Assessment of Cardiopulmonary Fitness and Physical Activity in Health Science Students

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ABSTRACT

Background

Insufficient physical activity and poor cardiopulmonary fitness increases the risk of chronic diseases and premature mortality. Sedentary lifestyle is observed among young health science students.

Objective

To assess cardiopulmonary fitness and physical activity levels among health science students at Jumla.

Method

A cross-sectional study was conducted on health science students at Karnali Academy, Jumla. Cardiopulmonary fitness was assessed using the Queen's College Step Test to calculate VO_{2max}. International Physical Activity Questionnaire was applied to measure physical activity in terms of Metabolic Equivalent of Task (MET) value. Data analysis utilized GNU-PSPP software with descriptive and inferential statistics.

Result

Total 107 students participated (56 females), aged 18-37 years. Their median VO2max was 40.05 ml/kg/min, significantly higher in males [51.69 (IQR 45.81 – 57.57)] than females [36.37 (IQR 34.90 – 38.58)] ($p<0.001$). Median weekly physical activity was 1030 MET-minutes/week, with males reporting higher levels [1436 (962 - 2670)] than females [678 (414 – 1103)] ($p<0.001$). VO_{2max} had a positive correlation with total MET value per week ($r = 0.504$, $p<0.001$), and negative correlation with body adiposity ($p<0.02$). Multiple linear regression revealed physical activity level, sex, and BMI as significant predictors of VO_{2max} ($p<0.01$).

Conclusion

Health science students at Karnali Academy have average levels of cardiopulmonary fitness and physical activity, lower in females. Targeted interventions can improve their fitness, benefiting the wider population in future. Further research should explore barriers to physical activity and factors influencing healthy lifestyle adoption among health science students in this region.

KEY WORDS

Exercise, Health occupations, Physical fitness, Students

INTRODUCTION

Physical activity is important for our health. It may be in the form of daily activities (such as field work and sports) or exercise (gym or athletics). Regular physical exercise increase cardiopulmonary fitness, which measures the ability of cardiopulmonary system to supply adequate oxygen to the muscles and reflects our ability to engage in activities without excessive fatigue. Low level of fitness increase the risks of the chronic conditions such as cardiovascular disease, neuromuscular and skeletal disorders, obesity, diabetes, and mental health disorders, as well as premature mortality.[1,2] However, around 30% adults worldwide fail to meet WHO's activity recommendations, which emphasizes that all adults (18-64 years) should undertake 150-300 min of moderate activity or 75-150 min of vigorous physical activity, or some equivalent combination of them, per week.[3-6] Measurement of cardiopulmonary fitness relies on VO_{2max}, a predictive marker of cardiovascular health and the gold standard for assessing fitness.[7]

An optimum fitness is an integral component of healthy lifestyle. This is crucial for healthcare professionals who often work long hours under stressful conditions. Health science students should be motivated to adopt a healthy lifestyle, but often struggle to meet activity levels and may have suboptimal fitness.[8-10] Active healthcare professionals are more effective in advising and encouraging healthy behaviours.[11] It also enables them to work long hours under stressful conditions. But the data about physical activity and fitness level in health workers and students is sparse, especially in Nepali population.

Karnali Academy, a government institution in Jumla, aims to improve healthcare services and education for a remote community with limited access to healthcare.[12,13] This study aims to assess cardiopulmonary fitness and physical activity among health science students at Karnali Academy of Health Sciences, Jumla.

METHODS

This study was an observational investigation conducted on health science students at Karnali Academy of Health Sciences (KAHS) in Jumla. Data were collected from April 2022 to September 2022. All the certificate and undergraduate level health-science students were selected for the study (census method of sampling). Data were collected via questionnaire as well as from Qieen's College 3-minute step test for measurement of VO_{2max}, as explained below Ethical clearance was taken from Institutional Review Committee, KAHS before starting the investigation (Ref. number 078/079/05). Informed written consent was taken from each participant before starting the investigation. All consenting certificate and undergraduate level health-science students were included, while those with cardiorespiratory conditions, musculoskeletal problems such as low back pain, and disability caused by trauma or surgery were excluded. Each student was assessed individually for general physical examination and data recording. Weight was measured using a calibrated digital weighing machine to the nearest 0.1 kg, while height was measured in centimeters using a stadiometer. Daily physical activity levels were determined using the International Physical Activity Questionnaire (IPAQ) in English. The questionnaire provided data on the amount of activity and metabolic equivalent (MET) values per week across different levels of activity (Table 1). According to the protocol, the values were classified into three levels of activity: inactive, minimally active, and health-enhancing physically active. A summary flow chart of steps of data collection is shown in figure 1. A summary chart of the classification protocol can be found in figure 2.[14,15]

