SUMMARY AND CONCLUSIONS

INTRODUCTION

Obesity epidemic is widespread globally and has reached in alarming levels in various parts of India as well. Obesity today poses a major global public health concern. The causes are multi-factorial ranging from rapid industrialization, transformation in home and school environment to an increasingly sedentary lifestyle, especially in the urban setting. Greater portion size, easy availability of high caloric low cost food (also known as junk food), high consumption of carbonated beverages has led to increased calorie consumption and a positive energy balance, thus leading to adolescent obesity. Childhood obesity has been associated with adult obesity and now poses as a major health concern (Dietz, 1998).

There is no dearth of scientific evidence proving the medical consequences of obesity in both adults as well as in adolescents. There is ample research evidence supporting strong correlation between paediatric and adolescent obesity and adult obesity which increases with the child’s age independent of the time duration the child has remained obese (Guo and Chumlea, 1999; Whitaker et al., 1997; Deshmukh-Taskar et al., 2006). Also, overweight adolescents (high BMI) are more likely to turn into overweight adults (Guo and Chumlea, 1999) irrespective of the timing of puberty. Medical consequences of obesity have been well documented but equally pernicious are the psychosocial, physical and academic corollaries of obesity in adolescents.

Adequate functioning of the musculoskeletal system has pre-requisites such as the muscles be able to produce torque or force, resist fatigue, and have sufficient full range of motion around joints. Research has provided ample evidence for children or adolescents as well as adults that adequate musculoskeletal fitness is positively associated with overall health status and reduced risk for disability and chronic disease (Payne et al., 2000; Warburton et al., 2006) and, mortality in adults. Several authors have reported negative influence of body composition on various health related fitness, including the PACER test (Lloyd et al., 2003), the test of aerobic capacity, the curl-up tests used to assess the abdominal muscle strength and endurance (Lloyd et al., 2003; Pate et al.,
Many investigators have examined associations between the type of food intake and cognitive brain functioning. Research undertaken by Zhang et al. (2005) investigating the amount of fat intake in the average American diet (rich in fat content especially, saturated fat, and cholesterol) with cognitive and psychosocial functioning in both children and adults, demonstrated that excessive consumption of polyunsaturated fatty acids and cholesterol in the diet was associated with a decreased academic performance and increased poor performance respectively. On the contrary, Datar et al. (2004) reported that there was no negative association between obesity and academic performance. Study conducted by Mo-suwan et al. (1999) reported significant correlation between Grade Point Average (GPA) and Body Mass Index (BMI) in children of grades 7-9 only, thus indicating that obesity did influence academic performance negatively, but only in selected adolescent age groups.

Several evidences subsist which validate that an individual’s health status affects his/her self-esteem (Wooley, 1995; Brown 1997; Faith et al., 2000). Fat stigmatization adversely affects self-esteem. Faith et al. (2002) reported that in overweight and obese children, while engaging in physical activity with peers, BMI was positively correlated with weight teasing, which consequently lead to the development of an adverse attitude towards sports which, in lieu, limited the sport participation to mild to moderate intensity only. Literature related to association of obesity with physical performance variables, academic performance and self-esteem in Indian adolescents is scanty, especially in north Indian context. Thus the present study was planned.

**AIMS AND OBJECTIVES**

The aims of the present study were:

- To compare physical performance variables, academic performance and self-esteem of obese children with normal weight adolescents.
- To examine the relationship between obesity and physical performance variables in adolescents.
To examine the relationship between obesity and academic performance in adolescents.

To examine the relationship between obesity and self-esteem in adolescents.

To determine the relationship between academic performance and physical performance variables.

To determine the relationship between academic performance and self-esteem.

To compare the gender differences in physical performance, academic performance and self-esteem in adolescents with respect to obesity.

HYPOTHESIS

There would be significant differences in physical performance variables, academic performance and self-esteem between obese and normal weight adolescents. Significant gender differences would be there between male and female adolescents.

