OPEN ACCESS

ORIGINAL ARTICLE

Six-Minute Walk Test Reference Values for Healthy Young Adults Aged 18–25 Years at Levy Mwanawasa Medical University in Zambia: A Cross-Sectional Study

Chisenga Bwalya[1], Chipo Malambo[2,3], Margaret M. Mweshi[2], Mujilowe Patricia Ndhlovu[2], Sporah Chisha[2*]

[1] *Levy Mwanawasa Medical University, Lusaka, Zambia.*
[2] *Department of Health and Rehabilitation Sciences, School of Medicine, Copperbelt University, Kitwe, Zambia.*
[3] *Faculty of Physical Education and Sport, Charles University, Prague, Czech Republic.*

ABSTRACT

Background: The Six-Minute Walk Test (6MWT) is a simple, inexpensive test used to assess functional exercise capacity and cardiopulmonary endurance in clinical and rehabilitation settings. Interpretation requires population-specific reference values, which are not available for Zambia. This study established preliminary six-minute walk distance (6MWD) values for healthy young adults aged 18–25 years at a single Zambian university.

Methods: This analytical cross-sectional study included 87 healthy physiotherapy students (67 females, 20 males) aged 18–25 years at Levy Mwanawasa Medical University, selected by stratified random sampling. The 6MWT was conducted on a 30-m corridor using an American Thoracic Society-based standardised protocol. Data were analysed in R version 4.4.1. The primary outcome was 6MWD; statistical significance was set at $p < 0.05$.

Results: The mean 6MWD was 553.4 ± 58.4 m. Males walked significantly farther than females (608.0 ± 41.8 m vs 537.0 ± 52.6 m; mean difference 71.0 m, 95% CI 48.1–93.9; $p < 0.001$; Hedges' $g = 1.40$). In unadjusted analyses, height and weight correlated positively with 6MWD; male sex was the only clear independent predictor in the exploratory multivariable model.

Conclusion: These preliminary 6MWD values provide functional-capacity baseline data requiring external validation before routine clinical application because they are based on physiotherapy students at a single institution and are not nationally representative.

Corresponding author:
Sporah Chisha,
Department of Health and Rehabilitation Sciences, School of Medicine, Copperbelt University, Kitwe, Zambia. Email: zchisha@yahoo.com.

Keywords: Exercise Test; Reference Values; Young Adult; Adolescent; Zambia; Students, Health Occupations; Physical Fitness.

This article is available online at: http://www.mjz.co.zm, http://ajol.info/index.php/mjz, doi: https://doi.org/10.55320/mjz.53.3.1148
The Medical Journal of Zambia, ISSN 0047-651X, is published by the Zambia Medical Association

© This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

The Six-Minute Walk Test (6MWT) is a simple, safe, and inexpensive tool for evaluating functional exercise capacity, reflecting an individual's ability to perform daily physical activities[1]. The test measures the distance a person can walk on a flat, hard surface in six minutes, providing a global assessment of the integrated responses of the cardiovascular, respiratory, neuromuscular, and musculoskeletal systems[2–5]. Its submaximal nature makes it particularly suitable for assessing functional capacity in both healthy individuals and those with chronic diseases[6,7].

The prognostic value of the six-minute walk distance (6MWD) has been established across various clinical populations. In patients with heart failure, the 6MWT serves as a useful tool for assessing functional capacity, monitoring treatment response, and predicting outcomes[8,9]. Similarly, in pulmonary arterial hypertension, the distance walked during the test correlates with disease severity and survival[10].

However, accurate interpretation of 6MWT results requires population-specific reference values, as walking distance varies significantly across populations due to differences in anthropometry, ethnicity, and lifestyle factors[11–13]. Numerous studies have established reference equations for healthy adults in different regions. For instance, a multicentre study conducted in India[14] on 617 healthy subjects reported a mean 6MWD of 586 ± 106 m, with males walking 54 m farther than their female counterparts, and 46% of the variance explained by age, sex, and BMI. The authors reported an increase in variance to 62% after accounting for changes in heart rate. Similarly, a study conducted among Brazilians aged 20–80 years reported that 55% of the variance was explained by stature, age, and BMI[15].

Contemporary studies worldwide have continued to report various 6MWT reference values, emphasising the need for population-specific reference values[16–19]. Studies conducted in selected African countries[13,20] similarly reveal differences in 6MWT values despite sharing similar climate, geographic makeup, and ethnic background. For example, a study of 422 healthy Nigerian adults aged 21–67 years reported a mean 6MWD of 517.6 ± 72.2 m, with males walking 66.4 m farther than females[21], while a study of 200 healthy Algerians aged 16–40 years found a mean 6MWD of 680 ± 70 m, with sex, BMI, age, and weight explaining 59% of the variance[13].

