

# Validity and Reliability of 2 Minutes Walking Test in Frailty Elderly

Niken Pratiwi<sup>1</sup>, Rwahita Satyawati<sup>1</sup>, Damayanti Tinduh<sup>1</sup>, Soenarnatalina Melaniani<sup>2</sup>, Mahmuddah Mahmuddah<sup>2</sup>

<sup>1</sup>Department of Physical Medicine and Rehabilitation, Dr. Soetomo General Hospital, Faculty of Medicine, University of Airlangga, Surabaya, Indonesia

<sup>2</sup>Department of Biostatistics and Population Study, Faculty of Public Health, University of Airlangga, Surabaya, Indonesia  
nlk3np@gmail.com

**Keywords:** 2MWT, 6MWT, Frailty, Elderly, Validity, Reliability

**Abstract:** Frailty and age-related conditions are associated with morbidity and mortality. The 6-minute walk test (6MWT) has been recommended by the American Thoracic Society to measure exercise capacity, but it is time-consuming for the investigator and exhausting for frailty elderly. This study aims to investigate the validity and reliability of 2 minutes walking test (2MWT) as measurements of physical performance. A cross-sectional study was performed. Each subject performed 6MWT as a gold standard and two trials of 2MWT in two consecutive days at approximately the same time. The walking test was performed in the same corridor with the same starting point. The subject was allowed to use ambulation aid. Frailty was measured using the Cardiovascular Health Study score. The final subjects included sixty elderly (26 men, 34 women with mean age 73.40 years old). Pearson's  $r$  correlation of VO<sub>2</sub>max between 6MWT and 2MWT was strong ( $r=0.791$ ,  $p=0.000$ ). The 6MWT and 2MWT showed excellent reliability (ICC=0.926,  $p=0.000$ ). The 2MWT was shown to be a reliable and valid test for assessment of exercise capacity following rehabilitation in frailty elderly. It is practical, simple, and well-tolerated by frailty Elderly.

## 1 INTRODUCTION

Frailty is a typical health condition associated with the aging process that is when the body's system gradually loses its ability to work. About 10% of people over 65 years experience frailty, increasing to between a quarter and half of those aged over 85 years (Clegg, 2013). Frailty can be a cause of disability in some patients (BGS, 2014). Decreased mobility, functional capacity and/or basic activities of daily life (ADL) such as bathing, dressing, and walking occur in 20-30% of the elderly population over 70 years (Manton, 2000).

Mobilization ability is one of the most important factors for assessing the level of health and well-being in the elderly. Functional mobility and independence are the main objectives of the rehabilitation program. Functional capacity reflects a person's cardiorespiratory capacity. Assessment of cardiorespiratory ability was generally assessed by measuring maximum oxygen uptake (maximal oxygen uptake/VO<sub>2</sub>max) (Sykes, 2004), but the measurement of VO<sub>2</sub>max directly requires complex

equipment and laboratories, specific and expensive equipment, supervision of a professional medical team, and also consideration of the motivation and physical effort of the subject to carry out the training test. Therefore an alternative test is needed to estimate VO<sub>2</sub>max with the submaximal training test (Katch, 2011).

The 6-minute walking test (6MWT) is a test standard developed by the American Thoracic Society in 2002 (ATS, 2002). However, this test has limitations on the elderly, especially the elderly with frailty. A 6-minute walking test (6MWT) is too tiring, takes longer and increases the risk of falling for elderly frailty, 2-minute walking test (2MWT) can be an alternative. The 2-minute walking test is considered to have the ability to assess exercise tolerance (Hiengkaew, 2012).

At present, there are no research data on the validity and reliability of 2MWT in elderly with frailty, and 2MWT is an easy, inexpensive and safer walking test for frailty elderly people. Researchers

are interested in researching the validity and reliability of 2MWT in the elderly with frailty.

## 2 METHODS

This study was an observational analytic study with a cross-sectional study to determine the correlation between the values of anthropometric parameters of body weight, height, age, and gender from 2MWT with VO<sub>2</sub>max from 6MWT. Besides, an assessment of 2MWT reliability (test-retest) was also carried out by measuring 2 times (1 consecutive day) by the same examiner (interrater). We hypothesize that the 2-minute walking training test (2MWT) has validity and reliability on the assessment of functional training capacity compared to 6MWT in frailty elderly.