Table 1. Questions of the International Physical Assessment Questionnaire

Please include your average activity in past 7 days or more.	
1. Vigorous activities (like heavy exercise, heavy weight lifting, digging, aerobics, karate, heavy outdoor sports like mountain biking)	..... minutes a day for ..... days per week.
2. Moderate physical activities (like jogging, light weight lifting, regular bicycling, light sports like table tennis, casual dance):	..... minutes a day for ..... days per week.
3. Walking for at least 10 minutes at a time:	..... minutes a day for ..... days per week.

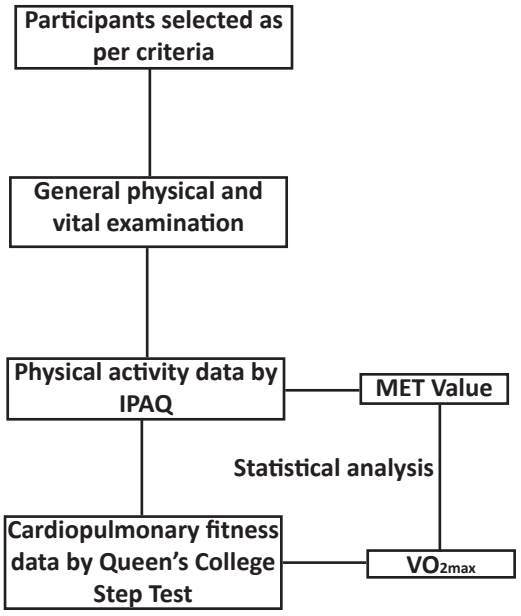
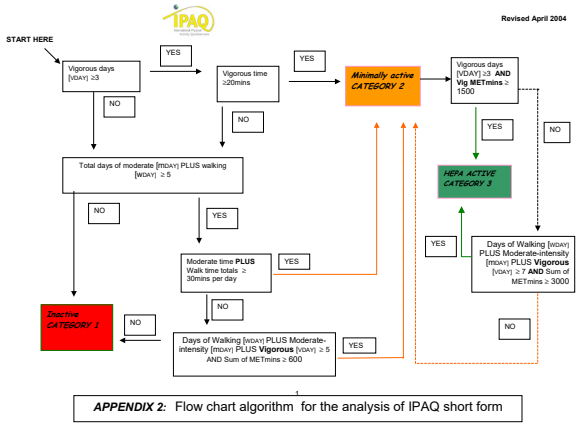


Figure 1. Flow diagram of steps of data collection in the study

(IPAQ, International Physical Activity Questionnaire; MET, Metabolic Equivalent of Task)

The Queen's College Step Test was conducted to determine the VO_{2max}, using a stool of 16.25 inches (41.3 cm) high. The participants were instructed to step for three minutes, with a rate of 24 cycles per minute for males, and 22 cycles per minute for females, with a metronome used to regulate the stepping cycle (four-step cadence: up-up-down-down).



APPENDIX 2: Flow chart algorithm for the analysis of IPAQ short form

Figure 2. Flow Chart algorithm for the analysis of IPAQ result

Adapted from IPAQ Research Committee (2005). Guidelines for data processing and analysis of the International Physical Activity Questionnaire (IPAQ) – Short and Long Forms.[15]

After completing the exercise, the participants were asked to stand comfortably, and their carotid pulse rate was recorded from the sixth to 20th second of the recovery period. The 15-second pulse rate was converted to the recovery pulse rate per minute.

The McArdle equation was used to calculate VO_{2max}: VO_{2max} (ml/kg/min) = 111.33 - (0.42 X recovery pulse rate per min) for males, and 65.81 – (0.1847 X recovery pulse rate per min) for females; which gives reliable measurement of VO_{2max}.[16]

For classification of the cardiopulmonary fitness, American College of Sports Medicine (ACSM) guideline based on VO_{2max} was used: Excellent: Men > 52 ml/kg/min, Women > 45 ml/kg/min; Good: Men 45-52 ml/kg/min, Women 38-45 ml/kg/min; Fair: Men 38-45 ml/kg/min, Women 32-38 ml/kg/min; Poor: Men < 38 ml/kg/min, Women < 32 ml/kg/min.[17]

The data were collected and analyzed using a spreadsheet program and GNU PSPP software version 1.4.1. Descriptive statistics, including frequency, percentage, and median with interquartile range were calculated to summarize the data. Spearman's correlation and linear regression analysis was used to compare the variables, and a p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 107 students (56 females) from certificate and undergraduate levels participated in this study. After filling the questionnaire form, each underwent anthropometric and cardiorespiratory evaluation, general physical examination followed by cardiopulmonary fitness test following Queen's college protocol. The number of participants in different courses is given in figure 2. The mean age of the students was 21.53 years with a SD of 3.53 years (range 18 to 37 years). Anthropometric and baseline cardiovascular parameters were within normal limits (Table 2).