Within the Zambian context[3], the 6MWT was utilised as an outcome measure in patients with knee osteoarthritis, demonstrating its utility in clinical populations. However, no published reference values exist for healthy Zambian adults, limiting the accurate interpretation of functional capacity in both clinical and research settings.

Therefore, this study aimed to establish preliminary 6MWT reference values for healthy university adults aged 18–25 years and to assess the influence of demographic and anthropometric variables on 6MWD.

METHODS

This study is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement for cross-sectional studies; the completed checklist is provided as an Appendix.

Study Design and Setting

An analytical cross-sectional study was conducted between July and October 2025 in the Physiotherapy Skills Laboratory at Levy Mwanawasa Medical University (LMMU), Lusaka, Zambia. LMMU is a public health sciences institution with a concentrated population of health sciences students, providing an accessible and controlled environment for standardised testing.

Study Population

The target population comprised 122 healthy male and female physiotherapy students aged 18–25 years enrolled in the second, third, or fourth year of study

during the 2025 academic year. This population was selected for its homogeneity in age, health status, and educational background, facilitating the establishment of clear potential benchmarks.

Sample Size and Sampling

The source population comprised 122 eligible second-, third-, and fourth-year physiotherapy students. Before data collection, a target sample of 93 participants was obtained using a single-population proportion formula with finite-population correction, assuming a 95% confidence level, a population proportion of 0.50, an absolute precision of 0.05, and a finite population of 122. This calculation yielded a sample size of 92.78, which was rounded to 93 participants. The use of a population proportion of 0.50 provided the maximum variance for a proportion in the absence of a prior local estimate. This was a pragmatic recruitment calculation and was not designed to provide a specified precision, in metres, for the continuous six-minute walk distance outcome. Stratified random sampling was used to obtain proportional representation by sex and year of study.

$$n = NZ^2p(1 - p) / [d^2(N - 1) + Z^2p(1 - p)]$$

where $N = 122$, $Z = 1.96$, $p = 0.50$, and $d = 0.05$.

Of the target sample of 93 students who were assessed and tested, six did not meet the resting oxygen-saturation eligibility criterion, leaving 87 participants in the final analysis.

Inclusion and Exclusion Criteria

Participants were included if they were aged 18–25 years, registered physiotherapy students at LMMU, apparently healthy with vital signs within normal ranges (heart rate 60–100 bpm, blood pressure 90/60–140/90 mmHg, oxygen saturation $\geq$95%), had no known chronic conditions, had a Body Mass Index (BMI) between 18.5–29.9 kg/m², and provided written informed consent. One minor protocol deviation occurred: one participant had a resting heart rate of 56 bpm, below the prespecified lower limit. He was asymptomatic and was retained in the primary analysis; a sensitivity analysis excluding him is reported below. Students were excluded if they had acute or chronic health conditions impairing exercise performance, BMI <18.5 or ≥ 30 kg/m², abnormal resting vital signs, current musculoskeletal injury limiting walking, confirmed or suspected pregnancy, use of medications affecting cardiovascular, respiratory, or metabolic function, or inability to provide informed consent.

Ethical Considerations

Ethical approval was obtained from the LMMU Research Ethics Committee (Ref: 0001022-25) and the National Health Research Authority (NHRA9542/26/08/2025). All participants provided written informed consent. Data were anonymised using participant identification codes, and all records were securely stored. Participation was voluntary and participants could withdraw at any time without penalty.

Data Collection Procedures

Pre-test screening and measurements. Eligible participants completed a health-screening questionnaire assessing medical history, medication use, and physical-activity patterns. Resting vital signs (blood pressure, heart rate, oxygen saturation, and respiratory rate) were measured after 10 minutes of seated rest using a digital monitor (Philips EarlyVue VS30). Height was measured to the nearest 0.1 cm (SECA 213 stadiometer) and weight to the nearest 0.1 kg (calibrated SECA digital scale). BMI was calculated as weight/height² (kg/m²). A single Borg score was recorded before testing using a 0–10 scale.

Six-Minute Walk Test protocol. The 6MWT was conducted in line with the American Thoracic Society (ATS) guidelines[22] with minor nonconformities due to practical constraints. A 30-metre straight course was measured with a tape measure and marked on the laboratory floor using tape and a marker pen, and subdivided into 3-metre

segments. One chair was placed at each end of the course, and two orange cones marked the turnaround points. Participants were encouraged to wear comfortable footwear and clothing, avoid vigorous physical activity, caffeine, and heavy meals before testing and were instructed to walk as far as possible in six minutes, at their own pace, without running or jogging. Standardised encouragement was provided by the same assessor at one-minute intervals using the ATS-prescribed phrases, which have been shown to influence walking distance and were applied consistently across all tests[1,23].

