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Original Research Article

Six-Minute Walk Test in Healthy Nepalese Young Adults Aged 18 to 25 Years: A Cross- Sectional Study

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ABSTRACT

Introduction: The six-minute walk test is a simple test used to assess the exercise capacity. Variability is noted in the six-minute walk distance in different population. Obesity also affects the six-minute walk test results. The aims of the study were to examine the relationship between body mass index and post exercise oxygen saturation and to establish reference equation for the six-minute walk distance in young adults. **Methods:** A cross-sectional study was conducted with 106 subjects of age 18-25 years. The participant walked as fast as possible on a flat surface for six minutes. After six-minute walk test, oxygen saturation and the distance walked were recorded. **Results:** Body mass index was negatively correlated with oxygen saturation ($r=-0.587, p<0.001$). Mean six-minute walk distance for males was 584.43±23.71 m and for females 469.85±30.38 m ($p<0.001$). Multiple linear regression analysis revealed sex and height as independent predictors of six-minute walk distance. The contributions of sex and height were statistically significant and explained 87.3% variance in the six-minute walk distance. **Conclusion:** Although the correlation between body mass index and oxygen saturation was statistically significant, the oxygen saturation values were still within normal range. Sex and height were the most significant predictors of the six-minute walk distance.

Keywords: Body mass index, Obesity, Oxygen saturation, Six minute walk distance, Six minute walk test

INTRODUCTION:

The six-minute walk test (6MWT) is a safe, easy to administer, and well tolerated submaximal test to evaluate exercise capacity that reflects activities of daily living better than other walk test.[1,2] The participant walks as fast as possible on a flat surface for six minutes, the distance walked is recorded as six-minute walk distance (6MWD).[2] Various factors including age, sex, height, weight, physical activity and body mass index (BMI) have been reported to affect 6MWD in healthy people.[3,4,5,6]

Abnormally high BMI is now one of the major health problems worldwide.[7,8] It causes accumulation of fat in the chest and abdomen causing restriction of lung expansion.[9] It has been found to be associated with lower oxygen saturation (SpO_2) after exercise and lower 6MWD.[10,11]

Besides these factors, 6MWD is variable in healthy population due to population related differences.[12] American Thoracic Society (ATS) encourages the investigators to publish reference values of the 6MWD for several healthy ethnicities using 6MWT.[2] The 6MWD reference value obtained from healthy participants helps the clinicians to interpret the 6MWD in patients and their expected 6MWD in the absence of disease of that age group. Recent studies have established

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regression equations to predict the 6MWD in healthy Nigerians,[3] Chinese population,[5] Western Indian Population,[4] Korean adults,[12] Brazilians,[13] and Arab populations.[14] However, regression equation has not been established in the Nepalese context. This study attempted to assess the relationship between BMI and oxygen saturation of hemoglobin after 6MWT. It also aimed to establish the regression equation for 6MWD in 18-25 years old healthy students of a medical college in Nepal.

METHODS:

This was a cross-sectional study conducted in the Department of Physiology, Lumbini Medical College (LMC), Pravas, Palpa. The study was carried out over a period of four months from August 2019 to November 2019. It included apparently healthy male and female students between age group of 18-25 years willing to participate voluntarily. Participants having physical disability affecting test procedure, basal heart rate < 50bpm or >100 bpm, basal systolic blood pressure >150 mmHg or diastolic blood pressure >100 mmHg, basal SpO_2< 85% and respiratory symptoms for a month before the study were not included in the study. Ethical clearance was obtained from Institutional Review Committee of the institute (IRC-LMC 08-J/018) prior to data collection. The sample size was calculated using the formula N= [(Zα + Zβ) /C] 2 + 3

Where, N=total number of subjects required

Zα and Zβ = the standard normal deviate for α and β

C = 0.5* ln {(1 + r) / (1 - r)}

r = expected correlation coefficient.[15]

For this study, the expected correlation coefficient was r = 0.27 based on study by Kapur VK et al.[10] with α = 0.05 and the power of study 80%. According to the calculations, a total of 106 health science students were selected by convenient sampling method.