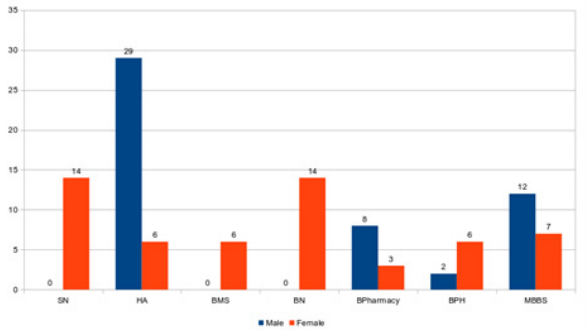


Figure 3. Number of participants in different courses (n=107)

[Note: SN, Staff Nurse; HA, Health Assistant; BMS, Bachelor in Midwifery Science, BN, Bachelor in Nursing; BPharmacy, Bachelor of Pharmacy; BPH, Bachelor of Public Health; MBBS, Bachelor of Medicine and Surgery]

Table 2. General characteristics of students and their sex distribution (n=107)

Parameters	Male (n=51) Median (IQR)	Female (n=56) Median (IQR)	Total students Median (IQR)
Age (years)	20 (19 – 21)	22 (19 – 25)	20 (19 – 23)
Body mass index (BMI) (Kg/sq m)	19.72 (18.44-21.48)	20.36 (18.9-22.52)	19.74 (18.78-22.13)
Waist-hip ratio (WHR) (dimension-less)	0.84 (0.81-0.88)	0.77 (0.75-0.8)	0.81 (0.77-0.85)
Baseline Sys-tolic blood pressure (SBP) (mm of Hg)	127(119-134)	119 (109-126)	122 (114-129)
Baseline Diastolic blood pressure (DBP) (mm of Hg)	80 (74-86.5)	80 (68-85)	79 (72.5-85.5)

Table 3. Physical activity in participants according to IPAQ, and VO_{2max} by 3-minute step test

Variables	Male Median (IQR)	Female Median (IQR)	Total students Median (IQR)	P value (Wilcoxon Ranksum)
MET-vigorous (min-ute per week)	400 (0 – 1080)	0 (0 – 0)	0 (0 – 440)	<0.001*
MET-moderate (minute per week)	240 (0 – 680)	240 (0 – 480)	240 (0 – 560)	0.470
MET-walking (min-ute per week)	693 (545 – 1287)	462 (285 – 693)	594 (321.75-792)	<0.001*
MET-total (minute per week)	1436 (962 – 2670)	678 (414 – 1103)	1030 (537 – 1593)	<0.001*
VO_{2max} (ml/Kg/min)	51.69 (45.81 – 57.57)	36.37 (34.90 – 38.58)	40.05 (35.68 – 50.85)	<0.001*

* Significant at 95% CI.

Physical activity were assessed using the IPAQ questionnaire. It shows that out of three different levels of activity, majority of students engaged in walking (Table 3). Students were classified into three categories of physical

Table 4. Comparison of physical activity or fitness categories with sex

Category	Male frequency (percent)	Female frequency (percent)	Total frequency (percent)	Chi Square value	P value
IPAQ category of activity					
Inactive	6 (11.76)	24 (42.86)	30 (28.04)	29.704†	<0.001*
Minimally active	24 (47.06)	31 (55.36)	55 (51.4)		
HEPA active	21 (41.18)	1 (1.78)	22 (20.56)		
Total	51 (100)	56 (100)	107 (100)		
ACSM category of fitness					
Poor	6 (11.76)	12 (21.43)	18 (16.8)	8.512	0.04*
Fair	13 (25.49)	10 (17.86)	23 (21.5)		
Good	16 (31.37)	27 (48.21)	43 (40.2)		
Excellent	16 (31.37)	7 (12.5)	23 (21.5)		
Total	51 (100)	56 (100)	107 (100)		

* Significant at 95% CI; † Fisher Exact test

activity: inactive, minimally active, and Health Enhancing Physically Active (HEPA). Males were significantly more active than females in terms of total MET value as well as category of activity (p<0.001). Only 20.6% of the students were under HEPA active category, almost all of which were males (Table 4).