Participants wore a pulse oximeter throughout the test for continuous monitoring of heart rate and oxygen saturation[1]. The 6MWT was performed between 08:00 and 16:00 hours; temperature and humidity were not documented. No participant required rest, and no adverse symptoms were recorded. The Borg score was assessed using the modified 0–10 scale[1,24]. The analytical dataset contained one Borg variable at baseline and post-test rather than separate dyspnoea and leg-fatigue values. Total distance (6MWD) was calculated from completed 30-m laps plus the final partial lap measured to the nearest metre. Post-test vital signs and the Borg score were recorded immediately after test completion[6,25]. A practice (learning) test before the actual test was not feasible.

Quality Control

All tests were conducted by the principal investigator and two trained research assistants following a standardised protocol. A pilot study involving 9 participants (approximately 10% of the sample), not included in the main study, confirmed the clarity, feasibility, and reliability of all procedures and instruments before main data collection. No modifications were required.

Statistical Analysis

Data were analysed using R version 4.4.1. Categorical variables were summarised using frequencies and percentages; continuous variables using means and standard deviations or medians and interquartile ranges, as appropriate. The primary outcome was 6MWD in metres. Overall and sex-specific distributions were summarised using selected percentiles, with 95% confidence intervals for the 5th and 10th percentiles estimated from 5,000 bootstrap resamples. Mean 6MWD was compared between sexes using Welch's t test, reporting the mean difference, 95% CI, and bias-corrected Hedges' g with a 10,000-replicate stratified-bootstrap 95% CI. Spearman correlations examined unadjusted associations with 6MWD, with Benjamini–Hochberg false-discovery-rate (FDR) adjustment. Within-participant physiological changes were assessed using paired t tests. An exploratory linear regression included age, sex, height, weight, and post-test heart rate as a percentage of age-predicted maximum, with HC3 heteroscedasticity-robust standard errors and confidence intervals; BMI was not entered with height and weight because of mathematical collinearity. Model assumptions were assessed using variance inflation factors and residual and influence diagnostics. All tests were two-sided, and $p < 0.05$ indicated statistical significance.

A sensitivity analysis repeated the primary between-sex comparison after excluding one apparently healthy participant whose resting heart rate (56 bpm) fell just below the prespecified screening range. The participant was asymptomatic and was therefore retained in the primary analysis.

RESULTS

Participant flow and characteristics

Of 93 students who were assessed and tested, 6 were excluded because their resting oxygen saturation was below the 95% eligibility threshold, leaving 87 participants in the final analysis. A total of 87 participants were analysed: 67 (77.0%) were female, and 20 (23.0%) were male, with a mean age of 20.6 years (SD 2.2; range 18–25). No participant had missing 6MWD data; participant identifiers were unique, and all recorded distances agreed with the distance reconstructed from completed 30-m laps plus the partial final lap.

One apparently healthy male participant had a resting heart rate of 56 bpm (asymptomatic resting bradycardia) and was retained in the primary analysis. A sensitivity analysis excluding this participant did not materially alter the results (overall 6MWD = 552.6 m; between-sex difference 70.5 m, 95% CI 46.7 to 94.4; Hedges' g = 1.38).

Table 1. Participant characteristics overall and by sex

Characteristic	Overall	Female	Male
Sex, n (%)	F 67 (77.0); M 20 (23.0)	67 (100.0)	20 (100.0)
Year 2, n (%)	38 (43.7)	29 (43.3)	9 (45.0)
Year 3, n (%)	29 (33.3)	22 (32.8)	7 (35.0)
Year 4, n (%)	20 (23.0)	16 (23.9)	4 (20.0)
Age, years	20.6 (2.2)	20.7 (2.2)	20.4 (2.3)
Height, cm	167.3 (9.6)	165.5 (8.9)	173.4 (9.3)
Weight, kg	63.7 (10.2)	62.4 (10.1)	68.3 (9.3)
BMI, kg/m²	22.7 (2.4)	22.7 (2.5)	22.7 (2.0)
Sleep duration, hours	6.6 (1.5)	6.5 (1.5)	6.7 (1.6)
Resting heart rate, bpm	74.7 (9.9)	74.7 (10.2)	74.5 (9.0)
Resting respiratory rate, breaths/min	14.0 (1.5)	14.0 (1.5)	13.8 (1.6)
Resting SpO2, %	96.5 (1.2)	96.6 (1.2)	96.0 (1.0)
Pre-test Borg score	0.1 (0.2)	0.1 (0.2)	0.2 (0.2)

Values are mean (standard deviation) unless otherwise indicated. BMI: body mass index; SpO□: peripheral oxygen saturation.

Six-minute walk distance

Mean 6MWD was 553.4 m (SD 58.4), median 6MWD was 561.0 m (IQR 512.5–597.5), and observed distances ranged from 444 to 687 m. Females walked a mean of 537.0 m (SD 52.6), compared with 608.0 m (SD 41.8) among males. The sample had an overall 10th percentile of 464.2 m. Sex-specific lower percentiles differed substantially, but the male percentiles should be interpreted cautiously because they are based on 20 participants (Table 2).