Test procedure:

One hundred six students who fulfilled inclusion criteria were recruited for the study after obtaining their verbal consent. Initial explanation about the aim and purpose of study, test procedure, method of testing, and instructions on how to perform the test was given. They were requested to complete the Physical Activity Readiness Questionnaire before test procedure.[16]

The 6MWT was performed according to the standardized protocol of American Thoracic Society between 09:00 and 13:00 hours in order to reduce intra-day variability.[2] The participants were asked to come with comfortable cloth and light meals. At the starting point, basic medical history and clinical examination were taken for check on contraindications. BMI, resting heart rate, BP, Borg scores for dyspnea[17] and fatigue, and SpO_2 (Dr. Morepen Pulse Oximeter P004) were recorded after rest for 10 minutes. For the 6MWT, the participants were asked to walk while attempting to cover as much distance as possible in six minutes. The test was performed on a flat surface corridor of 15- meter length marked with small cones at the starting and end points and at every three meter distance the corridor was marked, the time and laps were recorded on a worksheet. Participants were encouraged in every minute with standard statements "You are doing well", "keep up the good work". They were allowed to stop and rest during the test when tired, developed symptoms of dyspnea, dizziness, leg cramps or chest pain, but were instructed to resume walking as soon as they could. After completion of the test again heart rate, BP, SpO_2 and Borg dyspnea score were recorded. Also, the distance covered over the six minutes was recorded as the 6MWD.[3]

Data analysis:

Data were reported as mean and standard deviation (SD). Independent t-test was used to compare means of continuous variables. The relationship between SpO_2 after 6MWT and BMI was examined using Pearson's correlation coefficient. Pearson's correlation coefficients were also used to analyze relationships between 6MWD and participant's characteristics. Stepwise regression analysis was performed on the following characteristics: age, height, weight, sex and BMI to determine their contribution to 6MWD. All data were analyzed using Statistical Package for Social Sciences (SPSS™) software 16.0. p value less than 0.05 was considered as significant.

RESULTS:

Out of 106 participants, 53 were males and 53 were females. A summary of the physical characteristics of the participants is shown in Table 1. The mean height was higher in males (171.06±5.25 cm) than in females (157.26±5.89 cm). The mean values of SpO_2 before and after 6MWT were 98.03 ± 0.47% and 95.82 ± 0.88% respectively [t(105) = 28.361, p<0.001].There was no statistically significant correlation between SpO_2 before 6MWT and BMI (r=-0.108, p=0.27). SpO_2 after 6MWT was negatively correlated with BMI (r=-0.587, p<0.001) i.e. decrease in SpO_2 is associated with increasing BMI. However, the SpO_2 values were within normal range for all the participants.

The mean 6MWD was 584.43±23.71 m for male participants and 469.85±30.38 m for female participants. The females walked significantly shorter distance than the males [t(104) =12.730,p<0.001]. (Table 1)

1 shows the relationship between the 6MWD and height in the combined group. Weight and BMI did not have significant contribution to 6MWD. The regression equation for 6MWD (cm) when sex (male=1, female=2) and height (cm) are known is:

6MWD = 204.043 -77.652 X Sex + 2.678 X Height

(Standard error of estimate = 22.903)

Table 1: Characteristics of the study participants (N=106)

Variables	Males (Mean ± SD)	Females (Mean ± SD)	Statistics
Age (years)	22 ± 1.37	21.32 ± 0.73	t (104) = 3.18, p = 0.002
Height (cm)	171.06 ± 5.25	157.26 ± 5.89	t (104) = 12.73, p<0.001
Weight (kg)	69.40 ± 11.64	54.36 ± 9.12	t (104) = 7.39, p<0.001
BMI (kg/m²)	23.61 ± 2.90	21.95 ± 3.54	t (104) = 2.64, p = 0.010
SpO_2 before exercise (%)	97.98 ± 0.31	98.08 ± 0.58	t (104) = 1.04, p = 0.301
SpO_2 after exercise (%)	95.68 ± 0.87	95.96 ± 0.85	t (104) = 1.69, p = 0.094
Pulse rate before 6MWT (bpm)	83.15 ± 9.52	83.81 ± 7.82	t (104) = - 1.04, p = 0.301
Pulse rate after 6MWT (bpm)	121.74 ± 17.14	121.87 ± 8.66	t (104) = 1.688, p = 0.094
Modified Borg score	0.72 ± 0.30	0.62 ± 0.32	t (104) = 1.55, p = 0.124
6MWD (m)	584.43 ± 23.71	469.85 ± 30.38	t (104) = 21.64, p<0.001

Pearson's correlation matrix showed that 6MWD was positively correlated with age (r=0.248, p=0.010), height (r=0.852, p<0.001), weight (r=0.629, p<0.001), and BMI (r=0.265,p=0.006) in the overall analysis of the participants (Table2).

