CARDIO-PULMONARY FITNESS AMONG UNIVERSITY STUDENTS BASED ON PAST EXERCISE HISTORY

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ABSTRACT

Problem Statement: While a positive correlation between exercise/physical activities (PA) and fitness status is well documented and it is known that regular exercise patterns yield higher maximal oxygen uptake (VO_{2max}) which is indicative of more favourable cardio-pulmonary fitness and health, there currently is a noted decline in exercise from late adolescence. Longer school days and study time yields fewer PA opportunities. This prompted the current study, with the aim of ascertaining cardio-pulmonary measures of students in Kenyan setups.

Setting: The study was carried out in both Moi University and the University of Eldoret between January and April 2012.

Study population: Students between their 1st and 4th year of study at the university

Objective: To characterize cardio-pulmonary fitness among university students based on past exercise history.

Methodology: The current descriptive study assessed the VO_{2max}, heart rate (HR) and blood pressure (BP) in 80 randomly selected single male students aged between 18 and 25 years. While the participants belonged to different exercise regimes, they were matched for age at the inclusion. The 20 m shuttle run test (SRT) was used for VO_{2max} estimation. Other variables that were compared included HR and BP measures before the SRT, during the run (HR), at exhaustion, and for the first five minutes during the rest period.

Results: Participants in the current study were aged 21.4±1.8 years, weighed 65.0±7.2 kgs and had a height of 177.2±7.2 cm. 82.5% reported to have had at least one exercise session in the last three weeks, 57.6% of whom had had regular patterns. Mean VO_{2max}

for exercising students was higher than for their non-exercising colleagues (43.4±5.4 vs 38.6±4.1 ml/kg/min, $p<0.01$). Further, students who exercised regularly had a higher VO_{2max} when compared to their less regularly exercising counterparts (45.1±4.7 vs 41.0±5.4 ml/kg/min, $p<0.01$).
There was no significant difference between students with regular and those with irregular exercise at any stage in the test. However, comparing students on the basis of whether or not they had been involved in at least one session of exercise in the past three weeks showed lower HR during the 3rd to 6th minute of the SRT for those reporting exercise involvements. They also had lower HR after the 5th minute of rest.

Conclusion: Students with an exercise history adjust better to increased metabolic demands upon physical exertion causing them to attain higher VO_{2max} compared to matched controls that do not exercise. Further, the pattern plays an additional crucial role, which underscores the importance of encouraging regular exercise regimes among such cohorts, too.

Key words: Exercise, heart rate, VO2max, cardio-pulmonary fitness, university students.

Introduction:

A positive exercise or physical activity (PA) and fitness status correlation exist among individuals. This is well documented[1] as is a number of physiological factors for physical performance and fitness evaluation, including maximal oxygen uptake or consumption (VO_{2max}) calculated by subjecting one to any of several non-invasive fitness tests. Such teats include cycle ergometry, a treadmill test or a 20 m shuttle run test (SRT). Elite runners reach high VO_{2max} levels while adolescent and post adolescent Kenyan male only achieve lower percentages[2].
Reported prior exercise habits are associated with higher estimated VO_{2max} among subjects[3]. With increasing age however, there is a decline in PA that occurs throughout adolescence and early adulthood[4-7]. This is a cause for concern because physical inactivity is associated with increased ill health risk factors[8]. The greatest decrease in participation in PA occurs in late adolescence where rates fall sharply from 66% to 29% among the 18-24 year old[6]. This age bracket mainly comprises university/college students

who may be forced into sedentary lifestyles due to the trade-off between time spent in studies and that for physical exercises[4,7]. A VO_{2max} below 44 ml/kg/min in this age may lead to compromised health[9]. Persons who have low levels of PA, low VO_{2max} and high sedentary behaviour are more likely to have lower cardio-pulmonary fitness[10]. Population surveys in the United States for instance show fitness prevalence among adolescent males is low (32.9%)[11]. Influences from neighborhood's settings affect fitness levels of individuals and their behavior patterns, with positive associations reported between PA time and levels on the one side and social environment of participants on the other.[12-24] Others argue that competing demands on time is unrelated to participation in vigorous PA[25].