Table 2. Distribution and preliminary reference percentiles for 6MWD

Group	N	Mean (SD), m	Median (IQR), m	Min–Max, m	5th pct, m	95% CI 5th pct	10th pct, m	95% CI 10th pct
Overall	87	553.4 (58.4)	561.0 (512.5 – 597.5)	444–687	455.3	445.8–471.8	464.2	455.0–488.8
Female	67	537.0 (52.6)	538.0 (491.5 – 579.0)	444–642	455.0	444.0–462.1	458.8	453.0–483.6
Male	20	608.0 (41.8)	610.5 (581.2 – 637.5)	546–687	547.0	546.0–567.0	553.3	546.0–586.0

CI: confidence interval; IQR: interquartile range; pct: percentile. Confidence intervals for the 5th and 10th percentiles were estimated using 5,000 bootstrap replicates.

Sex difference in six-minute walk distance

Male participants achieved a significantly greater mean 6MWD than female participants. Males walked 71.0 m farther than females (95% CI 48.1 to 93.9; $p < 0.001$), with a large standardised effect (Hedges' g = 1.40, bootstrap 95% CI 0.99 to 1.88); the difference is calculated as male minus female.

Physiological responses to the 6MWT

Pre-to-post changes in heart rate, respiratory rate, peripheral oxygen saturation, Borg score, and blood pressure were evaluated within participants using paired t-tests and are treated as secondary physiological and safety outcomes. Heart rate, respiratory rate, and perceived exertion increased following the test, whereas diastolic blood pressure did not change significantly (Table 3)

Factors associated with 6MWD

In unadjusted Spearman analyses, height (rho = 0.42; FDR-adjusted $p < 0.001$) and weight (rho = 0.33; FDR-adjusted $p = 0.005$) were positively correlated with 6MWD. Age, BMI, sleep duration, and post-test heart rate (as a percentage of age-predicted maximum) were not associated with 6MWD after FDR adjustment (Table 4, Panel A).

The multivariable model explained 33.5% of the variation in 6MWD (adjusted $R^2 = 0.294$; residual SD = 49.0 m; overall $p < 0.001$). After simultaneous adjustment, male sex was the only clear independent predictor, associated with a 59.1-m greater 6MWD (robust 95% CI 35.4 to 82.7; $p < 0.001$); no other covariate showed an independent association (Table 4, Panel B).

Table 3. Physiological responses before and after the 6MWT

Outcome	N	Pre-test mean (SD)	Post-test mean (SD)	Mean change (95% CI)	p value
Heart rate, bpm	87	74.7 (9.9)	102.5 (19.0)	27.8 (24.3 to 31.4)	<0.001
Respiratory rate, breaths/min	87	14.0 (1.5)	19.4 (2.9)	5.4 (4.9 to 5.9)	<0.001
SpO2, %	87	96.5 (1.2)	96.8 (1.3)	0.4 (0.1 to 0.6)	0.009
Borg score	87	0.1 (0.2)	1.2 (0.6)	1.1 (0.9 to 1.2)	<0.001
Systolic blood pressure, mmHg	87	114.9 (8.7)	118.4 (8.6)	3.6 (1.9 to 5.2)	<0.001
Diastolic blood pressure, mmHg	87	71.1 (7.1)	71.7 (7.6)	0.6 (- 0.4 to 1.6)	0.215

Changes are post-test minus pre-test values, evaluated within-participants using paired t-tests. Values were recomputed on the final 87-participant sample. CI: confidence interval; SpO□: peripheral oxygen saturation.

Table 4. Associations between participant characteristics and 6MWD

Panel A. Unadjusted associations (Spearman correlation)				
Characteristic	**N**	**Spearman rho**	**p value**	**FDR-adjusted p**
Age, years	87	- 0.05	0.667	0.927
Height, cm	87	0.42	<0.001	<0.001
Weight, kg	87	0.33	0.002	0.005
BMI, kg/m²	87	- 0.03	0.772	0.927
Post-test HR, % predicted max	87	0.11	0.330	0.659
Sleep duration, hours	87	0.01	0.935	0.935
Panel B. Exploratory multivariable linear regression (HC3-robust)				
Predictor	**Coefficient, m**	**Robust SE**	**95% CI**	**p value**
Intercept	227.71	117.78	- 6.64 to 462.05	0.057
Age, per year	0.98	2.35	- 3.69 to 5.64	0.678
Male sex	59.07	11.88	35.43 to 82.70	<0.001
Height, per cm	1.69	0.86	- 0.03 to 3.41	0.054
Weight, per kg	- 0.18	0.83	- 1.83 to 1.47	0.825
Post-test HR, % predicted max	0.41	0.57	- 0.73 to 1.55	0.479

BMI: body mass index; CI: confidence interval; FDR: false discovery rate; HR: heart rate; SE: standard error. HC3 heteroscedasticity-robust standard errors and confidence intervals are reported. BMI was not entered with height and weight because of collinearity.

