Original Article

Association and correlation between cardiorespiratory fitness, BMI, musculo-skeletal and handgrip strength among young adult student girl population in Sullia, Karnataka, India

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Abstract:

Background: Obesity is at a rising trend among the childhood age group and is a WHO priority on classification of non-communicable diseases. High income group countries once had a statistically higher percent of obesity problems which has been extended both to the developing and low- income countries. Prevalence rate of obesity in India vary between 11.8% to 31.3% and is higher among the women than men. Obesity also affects the physical and cardio-respiratory fitness thereby leading to a group of metabolic, cardiovascular and musculoskeletal disorders. An association between BMI, musculo-skeletal and cardio-respiratory fitness is less reported among the young adult girl population in the context of Indian professional students. **Aim & Objectives:** To assess few of the musculo-skeletal, cardio-respiratory parameters in relation to BMI among the young adult girl students of medical and dental colleges. **Material & Methods:** One hundred and seventy-one girl students in the range of 19 to 21 years were randomly selected from the educational institute of Sullia, Dakshina Kannada, Karnataka and were assessed for BMI, muscular strength, handgrip strength, flexibility test, cardio-respiratory test and pulmonary function test by standard methods. Data was analysed. **Results:** Musculo-skeletal flexibility, strength, cardio-respiratory fitness and pulmonary functions have an inverse association when compared to the BMI and weight of the girl students. **Conclusion:** Obesity and overweight reduces the flexibility, musculoskeletal and cardio-respiratory fitness in addition to the pulmonary functions among the young adult girl population as confirmed by the battery of tests.

Keywords: obesity; girls; cardio-respiratory; fitness; handgrip

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Introduction:

Obesity is a growing problem due to the lack of physical activity and affluence among the public at large. It is a world health priority as the obesity at a rise among the childhood age group[1].

Once upon a time, high income yielding countries were facing the problems of obesity which gradually start rising in the middle-income countries and around 10% of low-income societies too come across the problems of overweight as per the recent data[2]. Prevalence rate of obesity and central obesity among Indians varies from 11.8% to 31.3% and 16.9%-36.3% respectively. In addition, different studies have proved that prevalence of obesity is much higher among women compared to the men[3]. Childhood obesity is a proved precursor for cardiovascular and adulthood obesity. Obesity and metabolic syndrome prevalence was also reported to be higher among the rural population as reported in Bangladesh with dyslipidaemia, hypertension compared to the urban population[4]. Medical, dental and most other professional degree students generally come either from high income to middle income families, their life comfort and nutritional factors are better compared to the low income families, magnitude of obesity related health factors among adolescents and early adulthood group of students in this group is not well studied and there are lacunae in terms of obesity, cardiorespiratory fitness, physical fitness, BMI among these group of adolescents and early adulthood girl students. In addition, obesity may also affect the physical fitness contributing to a lower academic performance[5].

Literature study reveals an inverse relationship between cardiorespiratory fitness and basal metabolic rate which also contribute to the musculoskeletal fitness adversely, an association between musculoskeletal fitness, cardiorespiratory fitness and BMI among the early young adult girl students in the Indian population is limited and less studied. Though data from high income nations are available, there is paucity of data in a developing country as India and hence this study was aimed to elucidate a possible correlation between musculoskeletal, cardiorespiratory fitness and BMI among the early adulthood girl students of professional degree colleges. It was further hypothesized that, participants with high BMI may show a lower musculoskeletal and cardiorespiratory fitness and vice versa when compared with the normal weight and age group peers.

Material and methods

One hundred and seventy-one female medical and dental degree students from KVG Campus of Sullia, Karnataka, India were selected between the age groups of 19 to 21 years based on cross sectional sampling method. Institutional ethical committee approval to conduct the research was obtained. Students were well elaborated about their participation and were purely voluntary and their consent in participation of the study was obtained, told that, they are free to withdraw from their participation any time during the study. Exclusion criteria involved was, students from any lung, cardiac and musculoskeletal diseases, medication, any physical disabilities and families with major cardiac, chronic lung and musculo-skeletal disorders. Different parameters of the study included were, anthropometric parameters such as height, weight and accordingly BMI was calculated with the standard formula. According to the BMI definitions students were classified into three groups, normal weight, over-weight and obesity.

Table 1: Anthropometric parameters: Height, weight, Age, BMI

Parameters of variables	Physiological normal weight among the members (n=98)	Overweight members (n = 62)	Members with obesity problems (n = 11)	ANOVA – F value	P values
Height	148.4 +_ 5.9	147.8 +_ 4.7	148.8 +_ 3.2	0.469	0.687
Weight	50.1 +_ 4.8	58.3 +_ 1.8	64 .4 +_ 4.2*	127.34	0.05
BMI – Body mass index	22.87 +_ 1.8	26.98 +_ 1.4	29.4 +_ 1.2*	242.02	0.05
Age	18 .3 +_ 0.8	18 .6+_ 0.9	18 .5+_ 0.6	.065	0.846

Data was presented as (Means _ SD); * $p < 0.05$, Normal vs overweight, + $p < 0.05$, Obese vs.

normal, # $p < 0.05$, Overweight vs. obese (Statistical test applied - One-way ANOVA followed by Bonferroni post hoc test).