Physical fitness was evaluated using the Queen's College protocol for the 3-minute step test, and VO_{2max} was calculated from carotid pulse measurements taken from sixth to 20th second post-exercise. The mean VO_{2max} was 43.51 ± 9.94 ml per kg-min with a median of 40.05 ml per kg-min. Male students had significantly higher VO_{2max} values than female students (Table 3). The category of fitness as per ACSM guideline shows that more male students were of higher fitness (good to excellent) than females (poor to good) (p=0.04, Table 4).

The association between physical activity and health parameters was evaluated by Spearman correlation coefficient (Table 5). We found a significant negative correlation between VO_{2max} and BMI (r = -0.323), VO_{2max} and waist-to-hip ratio (WHR) in males (r = - 0.336) (but not in females), and VO_{2max} percentile rank and BMI (r = - 0.365). Although the MET values were also negatively correlated with those indices of adiposity, they were not statistically significant. A significantly positive correlation was found in the MET total value with VO_{2max} (r = 0.504) and VO_{2max} percentile rank (r = 0.27). Predictably, BMI showed a significant positive correlation with WHR in both sexes. Finally, VO_{2max} percentile ranking had a significant negative correlation with diastolic blood pressure (DBP) (r = -0.198). The results suggest that physical activity and fitness are associated with various health parameters, including BMI, WHR, and MET total; and that these associations may differ by sex.

Table 5. Correlations of different health-related parameters (Spearman Correlation)

Parameter 1	Parameter 2	Spearman Rho	P value
VO_{2max}	BMI	- 0.323	0.001 *
VO_{2max}	WHR (in males)	- 0.336	0.016 *
VO_{2max}	WHR (in females)	- 0.045	0.741
VO_{2max}	METtotal	0.504	<0.001 *
VO_{2max} Percentile	BMI	- 0.365	<0.001 *
VO_{2max} Percentile	DBP	- 0.198	0.04 *
VO_{2max} Percentile	METtotal	0.27	0.005 *
VO_{2max} Percentile	Age	- 0.077	0.43
MET Total	BMI	- 0.172	0.076
MET Total	WHR (in males)	- 0.264	0.061
MET Total	WHR (in females)	- 0.095	0.486
BMI	WHR (in males)	0.542	<0.001 *
BMI	WHR (in females)	0.336	0.011 *

* Significant at 95% CI

In order to assess the predictability of VO_{2max}, a multiple linear regression analysis was performed, using age, BMI, and physical activity level (MET-total value) as predictor variables (Table 6). The model was found to be significant, $F(4, 135) = 55.05$, $p < 0.001$, with an R square value of 0.683, indicating that the model explains 68.3% of the variance in VO_{2max}. The results showed that the strong predictors of VO_{2max} were physical activity level with a standardized coefficient of 0.263 ($p < 0.001$); sex with a standardized coefficient of 0.638 ($p < 0.001$); and BMI with a standardized coefficient of - 0.183 ($p = 0.004$). However, age was not found to be significant predictors in this model. The final model included the intercept (constant) value of 45.158 and the beta coefficients for MET-total (0.002), age (0.204), sex (12.644), and BMI (-0.724). These findings suggest that physical activity level (measured by MET value), sex, and BMI were significant predictors of VO_{2max} ($p < 0.05$), but age was not a significant predictor (p=0.254).

DISCUSSION

Cardiopulmonary fitness is an important predictor of cardiovascular health and overall physical fitness. In this study, we aimed to assess the cardiopulmonary fitness of health science students at the Karnali Academy of Health Sciences in Jumla, Nepal. The participants were the students from the various programs of the academy. Majority of students were young adults of mean age 21.53 years. Our results showed that the mean VO_{2max} of the participants was 40.05 ml/kg/min, which is at average of the recommended level for optimal health for the age.[17] This is comparable with other studies that have found

Table 6. Linear regression analysis for prediction of VO2max with other predictors

Model Summary						
R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics		
				R Square Change	F Change	Sig F change
0.827[a]	0.683	0.671	5.701	0.683	55.05	<0.001*
[a]Predictors: (Constant), MET-total, age, sex, BMI						
Coefficients						
	Unstandard coefficients		Standard coefficients	T value	P value	
	Beta	Std error	Beta			
(constant)	45.158	5.303	-	8.515	<0.001	
Age	0.204	0.178	0.073	1.146	0.254	
Sex	12.644	1.311	0.638	9.644	<0.001*	
BMI	- 0.724	0.244	- 0.183	- 2.969	0.004*	
MET total	0.002	0.001	0.263	4.072	<0.001*	