DISCUSSION

The 6MWT is a fundamental tool for assessing physical fitness and monitoring patient recovery, and has been applied in rehabilitation, preoperative and postoperative care, and musculoskeletal, cardiopulmonary, and neurological conditions. Establishing locally tailored 6MWT reference values may therefore help assess and compare patient outcomes across populations. To our knowledge, this is a preliminary study to prospectively measure 6MWD in healthy young university students aged 18–25 years in Zambia. The mean 6MWD was 553.4 m (SD 58.4), with males walking significantly farther (608.0 m, SD 41.8) than females (537.0 m, SD 52.6); males walked a mean of 71.0 m farther than females (95% CI 48.1 to 93.9; $p < 0.001$; Hedges' $g = 1.40$, bootstrap 95% CI 0.99 to 1.88). In unadjusted analyses, height and weight were positively correlated with 6MWD; in the exploratory multivariable model, male sex was the only clear independent predictor.

The significant sex difference aligns with findings from numerous populations globally[26–29]. A study in Nigeria[21] reported a mean difference of 66.4 m between males and females, slightly lower than the 71.0 m reported here. A study from India[30] documented that males walked 584.4 ± 23.7 m versus 469.9 ± 30.4 m for females, while another study in Nepal[18] reported 602.2 ± 73.1 m for males versus 521.8 ± 67.8 m for females. These findings are consistent with established sex-related differences in body size, muscle mass, stride length, and aerobic capacity, although these characteristics were not directly measured in this study[6,21].

Comparable to Fernandes et al.[7] and Chaudhari[30], height and weight (rho = 0.42; FDR-adjusted $p < 0.001$ and rho = 0.33; FDR-adjusted $p = 0.005$) correlated positively with 6MWD. In the multivariable model including age, sex, height, weight, and post-test heart rate, neither height nor weight was independently associated with 6MWD. The positive correlation of height with 6MWD is consistent with the physiological advantage of

greater height, longer stride length, and greater lean muscle mass in males. Weight had a weak positive correlation with distance, possibly attributable to greater height and lean mass rather than weight itself, because height correlated positively with distance. Waist circumference or waist-to-height ratio may therefore better capture adiposity than BMI or body weight alone, a finding that warrants consideration in future work[31–33].

The mean 6MWD for Zambian females, 537.0 m (SD 52.6), closely approximates the value reported among Nigerian females[21], although direct comparison is limited by differences in participant age and sampling. Zambian males walked 608.0 m (SD 41.8), exceeding the value reported for Nigerian males; this may reflect differences in sample characteristics, as our cohort comprised university students aged 18–25 years, a younger and potentially more active population than the broader age range (21–67 years) in the Nigerian study[21].

When compared with other African populations, our findings show notable regional variation. A mean 6MWD of 680 ± 70 m was reported in healthy Algerians aged 16–40 years[13], considerably higher than in our cohort; this may reflect anthropometric differences, as the Algerian subjects were taller (169 ± 9 cm) and had greater lean mass. Conversely, Tunisian adults over 40 years covered a mean of 624 ± 111 m, emphasising the influence of age[20]. European populations generally demonstrated greater walking distances than our cohort[17,34,35].

Unadjusted analyses showed that height and weight were associated with longer 6MWD, but these associations were not retained in the adjusted model, indicating they were not independent predictors. The final model explained approximately one-third of the variability in 6MWD, with male sex the only significant independent predictor. Males walked an average of 59.1 m farther than females, consistent with established evidence that sex-related differences in muscle mass, stride length, and aerobic capacity contribute to functional exercise performance. Other factors, such as body composition, motivation, muscle strength, and cardiorespiratory fitness, were not measured and may explain the remaining variability[29,32,33].

The lack of a significant age effect within the narrow 18–25-year range is physiologically consistent. Young adulthood represents the peak of physical function, and within a seven-year band the natural rate of physiological decline is minimal and unlikely to manifest in a submaximal test. This aligns with studies showing age-related declines only across broader age ranges[14,36,37].

Heart rate increased by 27.8 bpm (95% CI 24.3 to 31.4; $p < 0.001$), respiratory rate by 5.4 breaths/min (95% CI 4.9 to 5.9; $p < 0.001$), and the Borg score by 1.1 (95% CI 0.9 to 1.2; $p < 0.001$), all consistent with the expected physiological response to exercise and appropriate test intensity[6]. Peripheral oxygen saturation increased slightly by 0.4% (95% CI 0.1 to 0.6; $p = 0.009$), a statistically significant but not clinically meaningful change. Systolic blood pressure increased by 3.6 mmHg (95% CI 1.9 to 5.2; $p < 0.001$), while diastolic pressure did not change significantly, demonstrating the expected physiological responses to the 6MWT.

