ORIGINAL ARTICLE

Effect of Walking Course Length on 6MWT: An Experimental Study

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Abstract

Introduction: The 6-minute walk test (6MWT) is a validated tool of submaximal intensity used as an objective measure of functional exercise capacity. Changes in 6-minute walk distance (6MWD) are used to evaluate the efficacy of therapeutic interventions. American Thoracic Society (ATS) guidelines state that the walking course for the 6MWT must be 30 m. In a primary care physiotherapy setting, a 30 m straight course is often not available. Space limitations often force clinicians and researchers to conduct 6MWT on shorter courses. The purpose of this study was to determine the influence of 5, 10, 15, and 30 m course lengths on 6MWD and physiological parameters during the 6MWT.

Materials and methods: A total of 80 healthy adults from 18 to 30 years performed four 6MWTs along 5, 10, 15, and 30 m course lengths in a corridor randomly, on consecutive days. The 6MWD and vital parameters on all four course lengths were recorded. Walking speed and maximal oxygen uptake (VO_2 max) were calculated.

Results: There was a significant difference in 6MWD, walking speed, and VO_2 max over 5, 10, 15, and 30 m course lengths during 6MWT ($p < 0.05$). There was no significant difference observed in the change in heart rate (HR) between 6MWT on 5 and 10 m course lengths and 6MWT on 15 and 30 m course lengths ($p > 0.05$).

Conclusion: The course length strongly influences the performance during the 6MWT and the results on 5, 10, 15, and 30 m courses are not interchangeable with each other. However, there was a similar submaximal cardiac performance on 15 and 30 m course lengths.

Keywords: 6-minute walk test, Course length, Maximal oxygen uptake, Walking speed.

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Introduction

The 6MWT is self-paced and is a validated tool of submaximal intensity used as an objective measure of functional exercise capacity.[1] It is used to evaluate cardiorespiratory fitness.[2] It is better tolerated and more reflective of regular activities of daily living than other field tests.[3]

The distance accomplished is also associated with clinical variables, such as hospitalization and mortality. The changes in 6MWD are used to gauge the efficacy of therapeutic interventions, including surgery, pulmonary rehabilitation, and pharmaceutical management.[4] The ATS has published guidelines on 6MWT procedures and interpretation and recommends using a 30 m course length.[1]

In a review by Fell et al., space limitation was frequently reported as a reason for the use of a shorter course length, to the alternatives to change in course length or configuration from that given by the ATS.[5]

In primary healthcare setups, due to unavailability or shortage of adequate space, clinicians and researchers are obligated to conduct 6MWT on shorter courses.

Hence, this study aimed to determine the influence of 5, 10, 15, and 30 m course lengths on 6MWD and physiological parameters during 6MWT.

Subjects and Methods

Approval for the study was obtained by the Institutional Ethics Committee and registered with Clinical Trial Registry – India. Figure 1 shows the flow of the study. Informed consent was obtained from the participants prior to the commencement of the study.

Each participant was screened using the Physical Activity Readiness Questionnaire. The sample size for the study was calculated using the following formula:

$$n = \frac{z|-\alpha|^{2^{2}}\ SD^{2}}{d^{2}}$$

Where, |-α| reflects type I error, for 95%, the critical value = 1.96, $p < 0.05$, SD—HR (22), d2—absolute error/precision which is 5%.

A total of 80 healthy adults were recruited from the institute campus and the surrounding community. Demographic and

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anthropometric data like height, weight, and body mass index (BMI) of all the participants were noted down.
Inclusion criteria:

- Both male and female subjects.
- Between the age-group of 18–30-year-old.
- With a BMI of 18–24.9 kg/m^2.

Exclusion criteria:

- Resting HR of >120 beats/minute.
- Systolic blood pressure (SBP) of >180 mm Hg.
- Diastolic blood pressure (DBP) of >100 mm Hg.
- Any known cardiovascular and/or respiratory condition.
- Any musculoskeletal and/or neurological disorder limiting ambulation.

Procedure

The tests were performed along 5, 10, 15, and 30 m straight courses. Each subject performed all four tests in a random order. Any two tests were run on the same day. The following day saw the completion of the final two tests.

After the course length was selected, the turnaround points were marked and markings were done every 3 m. On the ground was marked a starting line that served as both the beginning and the end were marked on the floor (Fig. 2).