Table 2: Correlation of 6MWD with different parameters in combined participants.

Parameters	Pearson's Correlation with 6MWD	p value
Age	0.248	0.010
Height	0.852	<0.001
Weight	0.629	<0.001
BMI	0.265	0.006

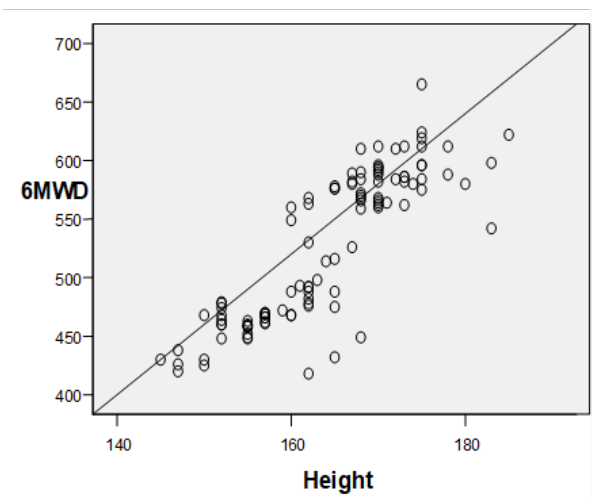

Fig 1: Relationship of 6MWD after 6MWT and Height

To analyze if the predictor variables were independently related to 6MWD, variables showing overall significant correlation were considered for stepwise regression analysis (Table 3). Stepwise regression analysis gave the model with sex and height that predicted 6MWD statistically significantly [F(2,103)= 353.774, p<0.001] with an R^2(coefficient of determination) of 0.873. Figure

DISCUSSION

The aims of this study were to determine the correlation of SpO_2 with BMI, and also to determine 6MWD, to establish prediction equation for 6MWD in apparently healthy young adults aged 18-25 years. The present study showed a significant

Table 3: Stepwise regression analysis of predictors of 6MWD in combined participants.

Model	Unstandardized coefficient(B)	Standard error (SE)	R	R^2	Standard error of estimate (SEE)	p value
Constant	204.043	74.763	0.934	0.873	22.903	0.007
Sex	-77.652	7.116				<0.001
Height	2.678	0.403				<0.001

R^2 = Coefficient of determination

decrease in SpO_2 after 6MWT with increasing BMI. Lower SpO_2 observed in the obese participants may be related to an imbalance in the ventilation/perfusion (V/Q) ratio during the exercise test. During exercise, cardiac output increases and increased cardiac output is not accompanied by increased ventilation, leads to decrease in (V/Q) ratio in obese participants. The result is decrease in oxygen saturation.[18] Pulmonary function decreases in obesity which may be due to the added mechanical load of adipose tissue that reduces chest wall compliance and impedes diaphragm descent.[10]

In our study the magnitude of correlation with SpO_2 after 6MWT and BMI was r = -0.587.The correlation was statistically significant (p<0.001) though, the SpO_2 values were still within normal range. This result is consistent with the previously published studies (r = -0.27, r = -0.81, p<0.001).[10,19]Similarly Faria AG et al.[18] and Anupama N et al.[20] had found lower oxygen saturation with increased BMI. Another study done by Zou H et al.[21] found a significant difference between oxygen saturation before and after the test both in males and females. Whereas in one study by Ahmed YB et al.[22] there was no significant correlation between SpO_2 and BMI. This difference may be explained by difference in the measurement of resting oxygen saturation. The author did not take the oxygen saturation after exercise.