Limitations

The sample-size calculation relied on practical assumptions rather than a population-specific variability estimate, owing to the lack of a published local standard deviation for 6MWD. The sample was drawn exclusively from physiotherapy students at a single university, limiting generalizability to the broader Zambian population; this cohort may have had greater health literacy and fitness awareness than non-university peers. The predominantly female sample (77.0%), while reflecting programme demographics, may have influenced overall mean values. The ATS guidelines recommend a second 6MWT to account for the learning effect[1]; this was not feasible within the study's constraints and may have introduced bias. Other factors, body composition, motivation, muscle strength, and cardiorespiratory fitness, may influence 6MWD but

were not measured. The analytical dataset contained only one Borg variable at each time point, so dyspnoea and leg fatigue could not be analysed separately.

Recommendations

Future research should expand to larger, more diverse samples across Zambia's provinces, including different educational and occupational groups and broader age ranges, to develop comprehensive national reference equations[28,33]. Studies should incorporate additional predictors, such as objective physical activity levels, lung function, body composition, grip strength, nutritional status, and psychological factors, to improve predictive accuracy. Multicentre studies across Sub-Saharan Africa would enable inter-population comparisons and potentially yield regional reference values. Validation studies applying these values to clinical populations are needed to confirm their utility in identifying functional impairment.

CONCLUSION

This study provides preliminary 6MWD data for healthy physiotherapy students aged 18–25 years at LMMU. These values are not nationally representative and should not be used as routine clinical reference standards without external validation. They provide baseline data and a foundation for larger, representative Zambian studies.

What is already known on this topic

- The 6MWT is a validated, simple measure of functional exercise capacity.
- Reference 6MWD values vary among populations and are influenced by demographic and anthropometric characteristics.
- Published reference values for healthy young adults in Zambia are limited.

What this study adds

- Provides preliminary 6MWD distributions for healthy physiotherapy students aged 18–25 years at LMMU.
- Shows a substantial sex difference in 6MWD, with male sex the only clear independent predictor in the exploratory multivariable model.
- Provides baseline data for future Zambian validation studies; the values require external validation before routine clinical application.

Acknowledgements

We thank the faculty, staff, research assistants, and participants for their support and participation and for providing a conducive research environment.

Competing interest

The authors declare that they have no competing interests.

Funding

No external funding was received for this study.

Data Availability Statement

The de-identified dataset and analysis scripts supporting the findings of this study are available from the corresponding author on reasonable request.

REFERENCES

1. Crapo RO, Casaburi R, Coates AL, Enright PL, MacIntyre NR, McKay RT, et al. ATS statement: Guidelines for the six-minute walk test. *American Journal of Respiratory and Critical Care Medicine*. American Lung Association; 2002. p. 111–7. doi:10.1164/ajrccm.166.1.at1102 PubMed PMID: 12091180.
2. Solway S, Brooks D, Lacasse Y, Thomas S. A qualitative systematic overview of the measurement properties of functional walk tests used in the cardiorespiratory domain. Chest. 2001;119(1):256–70. doi:10.1378/chest.119.1.256 *PubMed PMID*: 11157613.