The research will be conducted at Griya Wreda Jambangan Surabaya and carried out in November 2018. The target population of this study was Frailty Elderly with a sample size of 60 subjects taken based on simple random sampling, which was, calculated accordingly the following formula:

$$n = \frac{\sigma^2(Z_{1-\alpha/2} + Z_{1-\beta})^2}{(\mu_0 - \mu_1)^2} \quad (1)$$

Description:

*n*: Sample

$\alpha$ : Alpha Error Rate (5%)

*Z*: Normal Distribution

$\beta$ : Beta Error Rate (10%)

$\sigma$ : Frailty's elderly variance in the preliminary study(4,69)

$\mu_0$ : *first average* (9,91)

$\mu_1$ : *second average* (7,94)

In this study, inclusion and exclusion criteria were applied. Inclusion Criteria are: 1) Age more than or equal to 60 years. 2) Frailty criteria based on the Cardiovascular Health Study. 3) Good hearing function. Checked with a modified whisper test and said to be normal if you could hear 80% of all the items tested according to the procedure. 4) Good vision function. Judged by a visual inspection using Snellen u cards at a distance of 6 meters. 5) Can understand and follow verbal instructions well. 6)

Independent ambulation with or without walking aids. 7) Willing to participate in this study by signing an informed consent sheet after obtaining an explanation.

While the exclusion criteria used in this study were 1) Being undergoing a routine physical exercise program that aims to improve walking speed and lower limb muscle mass in the past month. 2) Severe cognitive impairment was assessed using the Mini-Mental State Examination questionnaire (MMSE <23). 3) Having dementia. 4) Suffering from severe cardiorespiratory disorder 5) Having acute-severe knee OA according to clinical appearance, 6) Chronic illness / that causes other long-term disabilities (eg. ambulation disorders due to stroke, uncontrolled diabetes, balance disorders due to intracranial or extracranial processes, visual disturbances, etc). 7) Falling risk is assessed by the Timed Up and Go Test, for risk fell in the elderly population  $\geq 13.5$  seconds.

Data from the results of the examination of anthropometric response parameters are displayed descriptively in table form. For correlation analysis between the values of weight, height, age and walking speed when 2MWT with VO<sub>2</sub>max when the 6MWT training test is used the Pearson correlation test. If a good correlation is obtained, then it will be followed by linear regression between each parameter of 2MWT and multiple regression with VO<sub>2</sub>max when the training test runs for 6 minutes to obtain the prediction (formula) of VO<sub>2</sub>max prediction. The interclass correlation coefficient (ICC) test was used for reliability analysis (test-retest reliability) of VO<sub>2</sub>max 2MWT. Data analysis was performed using SPSS 22 and Lisrel.

## 3 RESULTS

This research was conducted by setting a place at the Jambangan Surabaya nursing home. The number of elderly who can be ambulated is 102 elderly. Twenty-two elderly were included in the exclusion criteria due to 8 dementia disorders, 5 elderly with visual impairment and 8 elderly with hearing impairment. Sixty elderly subjects who met the inclusion and exclusion criteria completed the 2MWT I (first) and II (second) tests, as well as the 6MWT test. The characteristics of the research subjects are shown in Table 1.

Table 1: Characteristics of Research Subjects.

Variable	Min	Maks	Mean ± SD
Age (years)	60	96	73.40 ± 8.928
Weight (Kg)	33	78	51.70 ± 10.617
Height (cm)	130	175	153 ± 0.103
BMI (Kg/m <sup>2</sup> )	14.84	33.32	21.93 ± 3.918

Nb: SD = Standard Deviation, Min = Minimum Value, Max = Maximum Value.

Table 2: Percentage of Frailty.

Sex	Frailty	Pre frailty	Total
L	7 (26.9 %)	19 (73.1 %)	26 (100 %)
P	16 (47.1%)	18 (52.9 %)	34 (100 %)
Total	23 (38.3 %)	37 (61.7 %)	60 (100 %)

Nb: Sex = Gender, L = Male, P = Female.

Table 3: Correlation of VO<sub>2</sub>max 2MWT and 6MWT

Parameter		VO <sub>2</sub> max 6MWT	VO <sub>2</sub> max 2MWT
VO <sub>2</sub> max 6MWT	r	1	0.791**
	p		0.000
	N	60	60
VO <sub>2</sub> max 2MWT	r	0.791**	1
	p	0.000	
	N	60	60

Description: r = Pearson correlation coefficient, p = p value, N = number of subjects. Significant correlation at p < 0.01 (2-tailed)

Table 4: Test-retest reliability of Vo2Max 2MWT.

Parameter	ICC	CI 95%
VO <sub>2</sub> max	0.925	0.874 – 0.955

Description: ICC = Interclass Correlation Coefficient, CI Confidence Interval, TDS = Systolic Blood Pressure, TDD = Diastolic Blood Pressure

Based on the Frailty score Cardiovascular Health Study (CHS) Table 3.2 found 26 research subjects male 7 (26.9%) including frailty and 19 (73.1%) pre-frailty people. For female subjects, 16 (47.1%) were frailty and 18 (52.9%) were pre-selected frailty.

