusion criteria as evidenced by the results of anamnesis and physical examination. We used One Med digital weighing device, One Med height meter, Riestertensimeter, Littman stethoscope, Oxyone pulse oximeter, stopwatch, calculator, cone, markers, bright-coloredtape, gauge, chair, rating sheet, informed consent and emergency kit. Furthermore, we prepared a 15-meter walkway. The walkway was marked with a cone placed on the starting line and at the end of the track (15 meters) as a turning point. The line was marked with a bright-coloredtape as a marker for the subjects to walk straight alongside the mark. Black-colored tape was placedat a distance of 5, 10 and 15 meters.

We asked the subjects to have enough rest before the test.The test was carried outfor at least 2 hours after breakfast. The subjects must use sportwear and traning shoes, and they were not allowed to perform any exercise prior to the test. The subjects waited for their turn by sitting in a chair near the track. The subject's primary data were collected before the test. The data included subject's name, age, sex, weight, height, body mass index, vital signs (pulse, blood pressure and oxygen saturation).The researcher/assistant prepared the equipment and walkway.The subjects were given instructions and examples of how to perform the

6MWT. We marked the distance obtained by the subject with markers. Afterwards, we immediately measured the subject's vital signs.

All data were statistically processed using SPSS (SPSS., Inc., Chicago IL). The data were analyzed using several tests, including Kolmogorov-Smirnov test for data normality test and Pearson's correlation test.

Results

Subjects' Characteristics

Table 1 showed subjects' basic characteristics. The subjects' average weight was 29.49±9.10 kilograms. The subject's average weight in age group 7 and 8 were 26.88±7.58 kilograms and 32.10±9.85 kilograms, respectively. The subject's average height was 129.11±7.49 centimeters. The subject's average height in age group 7 and 8 were 125.68±6.70 centimeters and 132.55±6.69 centimeters, respectively. The subjects' average BMI was 17.42±4.06. The subjects' average BMI in age group 7 and 8 were 16.81±3.59 and 18.03±4.45, respectively (Table 1).

Table 1. Subjects' Anthropometry Characteristics

Variable		N	Mean±SD	Minimum	Maximum
Weight	**Total**	**60**	**29.4867 ± 9.10397**	**15.90**	**55.90**
	7 years old	30	26.8767 ± 7.58373	15.90	48.10
	8 years old	30	32.0967 ± 9.84964	17.50	55.90
Height	Total	60	129.1133 ± 7.48797	112.20	149.40
	7 years old	30	125.6767 ± 6.70238	112.20	138.00
	8 years old	30	132.5500 ± 6.68693	119.50	149.40
BMI	Total	60	17.4213 ± 4.05603	11.85	28.55
	7 years old	30	16.8150 ± 3.59440	12.29	25.70
	8 years old	30	18.0277 ± 4.44857	11.85	28.55

Based on anthropometry characteristics by sex, the boys' and girls' average height in age group of 7 were 125.04±7.67 centimeters and 126.16±6.06 centimeters, respectively. The boys' and girls' average weight were 26.19±9.66 and 27.40 ± 5.79 kilograms, respectively. The average BMI in both groups were 16.36±4.22 and 17.16±3.13, respectively.

Table 2. Anthropometry Characteristics in 7-Year Age Group by Sex

	Height		Weight		BMI	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**
Mean	125.0384	126.1647	26.1923	27.4000	16.3592	17.1635
SD	7.67198	6.05743	9.65889	5.79655	4.21806	3.12651

N for M = 13, F= 17

The boys' and girls' average height in age group of 8 were 132.99±6.65 centimeters and 131.89± 6.98 centimeters, respectively. The boys' and girls' average weight were 32.06±10.42 kilograms and 32.16±9.37 kilograms, respectively. The average BMI in both groups were 17.88±4.71 and 18.25±4.21 (Table3).

Table3. Anthropometry Characteristics in 8-Year Age Group by Sex

	Height		**Weight**		**Body Mass Index**	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**
Mean	132.9889	131.8917	32.0556	32.1583	17.8800	18.2492
SD	6.64883	6.98407	10.42301	9.37360	4.71477	4.21067

Results of Six-Minute Walking Test

We measured 6MWT distance after obtaining anthropometry characteristics. Of 60 subjects who participated in the 6MWT, no one dropped out. The subjects' average 6MWT distance was 390.45±50.05 meters. The subjects' average 6MWT distance in 7-year age group was 370±45.64 meters, with the shortest and longest distance were 300 meters and 462.8 meters, respectively (Table 4).

Table 4. Subjects' Six-Minute Walking Test Distance

		N	**Mean ± Std. Deviasi**	**Minimum**	**Maximum**
Distance	Total	60	390.4500 ± 50.04545	300.00	514.60
	7 years old	30	370.1500 ± 45.64013	300.00	462.80
	8 years old	30	410.7500 ± 46.47404	333.50	514.60

The average 6MWT distance achieved in the 8-year age group was 410.75 ± 46.47 meters, with the shortest and longest distance were 333.5 meters and 514.6 meters, respectively.