Table2: Lung function parameters among different groups

Parameters of lung functional variables	Normal weight subject (n=98)	Overweight subject (n = 62)	Obesity (n = 11)	P values
FVC (L)	3.28±0.18	2.99±0.22	2.94±0.28*	0.05
FEV_1(L)	2.98±0.11	2.92±0.17	2.92±0.2	NS
PEF(L/s)	7.8±1.8	7.9± 2.0	7.2±1.4	NS

Data presented as (Means ±SD); * $p < 0.05$, Normal weight vs.obesity (One-way ANOVA followed by Bonferroni post hoc test).

Table3: Data correlation of musculoskeletal fitness, cardio-respiratory fitness and pulmonary functions.

Parameters	Normal body weight, n= 98	Higher weight to–overweight subjects, n= 62	Obese subjects, n=11	ANOVA-F	P-value
Knee extension-Right leg N	182.7+/-58.7	152.4+/-25.2*	152.2+/-23.12$	5.22	0.007
knee extension-left leg N	171.3+/-46.4	148.6+/-23.2*	151.2+/-26.18$	3.34	0.04
Right elbow flexion N	139.1+/-26.6	129.4+/-25.5*	128.4+/-27.6$	3.41	0.035
Left elbow flexion N	139.2+/-23.5	129.4+/-24.2*	127.8+/-23.4$	0.006	0.893
Right elbow extension N	100.2+/-16.5	106.5+/-19.4*	110.2+/-12.7$	5.321	0.003
Left elbow extension N	99.92+/-18.7	103.2+/-21.5*	112.2+/-14.6$	9.241	0.001
Sit & reach test (flexibility) cm	8.4+/-4.2	12.2+/-6.5*	13.7+/-5.8$	10.342	0.001
Grip strength of Right arm N	22.43+/-3.2	23.88+/-4.2*	24.12+/-4.1$	18.43	0.001
Grip strength of – Left arm N	21.87+/-3.8	22.67+/-3.8*	23.63+/-3.4$	13.66	0.001
20- meter shuttle run test (level)	3.1+/-1.4	2.8+/- 1.1*	1.7+/-1.3$	9.222	0.001
FVC	3.28±0.18	2.99±0.22	2.94±0.28*	5.898	0.05
FEV_1	2.98±0.11	2.92±0.17	2.92±0.2	0.109	0.982
PEFR	7.8±1.8	7.9± 2.0	7.2±1.4	0.608	0.879

Data is presented - Means ± Std deviation. N-Newton. * $p < 0.05$, Normal weight vs overweight, + $p < 0.05$, Obese vs. normal weight,# $p < 0.05$, Overweight vs. obese (Statistical test, One-way ANOVA; followed by Bonferroni post hoc test).

Height was measured by stadiometer and pulmonary function parameters were recorded with the help of a computerized spirometer. Different spirometric measurements in standing position were estimated - vital capacity (FVC), forced expiratory volume in 1 sec (FEV_1) and peak expiratory flow rate (PEFR) were included in the study.

Muscular strength was evaluated using upper and lower extremity isometric strength.

Flexibility for the elbow flexors and extensors, knee extensors, ankle plantarflexors and dorsiflexors were assessedin both supine (for the muscles of the elbow and ankle) and in seated position (for the knee extensors)[6]. The hand dynamometer measures the isometric muscle strength; grip strength was estimated using Jamar hydraulic hand dynamometer[7].

Sit-and-reach (SR) test used for assessing the flexibility[8]. Participants were tested individually under the supervision of qualified staff. In SR test, each participant made to sit with her feet approximately hip-wide apart against a wooden testing box with knees in extension. Then, asked to place the right hand over the left, slowly reaching forward as far as possible by sliding the hands along the measuring rule. The farthest most distance reached was recorded which represented the flexibility. Three trials were conducted, and the best score was reported. The sit and reach is reported to have moderate criterion validity ($r = 0.32$–0.6) in young age group of people that were included in the study.

Cardio-respiratory fitness was recorded using the 20meter long standard shuttle run test[9]. Participants were asked to run from one point to another exactly 20 meter apart from each, keeping pace with pre-recorded beep[10]. The beep was increased following a lapse of every minute and participants needed to keep up their speed with the beep for as long as they can with their possible capability. Ifthevolunteer failed to reach the appropriate point within the set time on two consecutive occasions or if they could not maintain the set pace of the beep, they were stopped. The total number of shuttles were recorded and used in calculating their cardiorespiratory fitness level.