To calculate the VO<sub>2</sub>max correlation from 2MWT and 6MWT, then carried out the 2MWT validity assessment. The vo<sub>2</sub>max value obtained from the equation calculated using Confirmatory Factor Analysis. Table 3.3 illustrates the relationship between the VO<sub>2</sub>max value of the 2MWT and 6MWT submaximal load training tests. From the calculation of the Pearson correlation coefficient the strong correlation was found ( $r = 0.791$ ;  $p = 0.000$ ) between the VO value of 2max. The training test was two minutes and six minutes.

2MWT reliability (test-retest) assessment was carried out by comparing VO<sub>2</sub>max values on two measurements (between 2MWT I and 2MWT II) within a span of 1 day carried out by the same examiner (interrater), at the same hour and place.

## 4 DISCUSSION

In this study, 60 elderly subjects met the inclusion criteria and were not included in the exclusion criteria and were willing to take part in the study after signing informed consent. The age of the subjects in this study was 60-96 years (mean 73.40 years). The body mass index of the subjects in this study ranged from underweight to obese, namely 14.84 - 33.32 Kg/m<sup>2</sup>. The normal value of the Indonesian body mass index is 18.5 - 25 Kg/m<sup>2</sup> (Harahap, 2005). All research subjects completed the 2MWT I (first) training test and 6MWT training test at the first meeting, as well as the 2MWT II (second) training test 1 day after the first. Before carrying out the training test the subject's cardiorespiratory parameters were measured. The mean resting heart rate at the first meeting (before 2MWT I) was 77.20 beats/minute. The average resting heart rate is not much different when compared to the average resting heart rate during the second meeting (before 2MWT II), with an average of 77.30 beats/minute. From the paired t-test there was no significant difference between cardiorespiratory parameters (heart rate, systolic blood pressure, diastolic blood pressure, and pulse blood pressure) pre-2MWT I and pre-2MWT II with p values for all parameters >0.05. With this, it can be said that the conditions or cardiorespiratory parameters break the subjects between the first and second meetings in this study are the same. In this

study, the VO<sub>2</sub>max equation is calculated using Confirmatory Factor Analysis.

Prediction of VO<sub>2</sub>max values can be done using anthropometric parameters. This, of course, can be done if the anthropometric parameters have a good correlation with the VO<sub>2</sub>max value when the submaximal stress test measured using 6MWT. The statistical analysis used for this purpose is linear regression. From the linear regression analysis, a regression equation will be obtained which states the relationship of the variable you want to predict with the measured variable (Tumbelaka, 2014). In this study, the predicted variable is the value of VO<sub>2</sub>max and the measured variable is the anthropometric parameter namely age, weight, height, and walking speed (m / min). The regression equation for VO<sub>2</sub>max prediction is shown in Table 4.

Table 4: Regression equation for prediction of  $VO_{2max}$ .

Equation	VO <sub>2</sub> max
I (R <sup>2</sup> = 71.4 %)	- 116.244 + (1.17 x umur)
II (R <sup>2</sup> = 66.6%)	18.164 - ( 0.918 x BB)
III (R <sup>2</sup> = 62.4%)	105.432 - ( 0.878 x TB)
IV (R <sup>2</sup> = 93.6%)	- 0.854 x Running speed

Description: BB = Body Weight, TB = Height, R = Coefficient of determination

From the regression equation above we can see that the highest r-value ( $r = 1.00$ ) is obtained if all four parameters (weight, height, age, sex, and walking speed) during the 2MWT training test are included in the calculation. The higher the R-value of a regression equation, the higher the accuracy of the equation (the prediction results are getting closer to the actual value with a smaller error rate). Thus, the best equation from the 2MWT training test for the prediction of VO<sub>2</sub>max:

The submaximal training test developed in this

$$VO_{2Max} \text{ (mL/KgBB/minute)} = 2.809 + (0.868xU) - (0.0412 x BB) - (0.382 x TB) - (0.474 x \text{ Walking speed}) \quad (2)$$

Nb:

- U = Age (Years)
- BB = Weight (Kg)
- TB = Height (Cm)
- Running Speed (m/minutes)
- Estimation of Error Standart = 0.119

study is a 2-minute walking training test (2MWT).