3. Sporah C, Mweshi M, Chanda B. A Randomized Clinical Trial On Effectiveness Of Manual Therapy In Management Of Knee Osteoarthritis At Two Selected Teaching Hospitals In Zambia. *International Journal of Advanced Research and Publications* . 2020;4(3):178–200.
4. Faggiano P, D'Aloia A, Gualeni A, Brentana L, Dei Cas L. The 6 minute walking test in chronic heart failure: Indications, interpretation and limitations from a review of the literature. Eur J Heart Fail. 2004 Oct;6(6):687–91. doi:10.1016/J.EJHEART.2003.11.024 PubMed PMID: 15542403.
5. Rostagno C, Gensini GF. Six minute walk test: A simple and useful test to evaluate functional capacity in patients with heart failure. *Intern Emerg Med*. 2008 Sep;3(3):205–12. doi:10.1007/S11739-008-0130-6 PubMed PMID: 18299800.
6. Casanova C, Celli BR, Barria P, Casas A, Cote C, De Torres JP, et al. The 6-min walk distance in healthy subjects: Reference standards from seven countries. *European Respiratory Journal.* 2011;37(1):150–6. doi:10.1183/09031936.00194909 PubMed PMID: 20525717.
7. Fernandes L, Mesquita AM, Vadala R, Dias A. Reference equation for six minute walk test in healthy western India population. *Journal of Clinical and Diagnostic Research*. 2016;10(5):CC01–4. doi:10.7860/JCDR/2016/17643.7714
8. Giannitsi S, Bougiakli M, Bechlioulis A, Kotsia A, Michalis LK, Naka KK. 6-minute walking test: A useful tool in the management of heart failure patients. *Ther Adv Cardiovasc Dis*. 2019;13:1–10. doi:10.1177/1753944719870084 PubMed PMID: 31441375.
9. Bellet RN, Adams L, Morris NR. The 6-minute walk test in outpatient cardiac rehabilitation: Validity, reliability and responsiveness-a systematic review. Physiotherapy (United Kingdom). 2012;98(4):277–86. doi:10.1016/J.PHYSIO.2011.11.003 PubMed PMID: 23122432.
10. Andrianopoulos V, Holland AE, Singh SJ, Franssen FME, Pennings HJ, Michels AJ, et al. Six-minute walk distance in patients with chronic obstructive pulmonary disease: Which reference equations should we use? *Chron Respir Dis*. 2015 May 4;12(2):111–9. doi:10.1177/1479972315575201 PubMed PMID: 25754856.
11. Zou H, Zhang J, Zou Y, Chen X, Wang Y, Chen H, et al. Six-minute walking distance in healthy Chinese people older than 60 years. *BMC Pulm Med*. 2020;20(1):1–8. doi:10.1186/s12890-020-01211-w PubMed PMID: 32571358.
12. Alameri H, Al-Majed S, Al-Howaikan A. Six-min walk test in a healthy adult Arab population. *Respir Med*. 2009;103(7):1041–6. doi:10.1016/j.rmed.2009.01.012 PubMed PMID: 19230640.
13. Bourahli MK, Bougrida M, Martani M, Mehdioui H, Ben Saad H. 6-Min walk-test data in healthy North-African subjects aged 16–40 years. *Egyptian Journal of Chest Diseases and Tuberculosis*. 2016 Jan 1;65(1):349–60. doi:10.1016/J.EJCDT.2015.08.003
14. Ramanathan RP, Chandrasekaran B. Reference equations for 6-min walk test in healthy Indian subjects (25-80 years). *Lung India.* 2014 Jan;31(1):35–8. doi:10.4103/0970-2113.125892
15. Iwama AM, Andrade GN, Shima P, Tanni SE, Godoy I, Dourado VZ. The six-minute walk test and body weight-walk distance product in healthy Brazilian subjects (Brazilian Journal of Medical and Biological Research (2009) 42, 11, (1080-1085)). Brazilian Journal of Medical and Biological Research. 2010;43(3):324. doi:10.1590/s0100-879x2010000300016
16. Ulrich S, Hildenbrand FF, Treder U, Fischler M, Keusch S, Speich R, et al. Reference values for the 6-minute walk test in healthy children and adolescents in Switzerland. *BMC Pulm Med*. 2013;13(1):1. doi:10.1186/1471-2466-13-49 PubMed PMID: 23915140.