Correlation between Anthropometry Characteristics and Six-Minute Walking Test Distance

Kolmogorov-Smirnov test found normal distribution of all data in both groups. Pearson's correlation test showed a significant correlation between height and 6MWT distance, with r = 0.256 and p = 0.049 ($p < 0.05$). On the other hand, there was no significant correlation between weight (p = 0.585) and BMI (p = 0.829) with 6MWT distance ($p > 0.005$; Table 5).

Table 5. Subjects' Anthropometry Characteristics with Distance

Parameter	**Distance**		
	R	**P**	**N**
Height	0.256	0.049	60
Weight	0.072	0.585	60
Body Mass Index	-.029	0.829	60

r: correlation coefficient

p: p value shows significant level, significant if $p < 0.05$

Discussion

The anthropometric characteristics observed in this studywere height, weight and BMI. The basic anthropometric measurements in this study were in accordance with the standards used by the Ministry of Health of the Republic of Indonesia based on World Health Organization (WHO) regulation in 2005. The anthropometric data of children reflect the general health status, nutritional adequacy, growth and development [14].

Based on the growth table of children aged 2-20 from the Center for Disease Control (CDC) in 2000, indicates that the subjects' average body weight, height and BMI are normal. The 6MWT distance illustrates the walking ability and individual abilities in daily activities, as the energy used in daily activities matches the submaximal level [8,15].

The 6MWT is one of submaximal exercises used to assess training capacity in patients with chronic disease. This practice test has been widely used in adult and child population, including for estimating the physical fitness of children with severe illness [8]. The 6MWT in this study used a 15-meter indoor walkway. The procedure was in accordance with American Thoracic Society (ATS) standards. Subjects were instructed to walk as far as possible within 6 minutes without running.

Subjects were asked to rest for 10 minutes before undergoing the test. The subjects spent more time resting to keep doing the activity without control (rolling, jumping, running and so on). Vital sign monitoring, including blood pressure, pulse rate and oxygen saturation, was performed before and after the test. In this study, the average 6MWT distance was 390.45±50.05 meters, with the average distance in the age group of 7 and 8 were 370.15±45.64 meters and 410.75±46.47 meters, respectively. We found an increase in the average 6MWT distance as much as 40.6 meters between the age groups. Lammers et al. found an increase in 6MWT distance based on age. They found that distance increased by 37 meters at the age of 4-5, 43 meters at the age of 5-6 and 25 meters at the age of 6-7, while they not investigated increase in the age group 7-8 [7].

The average distance in this study was lower than two studies conducted by Goemans and Ulrich in the same age group. This study found the average distance in 7-year and 8-year age groupswere 370 meters and 410 meters, respectively. Goemans' studieswere conducted in Caucasian boys aged 5-12 years. They divided the subjects' age into 4 groups. The 7-8-year groupachieved average distance of 547 ± 68.9 meters [7].

Li argued that anthropometric character that mostly influencesdistance is height. Li's study found that subjects with a height of 120 centimeters had average distance of 550 meters and 595 meters for female and male, respectively[10]. This indicated the comparison between average distanceand height in this study was below the 25 percentiles in accordance with Li's standard. Lower average distance obtained in this study might be caused by various reasons, including motivation factor and child's cognitive level. According to Enright, walkway distance, motivation and cognitive levels are factors influencingchild's 6MWT distance [16].

Age, height, weight and gender factors affect the average 6MWT distance in healthy children. These factors should be taken into consideration when interpreting the results of 6MWT conducted in one time [17]. We found a significant positive correlation between height and 6MWT distance in all subjects. It indicated that the higher the child, the further the distance achieved.

Nevertheless, we found no significant correlation between height and distancein each age group. We also found a negative correlation between weight and BMI with 6MWT distance in all subjects. These findings were consistent with a study of 6MWT distance based on gender in the age group of 9-10conducted by Munadia in Jakarta. Munadia found no correlation between height, weight and BMI in boys aged 9-10. There was a correlation between distance and height in girls aged 9-10 [11].

Conclusion

We found a positive correlation between height and 6MWT distance in children aged 7-8. There was no correlation between weight and BMI with 6MWT distance in both groups. In this study, the average 6MWT distance in children aged group 7-8 years was lower than the studies conducted in other countries.

Ethical Clearance: The study protocol was approved by the Ethical Commission to conduct basic science/clinical research in Dr. Soetomo General Hospital Surabaya, Indonesia. This study implemented the basic principle ethics of respect, beneficence, non-maleficence, and justice.

Conflict of Interest: The authors report no conflict of interest of this work.

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