Untrained Kenyan male (14.2±0.2 years) at 2,000 metres above sea level (m.a.s.l) have a mean VO_{2max} of 47 (44-51) ml/kg/min whereas similarly aged male reach above 62 (58-71) ml.kg/min in VO_{2max}. Kenyan runners in active training have been shown to have VO_{2max} of up to 68±1.4 ml/kg/min at 2,000 m.a.s.l and 79.9±1.4 ml/kg/min at sea level, with a few individuals reaching 85 ml/kg/min[26]. Further, it has been shown that subjects with higher VO_{2max} spend significantly higher daily mean time in physical and sports activities $p<0.001$[27]. Given the challenge of an increasingly sedentary lifestyle society, and the already known ill effects of being physically unfit, this study sought to, by use of a 20 m SRT, compare the fitness levels amongst university students based on their reported exercise patterns.

Materials and Methods:

Design: This was an experimental design where eighty (80) healthy males aged 21.4±1.8 years were randomly drawn from a population of students of Moi University College of Health Sciences (MUCHS) and University of Eldoret, Kenya... Inclusion was based on their reported exercise regimes and being free from any physical or cardio-respiratory ailments. Matching was was done on the basis of age. Forty participants were drawn from each university. Ethical approval was granted by Institutional Research Ethics Committee (IREC) affiliated to MUCHS and Moi Teaching and Referral Hospital (MRTH). The students further gave informed written consent before participation. A qualified first aider remained on standby throughout the exercise and data collection. Forty (40) participants each from the first and fourth years of study were randomly sampled. They had to pass a full physical examination. Those with cardio-pulmonary or any physical ailments/injuries, with a smoking history, or those who drunk more than 280g of alcohol per week were excluded.

Procedure: The Participants height and weight measures were taken by use of a heightometer and a weighing scale (CAMRY, model BR9012) respectively. Also measured were cardiovascular variables of baseline and abscissa blood pressure (BP) by use of a Mercurial Sphygmomanometer (EKRA Erkameter 3000, Germany), and heart rate (HR) using ActITrainer™ (Actigraph, Pensacola, FL, USA) accelerometer. The HR was further taken continuously during the test and recovery phase. Participants were subjected to a 20 m SRT from which VO_{2max} was determined using the beep test score calculator developed from Ramsbottom published tables[28]. They were discontinued from the test at the point where they failed to cope with the beeps twice in a row, signifying exhaustion. The 20 m SRT is normally administered indoors. It is progressive in nature and utilizes pre-recorded sound signals to dictate running speed from 8.5 km/h in level one to a maximum of 18.5 km/h in level twenty one by decreasing the interval between beeps. It is a valid proxy for predicting laboratory VO_{2max} and is sufficiently reliable in healthy male adults[29].

Statistical analysis: Data were analyzed using STATA version 9. A t-test was performed for equality of VO_{2max} means and also for baseline and recovery period measurements between the exercising and non-exercising groups. Data on exercising students were further analysed on the basis of regular (at least three one-hour exercise sessions weekly) and irregular exercise by performing a t-test of their VO_{2max} equality. The P value was set at $p<0.05$.

Results:

Participants in the current study were all single male students aged 21.4±1.8 years. Other bio-demographic characteristics of these participants are shown in table 1 below. A proportion of 82.5% (n=80) reported to have had at least one exercise session in the last three weeks prior to the study. Of these, 57.6% (n=66) had regular exercise. There was no significant difference in the age, weight and height of participants basing on their exercise history.

Table 1. Bio-demographic Characteristics of Participants.

Variable	Mean
Age (years)	21.4±1.8
Weight (kg)	65.0±7.2
Height (cm)	177.2±7.2
Baseline HR	72.9±5.3
Baseline SBP	113.5± 7.6
Baseline DBP	72.6± 6.8
Inspiratory Reserve Volume	3.1±0.1
Tidal Volume	0.5±0.0
Expiratory Reserve Volume	1.1±0.1
Inspiratory Capacity	3.6±0.2
Vital Capacity	4.7±0.2
Estimated VO2max	42.5±5.5
BMI	20.8±2.3

BP in mmHg, HR in b/min; Lung volumes and capacities in Litres
All values in Means ±s.d.