MATERIALS AND METHODS

Sample Selection

A cross-sectional study, adopting a multi-stage stratified cluster sampling procedure was applied to purposively selected 1069 school going adolescents (643 boys and 426 girls) aged 9-16 years studying in grades 5\textsuperscript{th} to 10\textsuperscript{th} in three schools of Punjab namely, D.A.V. Public School, Amritsar (Majha region), Apeejay Senior Secondary School, Jalandhar (Doaba region) and General Gurnam Singh Public School, Sangrur (Malwa region). Demographic information and date of birth was recorded from the school record. The data was collected in the respective school’s gymnasium and multipurpose room during the school hours. The study was approved by the Institutional Ethics Committee and informed consent was obtained from both the students as well as their parents.

Methods

A weighing scale and anthropometer were employed to record weight (nearest to 0.5kg) and height (nearest to 0.1cm) as per Center for Disease Control and Prevention guidelines (Wang et al., 2006). Body Mass Index (BMI) was calculated as weight (kg)/height (m\textsuperscript{2}), following which BMI percentile was calculated (using the WHO
The subjects were further classified under gender-and-age specific cut-points of BMI percentile (CDC guidelines) into four weight categories as follows: underweight (BMI < 5th percentile), normal weight (BMI 5th to < 85th percentile), overweight (BMI 85th to < 95th percentile) and obese (BMI > 95th percentile).

The Progressive Aerobic Cardio-vascular Endurance Run (PACER) also known a 20meter shuttle run test was employed to estimate the aerobic capacity, the number of push-up in 1 minute was used to estimate the upper body endurance and back strength, 1 minute curl-up test was used to determine the middle and lower body strength and endurance, classic sit and reach test was used to measure flexibility, an anthropometric tape was used to measure the waist circumference and Harpenden skinfold caliper was used to assess percent body fat (derived from skinfold measurements; biceps, triceps, suprailiac and subscapular skinfolds). Academic performance/achievement was recorded as Grade Point Average (GPA) achieved by the adolescents in the previous class examination, from the school record. Standard statistical techniques were applied to analyze the data using SPSS version 17.

RESULTS AND DISCUSSION

The study is unique because it is first of its kind of investigation to examine the relationship of obesity with physical performance variables (including, aerobic capacity, muscular strength and endurance, flexibility and waist circumference), academic performance and self-esteem in school going adolescents of Punjab.

Obesity prevalence

From the findings of the present study it could be inferred that the prevalence of overweight and obesity amongst the school going adolescents of Punjab, aged between 9-16 years was 39% and 42% respectively (girls and boys considered together). In girls, the prevalence of overweight and obesity was 37% and 40% respectively and in boys, the prevalence of overweight and obesity was 38% and 41% respectively. The overweight and obesity prevalence rates reported by the present study were similar to the global trends in overweight and obesity. As per OECD update 2012, Indian children aged 5-17years had high prevalence rates of overweight and obesity (18.3% girls and 20.6% boys). Among Indian adolescents, various researchers have demonstrated the prevalence
rates ranging from 9-27.5% (for overweight) and 1 to 12.9% (for obesity) (Kapil et al., 2002; Chhatwal et al., 2004; Sidhu et al., 2006; Sharma et al., 2007; Bose et al., 2007).

Physical performance variables and obesity

**Aerobic capacity (VO₂max)**

In the present study, statistically significant differences (p<0.001) in the aerobic capacity was observed between the various BMI percentile categories in boys and in the girls and boys combined group. A statistically significant negative correlation was observed between the BMI percentiles and VO₂max in the girls and boys combined group (r= -0.231, p<0.001). This implied that as weight increased the aerobic capacity decreased. This might be accounted to the large (and deliberate) discrepancy in total mass between the BMI percentile categories. The findings of our study were supported by the studies conducted by Lloyd et al. (2003), Cureton, et al. (1975), Slaughter et al. (1977), Pate et al. (1989) and Rowland et al. (1999). The findings of the present study indicated that VO₂max had significant negative correlation with other indicators of obesity such as percent body fat, skinfold measurements and waist circumference.