There was a significant difference in the distance walked between male and female groups in our study. The male group walked a greater distance than the female group possibly because the males were taller and had higher levels of physical activity and a greater muscle mass. These results are consistent with the previous studies.[3,4,21] The result of this study showed negative correlation between the 6MWD and sex and positive correlation with height, weight and BMI. In the previous studies the results showed negative correlation of the 6MWD with weight and BMI which may be due to the fact that severe obesity rises the workload for a given exercise intensity, reducing the 6MWD.[11] These studies also showed positive correlation between 6MWD and height.[3,4,21] The contrast correlation of 6MWD with weight and BMI may be due to the fact that in our study the participants did not have severe obesity and those with higher BMI or weight also had greater height (evaluated with scatter plot). The significant effect of height on the 6MWD was attributed to a longer stride in the taller individuals. The stride length is one of the foremost determinants of gait velocity.[23] Moreover, physical activity level was a predictor factor for 6MWD.[6]

The major determinants of 6MWD in the overall analysis were sex followed by height. The forward stepwise multiple linear regression showed only sex and height were independent predictors explaining 87.3% of the variance in distance for combined group (coefficient of determination R^2=0.873) as shown in Table 3. These finding are comparable with previously published results (R^2=0.587, R^2=0.62, R^2= 20-78%).[6,13,14]

There are some limitations to our study. We did not recruit individuals who were older than 25 years of age. Our reference equation may not be applicable to the population beyond this age. In this study the subjects were medical students and many of them did not have severe obesity. We used convenience sample rather than a random sample which may not be representative of a wider Nepalese population.

CONCLUSION:

Although there was moderate negative statistically significant correlation between BMI and SpO_2 after 6MWT in young adults in the study, SpO_2 values were still within normal range. Sex and height were the most significant predictors of the 6MWD and the regression equation explained 87.3% of the variance in the distance for both sexes of same age.

Conflict of interest: The authors declares that no competing interests exist

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REFERENCES:

1. 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;44:1447-78. Available from: https://erj.ersjournals.com/content/erj/44/6/1447.full.pdf

2. Holland AE, Spruit MA, Troosters T, Puhan MA, Pepin V, Saey D, et al. An official European Respiratory Society/American Thoracic Society technical standard: field walking tests in chronic respiratory disease. Eur Respir J. 2014;44(6):1428-1446. PMID: 25359355. DOI: https://doi.org/10.1183/09031936.00150314

3. 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: https://doi.org/10.1016/j.hkpj.2014.04.003

4. Fernandes L, Mesquita AM, Vadala R, Dias A. Reference Equation for Six Minute Walk Test in Healthy Western India Population. J Clin Diagn Res. 2016;10(5):CC01-4. PMID: 27437206. DOI: https://dx.doi.org/10.7860/2FJCDR/2F2016/2F17643.7714

5. Zou H, Zhang J, Chen X, Wang Y, Lin W, Lin J, et al. Reference Equations for the Six-Minute Walk Distance in the Healthy Chinese Han Population, Aged 18–30 Years. BMC Pulm Med. 2017;17(1):119. PMID: 28851335. DOI: https://doi.org/10.1186/s12890-017-0461-z

6. Bourahli M-K, Bougrida M, Martani M, Mehdioui H, Ben Saad H. 6-Min walk-test data in healthy North-African subjects aged 16–40years. Egyptian Journal of Chest Diseases and Tuberculosis. 2016;65(1):349–60. DOI: https://doi.org/10.1016/j.ejcdt.2015.08.003

7. World Health Organization. Obesity and overweight. Geneva: World Health Organization. 2020. Available from: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight

8. Institute for Health Metrics and Evaluation. More than 2 billion people overweight or obese, new study finds: Massive global research project reveals 30 percent of the world's population affected by weight problems. Available from: https://www.sciencedaily.com/releases/2017/06/170612094128.htm [Accessed on 15th September 2019]

9. Van Huisstede A, Cabezas MC, Birnie E, van de Geijn G-JM, Rudolphus A, Mannaerts G, et al. Systemic inflammation and lung function impairment in morbidly obese subjects with the metabolic syndrome. J Obes. 2013;2013:131349. PMID: 23509614. DOI: https://doi.org/10.1155/2013/131349