Students who exercised at least once in the past three weeks had higher VO_{2max} compared to their colleagues who did not exercise at all (43.4±5.4 vs 38.6±4.1 ml/kg/min, $p<0.01$). Similarly, students who exercised regularly had higher VO_{2max} than their colleagues who exercised irregularly (45.1±4.7 vs 41.0±5.4 ml/kg/min, $p<0.01$). Figure 1 shows the VO_{2max} levels attained by students based on exercise history.

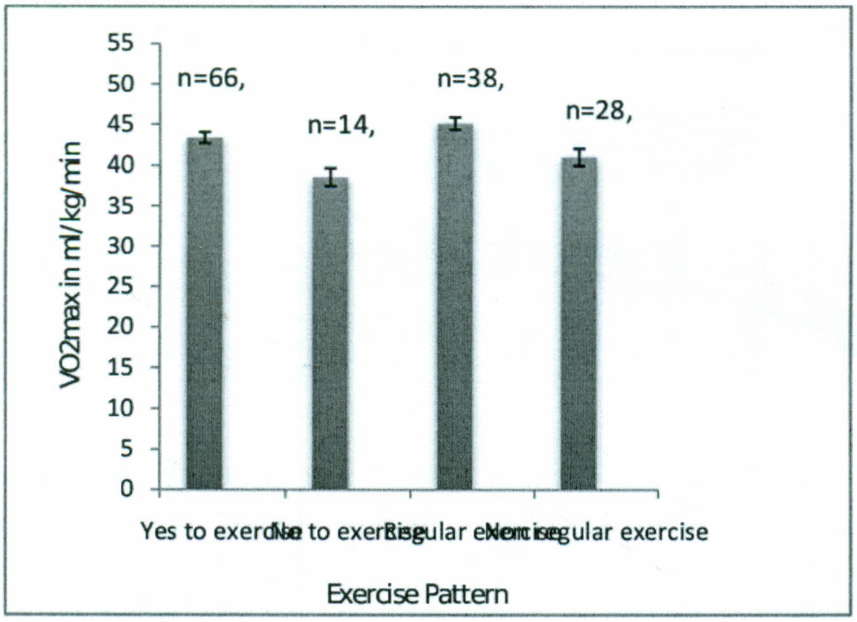

Figure 1. VO_{2max} levels attained by students based on exercise history.
Error bars represent standard error of the mean (SEM).

There was no cardiovascular variable either at the baseline, during the test or during the subsequent abscissa period that was statistically different between students with regular and those with irregular exercise. However, as shown in Figure 2, comparing students on the basis of whether or not they had been involved in at least one session of exercise in the past three weeks showed significantly lower HRs during the 3rd to 6th minute of the shuttle run for those reporting exercise involvement. They also had lower HR after the 5th minute of rest. No other variable showed significant difference in these students.