**Curl-up**

Statistically significant differences (p<0.001) in the curl-up score were observed between the various BMI percentile categories in boys and in girls and in the girls and boys combined group. A statistically significant negative correlation was observed between the BMI percentile and the curl-up scores in the boys and girls combined group (r= -0.275, p=0.001). In the normal weight category, there was a significant negative correlation between the BMI percentile and the curl-up scores in boys (r= -0.188, p<0.001), in the girls and boys combined group (r= -0.153, p<0.001); but not in girls. The findings of our study suggested that the mean scores of curl-up were decreased across all BMI percentile categories as the weight of the individual increased, in all the three groups (combined boys and girls, boys group and girls group). This was consistent with the findings of Coe et al. (2012) indicating that curl-up scores or overall health related fitness decreased with increasing weight of an individual. It might be assumed that being overweight/obese did lead to a greater waist circumference and greater abdominal muscle
mass deposition in the abdomen thus affecting the muscular endurance of the abdominals, which, in turn, accounted for the poor test scores, on 1 minute-curl up test.

**Push-up**

The present study demonstrated statistically significant differences (p<0.001) in the push-up score between the various BMI percentile categories in boys (F=22.854), in girls (F=13.113) and in the girls and boys combined group (F=18.774, p<0.001). Thus it implied that as the weight of an individual increased, the upper body strength muscular and endurance decreased. A statistically significant negative correlation was observed between the BMI percentiles and the push-up scores in the boys and girls combined group (r=−0.347, p<0.001). However between the various BMI percentile categories, statistically significant negative correlation of push-up was observed only in the normal weight and overweight BMI percentile categories (girls and boys combined). The findings of the present study was consistent with the findings of Duncan et al. (2013) which suggested that increased weight was significantly associated with poor functional movement including push-up scores.

**Flexibility**

When between-group differences were investigated, no significant effect of body weight was observed on flexibility in boys as well as in girls, implying the body weight had no significant effect on an individual’s flexibility. Furthermore, there was no correlation between the BMI percentile and the flexibility in the girls and boys combined group, for all the weight categories. In comparing boys and girls of respective weight categories, girls had significantly greater flexibility scores than boys in all the weight categories (except the overweight group). Some authors believed that in general, increased body fatness could increase the time consumed to perform activities and hence averted the attainment of optimum flexibility by the individual. From the present study it could be inferred that an individual’s weight had no effect on his/her flexibility.

**Academic Performance and obesity**

In the present study, statistically significant differences in the academic performance scores were observed between the various BMI percentile categories only in
the girls and boys combined group (F=3.373, p<0.001). In comparing the boys and the
girls group of respective weight categories, the girls had significantly greater academic
performance scores than the boys in all the weight categories (except the obese category).

Furthermore, no statistically significant correlation was observed between the
BMI percentiles and the academic performance scores. This implied that an individual’s
weight had no direct link with his/her body weight. The findings of the present study was
consistent with other researches that did not find a significant relationship between
academic achievement and childhood obesity (Abdelalim et al., 2012; Kaestner et al.,
2009; Edwards et al., 2011; Li and O’Connell., 2012) but these findings created conflict
with the inverse relationship observed in numerous studies conducted in the past both
globally (Li., 1995; Campos et al., 1996; Laitinen et al., 2002; Mikkila et al., 2003) and
within the US (Falkner et al., 2001; Cottrell et al., 2007). The disparities or the
inconsistencies in the findings might be attributed to the difference in methodologies
adopted to calculate BMI percentiles, including difference of instruments and
methodologies to calculate weight and height, the age group of the subjects, the
difference in methods employed to assess academic achievement (including, test scores
and IQ scores), GPA scores obtained by schools, ethnic/racial differences amongst other
factors.

**Academic performance and physical fitness (aerobic capacity, VO$_2$max)**

Pearson product-moment correlation coefficients were computed to assess the
relationship between aerobic capacity and academic performance. There was a significant
positive correlation between academic performance and VO$_2$max (r=0.118 and p<0.001)
in the girls and boys combined group, for all the weight categories. When correlation
between academic performance and VO$_2$max was investigated amongst the four weight
categories, in the normal weight, overweight and obese category, there was a significant
positive correlation between the two variables in girls, boys and in the girls and boys
combined group. Hence, in all the weight categories (except underweight adolescents)
VO$_2$max was positively correlated with academic performance.