Data was analyzed, SPSS (version 24.0, SPSS Inc., Chicago, IL, USA) was used. Descriptive statistical data - mean, standard deviation and percentage used to summarize the descriptive data. Differences in age of the students and their anthropometric parameters were established using the one-way Analysis of variance (ANOVA). Participants were divided into three groups for comparisons such as physiological normal body weight, overweight and obese groups as per the earlier explained guidelines. One-way

analysis of variance (ANOVA) was performed to compare any differences in cardiorespiratory fitness, flexibility and muscular strength. Statistical differences were extrapolated using Bonferroni post hocpairwise comparison. Pearson product-moment correlation coefficients were computed to establish the relationship between musculo-skeletal strength, cardio-respiratory fitness, flexibility parameters and BMI. $P<0.05$ was the level of significance.

Results:

Among the obesity group BMI was significantly higher ($P<0.05$) compared to the normal and overweight students. Forced vital capacity was lesser in the same group and in the flexibility tests both overweight and obesity group has compromised data compared to the normal weight group (Table 2& 3). Cardio-respiratory fitness by 20m shuttle run test exhibited a corresponding difference to the overweight and obesity group with a significant decline compared to the normal weight group.

Overall BMI, musculo-skeletal, cardio-respiratory and pulmonary functions have an association with a decline in related parameters compared to the BMI and weight of the individual.

Discussion:

Studies in the literature are sparse among the young adult girl population with reference to their BMI, cardiorespiratory fitness and musculoskeletal and handgrip strength. In this study an attempt has been done to establish a correlative association between few musculo-skeletal, cardio-respiratory and hand grip strength among the early adulthood population in a cross-sectional convenient sampling method among the medical and nursing students at the remote township Sullia of Dakshina Kannada district of Karnataka India. Being the professional study students, the cohort consisted of students from different parts of India who have come for their studies in Sullia. Overall there was a mix of students based on three categories of BMI classification with majority falling in the normal physiological weight with 62 number with higher weight and only 6.5% population obese. An increasing trend in higher to over-weight and obese may be due to the affluent background of the families and also due to the hormonal aspects of the individual student as almost 40 t0 45% students in the study category were falling in the higher category as dietary habits and nutritional status and lack of physical exercise with life-style are contributing for the observed trend. The

study also shows decrease in limb muscular strength among the over-weight and obese compared to the normal weight groups. Both higher BMI and lack of activities of lower extremities cause a decline in muscle strength[11]. A decline in lower extremity strength that correlates along with the BMI and the body weight further highlights the lack of regular activity also directly contributes to the observed musculo-skeletal strength of the lower limb muscles (Table 2&3).

Cardiorespiratory fitness was estimated by the standard 20 m shuttle run test, which found to be lesser among the overweight and obese compared to the normal weight group. Higher body mass – BMI is associated with lower cardiorespiratory fitness[12]. Shuttle run is a sustained activity which needs both muscle strength and proper oxygenation, decrease in cardiorespiratory fitness in this group correlates with the decrease in muscle strength and the faster fatigue in the muscles does not allow the over weight and obese individual to complete the assigned task of shuttle run test. In the running test, lower extremity needs a greater strength and as recorded in the study, over-weight and obese participants have both lower cardiorespiratory and lower extremity strength. The lower scores in shuttle run test may be also attributed to the build up of lactic acid in the muscles as reported earlier[13]. In the educational set-up lack of physical activity related non-academic subjects are less stressed and the professional pressure of academia may hinder the students from taking up regular physical activities and as outcome obesity and overweight and declining cardio-respiratory and physical fitness. Weight control and increase in lean body mass contributes directly in the fitness parameters of cardiac, respiratory and musculo-skeletal strength and an overall physical wellbeing[14]. Lesser physical activity with a higher relaxing time was also reported to affect fitness level negatively in male working adults[15]and regular breathing exercise may also be useful to enhance the cardiorespiratory fitness[16], further, this study also supports the earlier reports among South African low income group female adolescents wherein association of body mass index was negatively correlated with cardiorespiratory and musculo-skeletal fitness[17]. Level of daily activity affects the fitness which may need to be incorporated on a daily basis as recommended by WHO for physical wellbeing and fitness.

In conclusion, there is an association between cardiorespiratory, musculoskeletal, body weight and

BMI and girl students with a higher BMI – overweight and obese have a decline in their physical fitness. Pulmonary function parameters included in the study were lowered in obese group compared to the normal weight participant group and obese group number was very less in the group included in the study. This study needs to be extended to a bigger group of students and needs to be set up in different locations of the country to arrive at a conclusion and design exercise protocols in every college to prevent future cardiovascular, metabolic and age-related health problems in the population.

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