These submaximal training test subjects were asked to walk for 2 minutes in a 30m corridor. Unlike the 6MWT submaximal test as the gold standard, 2 minutes test in this study was chosen to minimize muscle fatigue, especially in untrained subjects. Besides, the cardiorespiratory physiological condition remained (steady-state) when the exercise test was reached after 2-3 minutes (Prentice, 2011). So that 2 minutes was sufficient to obtain the cardiorespiratory parameters of the condition during the training test. Maximum oxygen consumption (VO<sub>2</sub>max) is the largest amount of oxygen that can be inhaled during a training test, which involves a large part of the total muscle mass. This is considered the best measure of cardiovascular fitness and aerobic capacity.

This study found that there was a significant increase in walking distance in the 2MWT repeat trial in frailty elderly. According to a study conducted by Brooks in 2007 found an increase in walking distance in amputee patients and heart surgery patients who did not experience improvement after three trials. Repeated trials in pediatric patients with cystic fibrosis revealed no significant difference in walking distance. In contrast, repeated trials in pediatric patients with cystic fibrosis revealed no significant difference in walking distance (Upton, 2015). Guyatt et al. Showed that, in repeated trials of patients with limited chronic airflow and/or chronic heart failure, there was a stable training effect after two trials. An interesting finding from this study is that walking distance in 2 minutes increased during the two trials.

VO<sub>2</sub>max value generally decreased according to age. Decreasing VO<sub>2</sub>max 8-10% per decade in both mobile and inactive populations (Pin, 2012). In VO<sub>2</sub>max women are lower because muscle mass is smaller than men. Because both of these affect VO<sub>2</sub>max (Tumbelaka, 2014), anthropometric parameters are used to find out VO<sub>2</sub>max. In this study, 2MWT validity was assessed by analyzing anthropometric parameter correlations (age, weight, height, sex, and walking speed) at 2MWT against VO<sub>2</sub>max values measured using equations calculated using Confirmatory Factor Analysis. From the calculation of the Pearson correlation coefficient, we found a significant correlation ( $r = 0.791$ ) between the VO<sub>2</sub>max value at 2MWT and 6MWT.

Based on the interpretation of the Pearson ( $r$ ) correlation coefficient by Tumbelaka *et al*, the correlation is stated to be good if the value of  $r = >0.8$ ; medium if the value of  $r = 0.6 - 0.79$ ; weak if the value of  $r = 0.4 - 0.59$ ; and very weak if the

value of  $r = <0.4$ . Correlation values obtained in this study indicate that the 2MWT submaximal training test has quite good validity in the assessment of cardiorespiratory capacity in frailty elderly.

The VO<sub>2</sub>max correlation value in this study is not much different when compared with the VO<sub>2</sub>max correlation value in a study conducted by Bohannon *et al* and Bernstein *et al* both evaluated concurrent validity in individuals with respiratory disease and reported that the running distance at 2MWT was highly correlated with walking distance in 6 and 12 minutes running test ( $r = 0.892-0.995$ ). Bernstein examined the validity of individuals with COPD and reported that walking distance in 2 minutes was moderate to maximal correlated and strongly correlated with submaximal oxygen consumption ( $r = 0.45$ ;  $r = 0.55$ ; respectively). Furthermore, Upton et al. Concluded that, in children with cystic fibrosis who have a near-normal respiratory function, 2MWT is a measure that is more discriminatory than the peak expiratory flow rate. In individuals with lower limb amputations, a distance of 2MWT correlates with measures of physical function and prosthetic use.

Reliability Test is a fundamental measurement property that is relatively easy to determine and quantified in terms of the level of consistency and repetition when managed properly in similar circumstances for certain populations. Assessment of reliability (test-retest reliability) of 2MWT in this study was conducted by comparing the parameter values of age, weight, height, gender and walking speed with VO<sub>2</sub>max using the prediction formula on two measurements (between 2MWT-I and 2MWT-II) in the 1 consecutive day by the same examiner (interrater).

The 2MWT reliability for age parameters is quite good with a value of  $R^2 = 71.4\%$  ( $SE = 0.151$ ). 2MWT reliability for weight parameters is quite good with a value of  $R^2 = 66.6\%$  ( $SE = 0.135$ ). Reliability for the Height parameters is quite good with an ICC value of  $62.4\%$  ( $SE = 0.145$ ). Reliability for the sex parameter is quite good with an ICC value of  $58.1\%$  ( $SE = 3.132$ ). If the four parameters (weight, height, age, gender, and walking speed) during the 2MWT training test are included in the calculation, the ICC score is very good at  $92.5\%$ . The higher the ICC value of an equation, the higher the reliability. This shows that the 2MWT submaximal training test has good reliability in the assessment of cardiorespiratory capacity.