The present study had reported consistent relationship between aerobic capacity
and the academic scores. Several researchers had reported consistent relationships
between academic performance and physical fitness (Castelli et al., 2007; Chomitz et al.,
2009; Eveland-Sayers et al., 2009; Kwak et al., 2009; Wittberg, et al., 2009), in those studies physical fitness encompassed (aerobic capacity, strength and endurance as well as flexibility). The findings of the present study was similar to the findings of Chomitz et al. (2009), who reported that the chances of clearing a standardized English test as well as a Math test increased by 24% and 38% respectively with increased level of physical fitness. Furthermore, the possibility of increased academic scores increased with the level of physical fitness of the adolescent. While cause-effect relationship or physiological rationalizations for the physical fitness-academic performance link could not be stemmed from the present study, nonetheless, previously conducted researches had reported enhanced cognitive functioning (in reaction time, response accuracy and concentration) with increased level of physical fitness in adults (Hillman et al., 2009) as well as in elementary school children and mid-school adolescents (Sibley and Etnier, 2003).

**Academic performance and self-esteem**

Pearson product-moment correlation coefficients were computed to assess the relationship between academic performance and self-esteem. There was a significant positive correlation between academic performance and self-esteem (r=0.131, p<0.001) in the girls and boys combined group, for all the weight categories. When correlation between the academic performance and self-esteem was investigated, in the underweight and obese category, no correlation was observed between academic performance and self-esteem in girls, boys or combined girls and boys group. In the normal weight and overweight category, there was a significant positive correlation between academic performance and self-esteem in girls and in the girls and boys combined group. Hence, in the normal weight and overweight categories (in girls and girls and boys combined group) academic performance was significantly positively correlated with self-esteem.

There is ample body of evidence documenting relationship between self-esteem and academic performance. Enormous literature supported positive association between academic performance and self-esteem (Bankston and Zhou, 2002; Lockett and Harrell, 2003; Schmidt and Padilla, 2003). West et al. (1980) demonstrated positive correlation (p=0.18-0.50) between academic performance and self-esteem. Purky (1970) reported that self-esteem was associated with few constituents determining either academic success or verbal speaking skills and concluded that there was an incessant relationship
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between self-esteem and academic performance. Reynolds (1988) reported that academic self-concept was positively correlated with grade point average (GPA) scores in collegiate students. Covington (1989) demonstrated that there was a corresponding increase in academic performance with increase in self-esteem of the individual and vice versa. He further stated that by manipulating self-esteem (positively) greater academic scores could be achieved. In another study, Carr et al. (1991) while observing motivational achievement in underperformers demonstrated that self-esteem was an important determinant of reading awareness. Reasoner (2005) elucidated that there existed a universal concord among researchers supporting the fact that there was an intimate association between academic performance and self-esteem but considerable incongruities exist in the description/nature of this relationship.

Few researchers urged that pupils achieving greater scores in schools did so to achieve positive self-esteem, whereas, other believed greater academic scores were by virtue of positive self-esteem. On the contrary, there is ample research evidence documenting conflicting relationship between academic performance and self-esteem (ranging from negative to no relationship between the two variables). Yogev and Ilan (1987) and Van-Tuinen and Ramanaiah (1979) reported that self-esteem was not related to academic performance.

Self-esteem and obesity

Findings of the present study indicated that in boys, no significant differences in the self-esteem score was observed between any of the weight categories. In girls, significant differences was observed only between the underweight and obese girls, normal weight and obese girls and overweight and obese girls. When between-groups differences were investigated to observe the effect of body weight on self-esteem, no statistically significant effect was observed in boys. On the contrary, in girls, a significant effect (p<0.008) of body weight on self-esteem was observed. The findings of the present study indicated that self-esteem in obese girls (53.87±12.09) was significantly lower than underweight (62.63±10.27), normal weight (60.42±13.66) and overweight (61.30±13.19) girls. Pearson product-moment correlation coefficients were computed to assess the relationship between BMI percentile and self-esteem. There was no correlation between the BMI percentile and the self-esteem in the girls and boys.
combined group. However, a significant positive correlation between BMI percentile and self-esteem in the combined girls and boys group, of obese weight category \( r=0.178, p<0.030 \) was observed. There was no significant correlation between BMI percentile and self-esteem in boys or in girls, of the respective weight categories. Furthermore, on comparing the boys and the girls group of respective weight categories, no significant differences in the self-esteem score was observed in any of the weight categories.