17. Vandoni M, Correale L, Puci MV, Galvani C, Codella R, Togni F, et al. Six minute walk distance and reference values in healthy Italian children: A cross-sectional study. *PLoS One.* 2018 Oct 1;13(10). doi:10.1371/JOURNAL.PONE.0205792 PubMed PMID: 30321226.
18. Pant S, Basnet K, Shrestha P, Mathura KC. Mean Six Minute Walk Distance of Healthy Healthcare Workers of a Tertiary Care Centre: A Descriptive Cross-sectional Study. *Journal of the Nepal Medical Association.* 2022;60(251):604–7. doi:10.31729/jnma.7541 PubMed PMID: 36705197.
19. Shrestha SK, Srivastava B. Six minute walk distance and reference equations in normal healthy subjects of Nepal. *Kathmandu University Medical Journal.* 2015 Apr 1;13(50):97–101. doi:10.3126/KUMJ.V13I2.16780 PubMed PMID: 26643825.
20. Ben Saad H, Prefaut C, Tabka Z, Hadj Mtir A, Chemit M, Hassaoune R, et al. 6-Minute walk distance in healthy North Africans older than 40 years: Influence of parity. **Respir Med.** 2009 Jan;103(1):74–84. doi:10.1016/j.rmed.2008.07.023 PubMed PMID: 19041233.
21. Ajiboye OA, Anigbogu CN, Ajuluchukwu JN, Jaja SI. Prediction equations for 6-minute walk distance in apparently healthy Nigerians. *Hong Kong Physiotherapy Journal.* 2014;32(2):65–72. doi:10.1016/j.hkpj.2014.04.003
22. Agarwala P, Salzman SH. Six-Minute Walk Test: Clinical Role, Technique, Coding, and Reimbursement. Chest. 2020;157(3):603–11. doi:10.1016/j.*chest.*2019.10.014 PubMed PMID: 31689414.
23. Singh SJ, Puhan MA, Andrianopoulos V, Hernandes NA, Mitchell KE, Hill CJ, et al. An official systematic review of the European Respiratory Society/American Thoracic Society: Measurement properties of field walking tests in chronic respiratory disease. *European Respiratory Journal.* 2014 Dec 1;44(6):1447–78. doi:10.1183/09031936.00150414 PubMed PMID: 25359356.
24. Przybyłowski T, Tomalak W, Siergiejko Z, Jastrzębski D, Maskey-Warzęchowska M, Piorunek T, et al. Polish respiratory society guidelines for the methodology and interpretation of the 6 minute walk test (6MWT). *Pneumonol Alergol Pol*. 2015 Jul 14;83(4):283–97. doi:10.5603/PIAP.2015.0048 PubMed PMID: 26166790.
25. Ubuane PO, Animasahun BA, Ajiboye OA, Kayode-Awe MO, Ajayi OA, Njokanma FO. The historical evolution of the six-minute walk test as a measure of functional exercise capacity: a narrative review. *J Xiangya Med.* 2018 Nov 9;3(0):40–40. doi:10.21037/JXYM.2018.11.01
26. Kim AL, Kwon JC, Park I, Kim JN, Kim JM, Jeong BN, et al. Reference equations for the six-minute walk distance in healthy Korean adults, aged 22-59 years. *Tuberc Respir Dis* (Seoul). 2014;76(6):269–75. doi:10.4046/trd.2014.76.6.269
27. Hussain SM, Tausif F, Aziz N, Hussain SM. 6 Minute Walk Test (6MWT) for Healthy Adult Volunteers. *Journal of Rawalpindi Medical College*. 2021;25(3):333–8. doi:10.37939/jrmc.v25i3.1485
28. Cazzoletti L, Zanolin ME, Dorelli G, Ferrari P, Dalle Carbonare LG, Crisafulli E, et al. Six-minute walk distance in healthy subjects: reference standards from a general population sample. *Respir Res*. 2022;23(1):1–9. doi:10.1186/s12931-022-02003-y PubMed PMID: 35382813.
29. Castro-Piñero J, Marín-Jiménez N, Perez-Bey A, Jiménez-Iglesias J, Grao-Cruces A, Alvarez-Gallardo IC, et al. Criterion-related validity and reliability of the 6-minute walk test in adults according to sex, age and physical activity level: The ADULT-FIT project. *J Sports Sci.* 2025;43(10):943–55. doi:10.1080/02640414.2025.2481361 PubMed PMID: 40148739.
30. Chaudhari M, Mehta HK, Shah C. Study of the Six Minute Walk Test in Healthy Adults of 17 to 50 Years. Int J Clin Exp Physiol.

2019;5(4):211–5. doi:10.5530/ijcep.2018.5.4.25

31. Freedman DS, Thornton JC, Pi-Sunyer FX, Heymsfield SB, Wang J, Pierson RN, et al. The body adiposity index (Hip Circumference ÷ Height 1.5) Is not a more accurate measure of adiposity than Is BMI, waist circumference, or hip circumference. Obesity. 2012;20(12):2438–44. doi:10.1038/oby.2012.81 PubMed PMID: 22484365.
32. Pereira LMC, Souza MFC de, Aidar FJ, Getirana-Mota M, Santos-Junior AM dos, Filho MFD de S, et al. Wrist Circumference Cutoff Points for Determining Excess Weight Levels and Predicting Cardiometabolic Risk in Adults. *Int J Environ Res Public Health.* 2024 May 1;21(5). doi:10.3390/ijerph21050549 PubMed PMID: 38791764.
33. Flegal KM, Shepherd JA, Looker AC, Graubard BI, Borrud LG, Ogden CL, et al. Comparisons of percentage body fat, body mass index, waist circumference, and waist-stature ratio in adults. *American Journal of Clinical Nutrition.* 2009;89(2):500–8. doi:10.3945/ajcn.2008.26847 PubMed PMID: 19116329.
34. Delbressine JM, Jensen D, Vaes AW, Li PZ, Bourbeau J, Tan WC, et al. Reference values for six-minute walk distance and six-minute walk work in Caucasian adults. *Pulmonology*. 2023;29(5):399–409. doi:10.1016/j.pulmoe.2023.02.014 PubMed PMID: 37045743.
35. Oliveira MJ, Marçôa R, Moutinho J, Oliveira P, Ladeira I, Lima R, et al. Reference equations for the 6-minute walk distance in healthy Portuguese subjects 18–70 years old. *Pulmonology*. 2019;25(2):83–9. doi:10.1016/j.pulmoe.2018.04.003 PubMed PMID: 29980459.
36. Camarri B, Eastwood PR, Cecins NM, Thompson PJ, Jenkins S. Six minute walk distance in healthy subjects aged 55-75 years. Respir Med. 2006;100(4):658–65. doi:10.1016/j.rmed.2005.08.003 PubMed PMID: 16229997.
37. Vaish H, Ahmed F, Singla R, Shukla DK. Reference equation for the 6-minute walk test in healthy North Indian adult males. *International Journal of Tuberculosis and Lung Disease.* 2013 May 1;17(5):698–703. doi:10.5588/IJTLD.12.0474 PubMed PMID: 23575339