The participants were asked to rate their baseline dyspnea and rating of perceived exertion (RPE) using the modified borg dyspnea scale (0–10 scale). According to ATS guidelines, the participants were instructed to walk as far as possible back and forth in the hallway for 6 minutes. Standard instructions and encouragement were provided before and during the test, respectively. The participants were advised to wear loose, comfortable clothing and appropriate footwear and refrained from caffeine consumption or performing any physical exercise at least 2 hours prior to the test.[1]

The 6MWD achieved on all the four course lengths after 6 minutes was recorded. Vital parameters like respiratory rate, HR, oxygen saturation, blood pressure, and rate of perceived exertion were documented at rest, immediately after the test and at 1 and 3 minutes after the test. Time for HR recovery was also noted down after all four tests.

Walking speed and VO_2 max were calculated using the following formula:[6]

Walking speed = distance (meters)/time (minutes)

VO_2 max (mL/kg/minutes) = 70.161 + [0.023 × 6MWD (m)] – [0.276 × weight (kg)] – (6.79 × sex, where m = 0, f = 1) – [0.193 × resting HR (bpm)] – [0.191 × age (year)].

Statistical Analysis

Data analysis was done using the Statistical Package for the Social Sciences version 26. Descriptive analysis (mean ± SD) was done for all the variables. Repeated measure analysis of variance (ANOVA) was used to compare the difference between 6MWD, walking speed, VO_2 max, change in HR, change in blood pressure, and change in RPE on each course length with every other course length. Adjustment for multiple comparisons was done using Bonferroni correction. The level of significance for the statistical test was set at $p \leq 0.05$.

Results

A total of 80 participants was recruited in this study who met the inclusion and exclusion criteria. There were 53 female and 27 male participants between the age of 18 and 30 years. The demographic details of the participants are enlisted in Table 1.

Mean ± SD for the 6MWD, walking speed, VO_2 max, change in HR, change in blood pressure, and change in RPE on all four courses are enlisted in Table 2.

The comparison of 6MWT parameters (6MWD, walking speed, VO_2 max, change in HR, change in blood pressure, and change in RPE) on each course length with every other course length using repeated measures ANOVA are enlisted in Table 3.

Table 1: Demographic details ($n = 80$)

Characteristics	*Mean ± SD*
Age (in years)	23.93 ± 3.01
Height (in meters)	1.625 ± 0.07
Weight (in kilograms)	60.34 ± 7.62
BMI (in kg/m^2)	22.71 ± 1.87

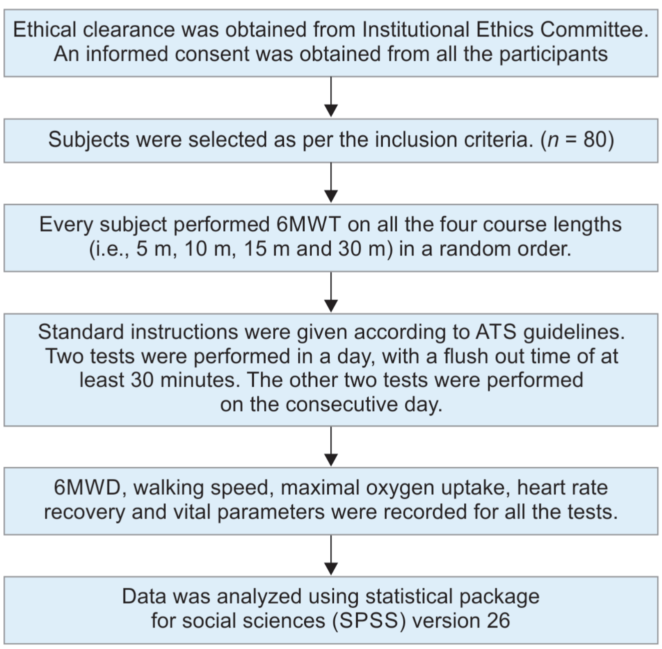

Fig. 1: Flow of the study

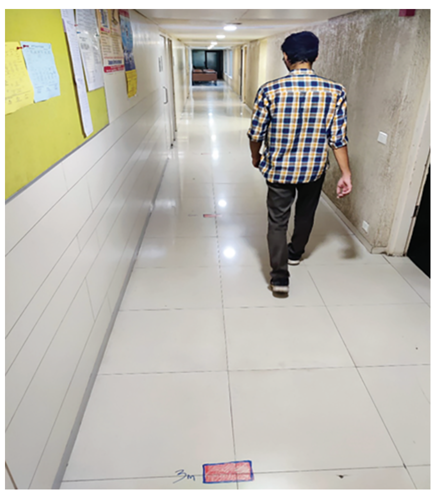

Fig. 2: 6MWT performed in the corridor

Table 2: Mean ± SD of 6MWD, walking speed, VO_2 max, change in HR, change in SBP, change in DBP, and change in RPE on 5, 10, 15, and 30 m course lengths