From the findings of the present study it might be inferred that as an individual’s body weight adversely affected his/her self-esteem, but the same was true only in the case of girls and not in boys. Since the studies which had documented an association between obesity and self-esteem were longitudinal in nature and a cross-sectional study design sometimes failed to report the covariates associated with body weight and self-esteem. Hence, it might be possible that the design of the present study did not facilitate investigation of relationship between self-esteem and academic performance. Ambiguity in consensus existed on the role of gender in determining an individual’s self-esteem with studies reporting inconsistent results. While few researchers had reported greater self-esteem in females as compared to males, of the same age group (Kearney-Cooke, 1999; Sotelo, 2000; Jacobs et al., 2002), other studies had failed to report any such trend (Mullis et al., 1992; Sotelo, 2000). The present study found that boys had a greater self-esteem than girls, across all weight categories. Similar findings were reported by Wang et al. (2009) who demonstrated that boys had a greater self-esteem than girls aged 10-11 years, and the same pattern was observed after a four year follow-up. It was postulated that in comparison to boys, girls evaluated their physique and athletic capabilities more adversely, resulting in a low self-esteem (Vasta et al., 2009).

**CONCLUSIONS**

The findings of the present study were concluded as follows:

1. In the present study, the prevalence rates of overweight and obesity were 39% and 42% respectively, in school going adolescents of Punjab.

2. Boys had significantly greater \( p<0.001 \) aerobic capacity, curl-up scores, push-up scores and waist circumference than the girls in all the weight categories (i.e. underweight, normal weight, overweight and obese categories).
3. Girls had significantly greater flexibility (except the overweight category) and
academic performance scores (p<0.001) (except the obese category), than boys,
for all the weight categories.

4. No significant differences in the self-esteem score was observed (p>0.05)
between the girls and boys, for any of the weight category.

5. Statistically significant differences (p<0.001) in aerobic capacity were noticed
between underweight boys and overweight and obese boys; between normal
weight boys and overweight and obese boys, but not in girls, implying that
obesity had negative impact on boys aerobic capacity.

6. In both boys and girls, statistically significant differences (p<0.001) in curl-up
was noticed between underweight category and overweight and obese category;
between normal weight category and overweight and obese category and there
was a significant negative correlation (p<0.001) between the BMI percentile and
the curl-up scores in the girls and boys combined group, for all the weight
categories, implying that obesity had negative impact on an individuals’ lower
extremity and back strength.

7. There was a significant negative correlation (p<0.001) between BMI percentile
and the aerobic capacity (r = -0.231), push-up score (r = -0.347) and curl-up score
(r=-0.275), for all the weight categories, implying that increased weight
negatively affected the physical performance variables (except flexibility), in the
combined girls and boys group.

8. There was a significant negative correlation (p<0.001) between BMI percentile
and percent body fat and waist circumference in combined boys and girls of
respective weight categories. This implied that obese adolescents had greater
percent body fat as well as abdominal fat.

9. There was a significant negative correlation (p<0.001) between the aerobic
capacity and BMI percentile (r=-0.231), percent body fat (r=-0.496) and waist
circumference (r=-0.329, p<0.001) in the combined girls and boys group,
implying that cardio-respiratory endurance decreased with increased weight and
abdominal fat content of the adolescents.
10. There was a significant positive correlation (p<0.001) between the academic performance and the aerobic capacity (r=0.118) and self-esteem (r=0.131) in the combined girls and boys group, implying that adolescents with greater academic scores were physically fit and had greater self-esteem than their counterparts.

RECOMMENDATIONS
1. Study needs to be replicated on a larger sample size with a longitudinal study design to better predict the casual relationships amongst the variables.

2. Objective measures of body composition assessment may be adopted to accurately predict percent body fat, fat mass, fat free mass, for categorization of the subjects into different weight categories, for example, telemetry and underwater weighting may be used to accurately assess physical activity levels and percent body fat accurately.

3. The study may include other fitness parameters.