10. Kapur VK, Wilsdon AG, Au D, Avdalovic M, Enright P, Fan VS, et al. Obesity is associated with a lower resting oxygen saturation in the ambulatory elderly: results from the cardiovascular health study. Respir Care. 2013;58(5):831–7. PMID: 23107018. DOI: https://doi.org/10.4187/respcare.02008

11. Capodaglio P, De Souza SA, Parisio C, Precilios H, Vismara L, Cimolin V, et al. Reference values for the 6-Min Walking Test in obese subjects. Disability and Rehabilitation. 2013;35(14):1199–203. DOI: https://doi.org/10.3109/09638288.2012.726313

12. 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. PMID: 25024720. DOI: https://doi.org/10.4046/trd.2014.76.6.269

13. Britto RR, Probst VS, de Andrade AF, Samora GAR, Hernandes NA, Marinho PEM, et al. Reference equations for the six-minute walk distance based on a Brazilian multicenter study. Braz J Phys Ther. 2013;17(6):556–63. PMID: 24271092. DOI: https://doi.org/10.1590/S1413-35552012005000122

14. Joobeur S, Rouatbi S, Latiri I, Sfaxi R, Ben Saad H. Influencing factors of the 6-min walk distance in adult Arab populations: a literature review. Tunis Med. 2016;94(5):339–348. PMID: 27801484.

15. Hulley SB, Cummings SR, Browner WS, Grady DG, Newman TB. Estimating sample size and

power: applications and examples. In designing clinical research, 4rth ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2013. pp.79.

16. National Academy of Sports Medicine. PHYSICAL ACTIVITY READINESS QUESTIONNAIRE (PAR-Q). Available from: https://www.nasm.org/docs/default-source/PDF/nasm_par-q-(pdf-21k).pdf [Accessed 20 October 2019]
17. Kendrick KR, Baxi SC, Smith RM. Usefulness of the modified 0-10 Borg scale in assessing the degree of dyspnea in patients with COPD and asthma. J Emerg Nurs. 2000;26(3):216–22. PMID: 10839848. DOI: https://doi.org/10.1016/s0099-1767(00)90093-x

18. Faria AG, Ribeiro MA, Marson FA, Schivinski CI, Severino SD, Ribeiro JD, et al. Effect of exercise test on pulmonary function of obese adolescents. J Pediatr (Rio J). 2014;90(3):242-9. PMID: 24184270. DOI: https://doi.org/10.1016/j.jped.2013.08.005

19. Petrofsky J, Laymon M, Khowailed IA, Fisher S and Mills A. The effect of BMI on oxygen saturation at rest and during mild walking. Journal of Applied Medical Sciences.2015;4(2):1-8. Available from: http://www.scienpress.com/Upload/JAMS/Vol%204_2_1.pdf

20. Anupama N, Kini RD, Sharma MV, Bhagyalaksmi K, Nayanatara AK, Shetty S, et al. Effect of exercise on oxygen saturation and heart rate in healthy young adults of different body mass index. Research Journal of Pharmaceutical, Biological, and Chemical Sciences. 2016;7(5):594–7. Available from: https://www.rjpbcs.com/pdf/2016_7(5)/[73].pdf

21. Zou H, Zhu X, Zhang J, Wang Y, Wu X, Liu F, et al. Reference equations for the six-minute walk distance in the healthy Chinese population aged 18–59 years. PLoS ONE. 2017;12(9):e0184669 PMID: 28910353. DOI: https://doi.org/10.1371/journal.pone.0184669

22. Ahmed YB, Ahmed ZT, Abdullah NS and Ismael SA. Assessment of pulse rate and oxygen saturation of obese and non-obese 509 healthy males in Erbil city. Diyala Journal of Medicine.2016;10(1):25-29. Available from: https://www.iasj.net/iasj?func=fulltext&aId=139681

23. Callisaya ML, Blizzard L, Schmidt MD, McGinley JL, Srikanth VK. Sex modifies the relationship between age and gait: a population-based study of older adults. J Gerontol A Biol Sci Med Sci. 2008;63(2):165–70. PMID: 18314452. DOI: https://doi.org/10.1093/gerona/63.2.165