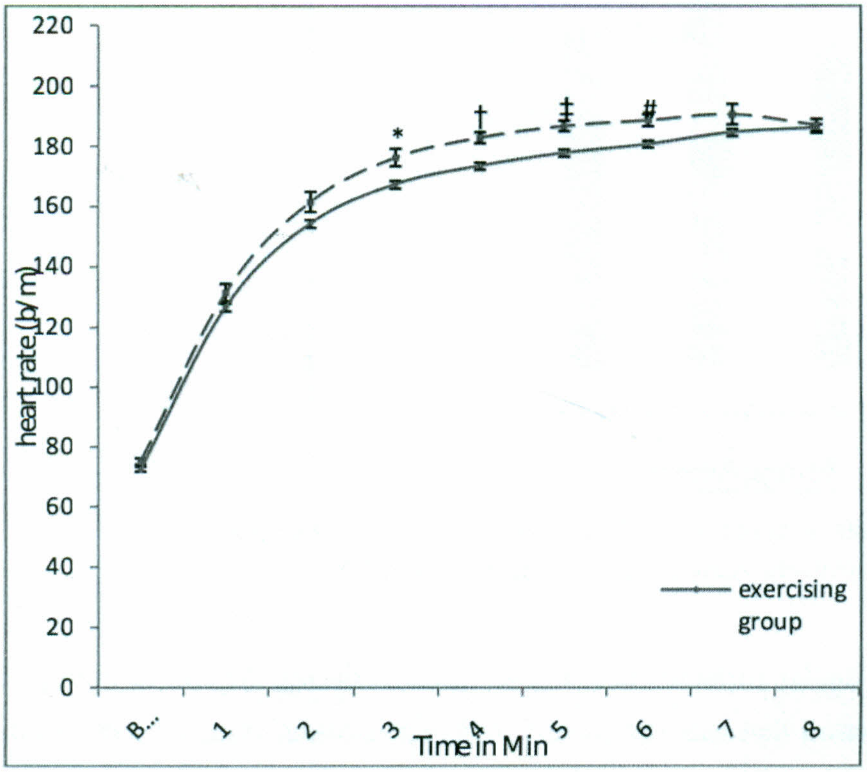

Figure 2: Comparison of HR during SRT basing on past exercise history. Error bars represent SEM.
*p=0.02, †p<0.01, ‡p=0.01, #p=0.02.

Discussion:

With similar bio-demographic characteristics but different levels of exposure and participation in PA, subjects would be expected to portray different fitness levels. In the present study, this homogeneity enhanced comparison after the run test. Mean VO_{2max} for University students who reported to have exercised at least once in the past three weeks was significantly higher than for their colleagues who had not. Reported exercise appeared to have improved the VO_{2max} of these students. Prior exercise habits have previously been associated with higher estimated VO_{2max} among individuals[3] which is indicative of more favorable cardio-pulmonary fitness.

Based on regularity of exercise, those who exercised regularly had higher VO_{2max} compared to their colleagues who exercised less regularly, indicating the importance of not only exercising but ensuring that it is done in a regular manner. While previous studies have shown that subjects who spend significantly higher mean time in physical exercise have higher VO_{2max}[26, 27], the present study underscores the importance of not only spending higher mean time in exercise but also ensuring this is done in regular patterns.

Students with reported involvement in exercise activities had significantly lower HRs from the 3rd to 6th minute of the shuttle run. In the 3rd minute of exercise, students who reported prior exercise patterns had a lower mean HR than their non-exercising colleagues indicating that by then, the metabolic needs of the various body systems had adjusted such that with the increased demand, the difference in HR increase becomes more pronounced between the two groups. This is in the effort to increase cardiac output to cater for the increasing demands during exertion. While subjects with a favourable exercise history have less stiff blood vessels due to less fat deposits which, with increased skeletal muscle tone and sympathetic stimulation during exercise increase venous return by reducing peripheral resistance and thereby increase stroke volume, non-exercising subjects are more likely to increase their cardiac output mainly by significantly raising their HRs instead[30, 31]. It has similarly been demonstrated that the body adjusts the various factors that increase cardiac output during exercise[32], which is necessary for exertion endurance in fitness. By the 4th minute into the SRT, the body systems for the non-exercising students appear to be so stressed that the HR must rise much more significantly above that of exercising students. This difference remains clear but in a diminishing manner for the exercising and non-exercising groups after the 5th minute.

Given that there was no significant difference in the mean baseline HR before the test, it is evident that students who do not exercise have a higher increase in HR after the 3rd minute following physical exertion when compared to their exercising colleagues. The higher increase in HR may contribute to the fact that they are only able to achieve lower VO_{2max} and therefore at a greater risk for compromised cardio-pulmonary fitness upon exertion.

In order to improve physical fitness in university students, the findings imply the need to schedule and follow up students into the exercise activities. There is also need to encourage and reinforce not just exercise but also its pattern – to ensure regular exercise regimes among university students.

Study limitations

The method used to estimate VO_{2max} (SRT), although valid and reliable[29] may have greater variability compared to the more direct measure – the doubly labelled water method.[33] Another limitation that could not be addressed using SRT was the inability to separate performance defined by motivation of participating in the field test from that of actual fitness. However, the results obtained are useful in highlighting differences in cardio-pulmonary fitness markers between the students based on their exercise regimes.

Conclusion

The mean VO_{2max} for students with a history of exercise is significantly higher than for their matched colleagues who do not exercise. Further, even when students report exercise involvement, the frequency plays a crucial role, with regular exercise activities yielding higher VO_{2max}. In addition, exercising students have significantly lower HRs from the 3rd to 6th minute of exercise activity indicating that their bodies adjust better to increasing metabolic demands upon physical exertion compared to their more sedentary matched colleagues, whose exertion yield higher HRs and a greater risk of compromised cardio-pulmonary fitness.

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