	6MWD (m)	*Walking speed (m/minute)*	*VO_2 max (ml/kg/minute)*	*Change in HR (beats/minute)*	*Change in SBP (mm Hg)*	*Change in DBP (mm Hg)*	*Change in RPE*
5 m	418.03 ± 51.70	69.67 ± 8.61	38.22 ± 4.37	18.975 ± 0.639	4.950 ± 0.302	2.150 ± 0.177	1.463 ± 0.097
10 m	449.79 ± 47.51	74.96 ± 7.91	38.96 ± 4.36	19.313 ± 0.575	5.075 ± 0.312	2.175 ± 0.168	1.188 ± 0.082
15 m	500.09 ± 41.73	83.35 ± 6.96	39.86 ± 4.25	22.763 ± 0.760	5.075 ± 0.291	2.100 ± 0.163	1.475 ± 0.102
30 m	543.05 ± 43.80	90.51 ± 7.30	40.88 ± 4.3	22.275 ± 0.506	4.850 ± 0.227	2.025 ± 0.144	1.300 ± 0.080

6MWD, 6-minute walk distance; DBP, diastolic blood pressure; HR, heart rate; RPE, rating of perceived exertion; SBP, systolic blood pressure; VO_2 max: maximal oxygen uptake

Table 3: Comparison of 6MWD, walking speed, VO_2 max, change in HR, change in SBP, change in DBP, change in RPE on 5, 10, 15, and 30 m course lengths

		6MWD	*Walking speed*	*VO_2 max*	*Change in HR*	*Change in SBP*	*Change in DBP*	*Change in RPE*
5 m	10 m	<0.05	<0.05	<0.05	>0.05	>0.05	>0.05	>0.05
	15 m	<0.05	<0.05	<0.05	<0.05	>0.05	>0.05	>0.05
	30 m	<0.05	<0.05	<0.05	<0.05	>0.05	>0.05	>0.05
10 m	5 m	<0.05	<0.05	<0.05	>0.05	>0.05	>0.05	>0.05
	15 m	<0.05	<0.05	<0.05	<0.05	>0.05	>0.05	<0.05
	30 m	<0.05	<0.05	<0.05	<0.05	>0.05	>0.05	>0.05
15 m	5 m	<0.05	<0.05	<0.05	<0.05	>0.05	>0.05	>0.05
	10 m	<0.05	<0.05	<0.05	<0.05	>0.05	>0.05	<0.05
	30 m	<0.05	<0.05	<0.05	>0.05	>0.05	>0.05	>0.05
30 m	5 m	<0.05	<0.05	<0.05	<0.05	>0.05	>0.05	>0.05
	10 m	<0.05	<0.05	<0.05	<0.05	>0.05	>0.05	>0.05
	15 m	<0.05	<0.05	<0.05	>0.05	>0.05	>0.05	>0.05

6MWD, 6-minute walk distance; DBP, diastolic blood pressure; HR, heart rate; level of significance was set at $p \leq 0.05$; RPE, rating of perceived exertion; SBP, systolic blood pressure; VO_2 max, maximal oxygen uptake

There was a significant difference observed in 6MWD ($p < 0.05$), walking speed ($p < 0.05$), and VO_2 max ($p < 0.05$) over 5, 10, 15, and 30 m course lengths when compared with each other.

No significant change in HR ($p > 0.05$) was observed between 6MWT on 5 and 10 m course lengths. Also, there was no significant difference observed in the change in HR ($p > 0.05$) between 6MWT on 15 and 30 m course lengths.

There was a significant difference in HR change ($p < 0.05$) between 6MWT on 5 and 15 m and 6MWT on 5 and 30 m course lengths, respectively.

There was a significant difference observed in the change in HR ($p < 0.05$) between 6MWT on 10 and 15 m and 6MWT on 10 and 30 m course lengths, respectively.

There was no significant difference observed in the change in systolic and DBP ($p > 0.05$) during 6MWT on all the four course lengths when compared with each other.

There was a significant difference ($p > 0.05$) observed in the change in RPE during 6MWT between 10 and 15 m course lengths and between 6MWT on 5 and 30 m course lengths.

Discussion

Functional walk tests measure the functional status or functional capacity of patients, and mainly their ability to sustain physically demanding activities of daily living. Due to the limitation of time and equipment, clinicians prefer field tests. The 6MWT is an easy way to estimate exercise capacity in patients with cardiopulmonary disorders.[3] According to the ATS guidelines, a flat 30 m walking course is required to perform 6MWT.[1] Clinicians use different course lengths in cases of time and space constraints.

The mean distance walked on a 30 m course length was 543.05 ± 43.80 m, 15 m course length was 500.09 ± 41.73 m, 10 m course length was 449.79 ± 47.51 m, and on a 5 m course length was 418.03 ± 51.70 m.