* Significant at 95% CI.

average to good levels of physical activity among university students of Nepal.[18,19] Low level of fitness in medical students is possibly because of the demanding academic schedule, which may limit the time and energy available for exercise. A study conducted among UK medical and nursing students found that lack of time and tight academic schedule was significant barrier to physical activity.[8]

Regular physical activity can improve cardiopulmonary fitness; while lower levels of physical activity and higher sedentary behaviours are associated with lower levels of cardiorespiratory fitness.[4,6] WHO recommends all adults to undertake 150-300 min of moderate-intensity, or 75-150 min of vigorous-intensity physical activity, or some equivalent combination of them, per week.[5] Only 22 (20.6%) students of KAHS met this WHO recommendation of physical activity, almost all of which (21) were boys. Also, the median value of VO_{2max} for males was significantly higher than for females ($p < 0.001$), suggesting that females are at the lower side of fitness level than males. This finding was similar to other studies.[7,19,20] Lower fitness in female is attributed to lower level of haemoglobin, hormonal profile difference, lower muscle mass, higher adiposity and lower activity compared to males.[7] In contrast, Canadian students have shown that girls were more physically active than boys. The study also highlighted that the university students' poor dietary intake, low physical activity, and high sedentary behaviour were further compounded due to COVID pandemic.[21] This reflects geographical variation in physical activity levels in the population.

In our study, the VO_{2max} was positively correlated with total MET values per week, and negatively with BMI, and with waist:hip ratio in males. Moreover, the percentile ranking of fitness according to VO_{2max} was negatively associated with BMI. Conversely, it was positively correlated with total MET value, which in turn was negatively correlated to body fat parameters in both sexes. This means higher cardiopulmonary fitness was seen in participants with higher physical activity and lower body fat. Studies have shown that VO_{2max} has inverse relation with body fat percentage and BMI.[7,22,23] This endorses the common notion of reducing body fat for better fitness.

VO_{2max} is the indicator of person's aerobic power or cardiorespiratory status. Cardiorespiratory fitness has been shown to have multiple beneficial effects. Imboden et al. calculated that every 1-metabolic equivalent (MET) increase in fitness was associated with a 12%, 16%, and 14% reduction in all cause, cardiovascular diseases, and cancer mortality risk, respectively.[23] Authors conclude that the cardiopulmonary fitness score has prognostic ability for mortality, and this should be considered for apparently healthy populations, given its utility in the individualized patient risk assessment and guide clinical decisions.[24] Other effects of the fitness include better cognitive function, and lower risks of depression and atrial fibrillation.[24-26] This highlights the importance of maintaining cardiorespiratory fitness.

The multiple linear regression analysis in our data revealed that physical activity level, sex, and BMI but not age were significant predictors of VO_{2max}. These findings are consistent with previous research indicating that physical activity level is a key predictor of VO_{2max}, and sex and BMI are also important predictors.[27] The lack of significance for age may be due to low variation of age in our sample. The present study adds to the growing body of evidence supporting the use of physical activity level, sex, and BMI as predictors of VO_{2max}, and highlights the importance of considering these variables when assessing cardiovascular fitness. Future research could explore additional variables that may contribute to the predictability of VO_{2max}, such as dietary habits or genetic factors.

Norris et al. have shown that incorporating physical activity into the school curriculum can improve students' physical activity.[28] This approach could be effective in health science programs, where the importance of physical activity for overall health is emphasized.

The limitations of the Queen's college step test include inappropriate step height for individuals who are shorter or taller, low-exercise tolerance, less accurate measurement of VO_{2max}, and low test-retest reliability. Despite this, it is a cost-effective and simple method of VO_{2max} measurement. This study also has limited sample size and is single-centric, which limits its generalizability. Being a cross-sectional study, the causal association between parameters cannot be established.

CONCLUSION

The study suggest that health science students at Karnali Academy, Jumla have average levels of cardiopulmonary fitness and physical activity, which is lower in females. Only about one fifth of the students met the WHO recommendation level of physical activity. There is a need for targeted interventions to improve the health and well-being of these students, that in turn could benefit the wider population in future. Further research is needed to explore the barriers to physical activity and the factors that influence the adoption of healthy lifestyles among health science students in this region.

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