## 5 CONCLUSIONS

The 2-minute walking exercise test (2MWT) has good validity where anthropometric parameters of weight, height, age, sex and walking speed when 2MWT have a significant correlation with VO<sub>2</sub>max values during the 6MWT submaximal training test. The 2-minute walking test (2MWT) has very good reliability (test-retest reliability).

## REFERENCES

- American Thoracic Society (ATS)., 2002. ATS Statement: Guidelines for the Six-Minute Walk Test. *American Journal of Respiratory Critical Care Medicine*, 166(111117).DOI:10.1164/rccm.166/1/111
- Bernstein, ML., Despars, JA., Singh, NP., Avalos, K., Stansbury, DW., Light RW., 1994, Reanalysis of the 12 minute walk-in patients with chronic obstructive pulmonary disease, *Chest*, 105:163–7.
- Bohannon, RW., Bubela, D., Magasi, S., McCreath, H., Wang, YC., Reuben, D., Gershon, R., 2014, Comparison of walking performance over the first 2 minutes and the full 6 minutes of the Six-Minute Walk Test. *BMC Research Notes*, 7, 269. <http://doi.org/10.1186/1756-0500-7-269>
- British Geriatric Society (BGS)., 2014. Fit For Frailty, Consensus Best Practice Guidance for the Care of Older People Living with Frailty in Community and Outpatient Setting, Majory Warren House, London.
- Brooks, Dina., 2002, Reliability of the two-minute walk test in individuals with transtibial amputation, *Archives of Physical Medicine and Rehabilitation*, 83(11), 1562–1565.
- Brooks, D., Parsons, J., Hunter, JP., Devlin, M., Walker, J., 2001, The 2-minute walk test as a measure of functional improvement in persons with lower limb amputation, *Arch Phys Med Rehabil*, 82:1478–83.
- Clegg, A., Young, J., Iliffe, S., Rikkert, MO., Rockwood, K., 2013, Frailty in elderly people, *Lancet*, 381(868):752-762.
- Guyatt, GH., Sullivan, MJ., Thompson, PJ., Fallen, EL., Pugsley, SO., Taylor, DW., 1985, The 6-minute walk: a new measure of exercise capacity in patients with chronic heart failure. *Can Med Assoc J*, 132(8):919-23.
- Harahap, H., Widodo, Y., Mulyati Sri., 2005, Penggunaan berbagai *cut-off* indeks massa tubuh sebagai indikator obesitas terkait penyakit degeneratif di Indonesia. *Gizi Indon*, 31, pp. 1-12.
- Hiengkaew, V., Jitaree, K., Chaiyawat, P., 2012, Minimal detectable changes of the Berg balance scale, Fugl–Meyer Assessment Scale, Timed "Up & Go" Test, gait speeds, and 2-minute walk test in individuals with chronic stroke with different degrees of ankle plantar flexor tone, *Archive of Physical Medicine Rehabilitation*, 93:1201–1208.
- Katch, VL., McArdle, WD., Katch, F. I., 2011, Measuring and Evaluating Human Energy-Expenditure Capacities During Exercise, In: *Essential of Exercise Physiology, 5th edition*, Philadelphia: Lippincott William & Wilkins, pp. 203-233.
- Manton, KG., Land, KC., 2000, Multidimensional Disability/Mortality Trajectories at Ages 65 and Over: The Impact of State Dependence, *Social Indicators Research*, 51: 193.
- Pin, TW., Lewis, J., 2012, Pilot normative study on 2- and 6-minute walk tests on typically developing children in Australia, Australasian Academy of Cerebral Palsy and Developmental Medicine Conference. *Developmental Medicine Children Neurology*, 54:85.
- Prentice, W., 2011, Maintaining Aerobic Capacity and Endurance during Rehabilitation. In W. Prentice, *Rehabilitation Techniques for Sports Medicine and Athletic Training*, New York: McGraw-Hill, pp. 214-25.
- Sykes, K., Roberts, A., 2004, The Chester Step Test - a Simple yet Effective Tool for The Prediction of Aerobic Capacity, *Physiotherapy*, 90, pp. 183- 188.
- Tumbelaka, A. R., Riono, P., Sastroasmoro, S., Wirjodiarjo, M., Pudjiastuti, P., Firman, K., 2014, Pemilihan Uji Hipotesis. In: S. Sastroasmoro & S. Ismael, eds. *Dasar-dasar Metodologi Penelitian Klinis*. Jakarta : CV. Sagung Seto, pp. 328-350.
- Upton CJ, Tyrrell JC, Hiller EJ., 2015. Two-minute walking distance in cystic fibrosis. *Arch Dis Child*; 63:1444–1448