We found out that the distance covered during the 6MWT on 30 m was higher compared to the other three course lengths as there were less number of turns involved in the 30 m walkway; therefore, the subjects could walk farther on that course. The shorter walkways involved frequent turning for 6 minutes; as a consequence of the same, the participants consumed more time and effort, hence reducing the total distance accomplished. Our findings agree with Ng et al; they conducted 6MWT on 10, 20, and 30 m with chronic stroke patients and observed that the highest 6MWD was recorded on the 30 m course.[7]

Enright also compared 6MWD on 10 and 30 m course lengths and found that there was a difference of 49.5 m between the course lengths. They explained that the lower 6MWD achieved on a 10 m course could be explained by the increase in the number of turns involved on a shorter course of 10 m.[8] Hence, the distance walked during 6MWT is inversely proportional to the number of turns taken during the test.

There was a significant difference in walking speeds among all the four course lengths, with greater speed on 30 m walking course with mean of 90.51 ± 7.30 m/minute, followed by 83.35 ± 6.96 m/minute on 15 m course, 74.96 ± 7.91 m/minute on 10 m course, and 69.97 ± 8.61 m/minute on 5 m course. The 30 m course length allowed more room for acceleration during walking;

therefore, the participants walked at a faster pace. Our findings can be supported by the results of Macfarlane and Looney in a study with 34 older adults showed that a minimum walkway length for acceleration (2.17–3.23 m) and deceleration (1.80–1.85 m) was required to achieve a steady walking speed during the walking test.[9] Moreover, the walkway length might influence the subject's self-selected walking pace.

In our study, we calculated VO_2 max using a predictive equation given by Burr et al.[6] There was a significant difference in VO2 max over 5, 10, 15, and 30 m walking course lengths during 6MWT with a higher VO_2 max of 40.88 ± 4.3 mL/kg/minute during 6MWT on 30 m course length, followed by 38.22 ± 4.37 mL/kg/minute, 38.96 ± 4.36 mL/kg/minute, and 39.86 ± 4.25 mL/kg/minute on 5, 10, and 15 m course lengths, respectively.

Beyond these physical considerations, Almeida et al. performed 6MWT on 10, 20, and 30 m course lengths and found that 6MWD correlated positively with sex, body height, International Physical Activity Questionnaire classification, change in RPE, and change in HR.[10] We also recorded the change in HR, blood pressure, and RPE to see if there was a similar performance rate on all four course lengths.

The change in HR on 5, 10, 15, and 30 m course lengths were 18.975 ± 0.639, 19.313 ± 0.575, 22.763 ± 0.760, and 22.275 ± 0.506 beats/minute, respectively. There was no statistically significant difference observed in the change in HR between 6MWT on 5 and 10 m walking course lengths and between 6MWT on 15 and 30 m walking course lengths, which shows that 6MWT on 15 and 30 m course length had a closely relatable submaximal cardiac performance.

Furthermore, there was a significant difference observed in the change in HR between 6MWT on 5 m when compared to 15 and 30 m course lengths and between 6MWT on 10 m when compared to 15 and 30 m, suggesting that the smaller tracks did not produce similar effort compared to 15 and 30 m tracks. Although, there was no statistically significant difference observed in the change in blood pressure on all four course lengths.

These findings can coincide with a study done by Aquino et al. as they found that the walked distance during the 6MWT in a 30 m corridor was significantly higher (up to 3.57%) when compared to 6MWT in a 20 m corridor with no differences in cardiac overload between corridors, suggesting a similar effort in the performance of the test on different lengths.[11]

Gochicoa et al. conducted a cross-sectional study involving 45 healthy individuals and 45 patients with chronic lung diseases who performed two 6MWTs on 15 and 30 m corridors randomly and individually. They suggested that if the test methods (including the walkway length) do not change from the baseline to the follow-up test, direct comparisons can be made if the corridor length is shorter than the standard of 30 m.[12]

Hence, we also support using a course length of at least 15 m when performing a 6MWT because of a similar cardiac workload achieved compared to 6MWT on 30 m.

During 6MWT on a 5 m course length, a few participants also reported dizziness and cramps in their calves. This could be because of frequent turning, as the course length was too short. The reduced distance achieved could also have been influenced because of these factors.

Conclusion

The course lengths of 5, 10, 15, and 30 m substantially influence the performance during 6MWT in healthy young adults; hence the results obtained are not interchangeable. The difference in 6MWD achieved on all four course lengths was owing to the length of the walkway and the walking speed for the particular course length. In routine practices, where there is space constraint, we support the use of available space, although the course length is at least 15 m when performing a 6MWT.

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