DESIGN AND METHODOLOGY

3.1 Research design

A cross-sectional study, adopting a multi-stage stratified cluster sampling procedure was applied to purposively selected 1069 school going adolescents aged 9-16 years of age from the various wards of Punjab. The study assessed the effect of obesity (body composition, independent variable) on academic performance, self-esteem and physical performance variables viz. curl-up, push up, flexibility, cardio-respiratory endurance and skin-fold thickness (dependent variables).

3.1.1 Selection of subjects

A total of 1069 school going adolescents (426 girls and 643 boys) aged 9-16 years participated in the study. These students were from grades 5th to 10th. From each grade and across various sections of the same grade/class, 170-175 participants were randomly selected (57-58 students per class per school). The students studied 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) between April, 2013 and October, 2014. The subjects were divided into four weight categories depending upon their body mass index (BMI) percentiles into underweight (BMI <5th percentile), normal weight (BMI 5th to <85th Percentile), overweight (BMI 85th to <95th Percentile) and obese (BMI ≥95th percentile) categories (as per CDC guidelines). The age of the subjects was recorded from the date of birth registered in their schools. The experimental protocol and potential risks of the study were explained to each subject both verbally and in writing before their informed consent was obtained. Furthermore, informed consent of their parents was also obtained before the subject participated in the study. The study was approved by the local ethical committee.

3.1.2 Sample size determination

For the determination of sample size, the following formula was applied:

\[ n = \frac{t^2 \times p \times (1-p)}{m^2} \]
where, \( n \) = sample size
\( t \) = 95% Confidence interval (standard value of 1.96)
\( p \) = frequency of dependent variables in the population
\( m \) = margin of error

### 3.1.3 Inclusion Criteria

Followings were the inclusion criteria of the subjects.

1. The subjects were of age group 9-16 years.
2. Only healthy subjects with no history of injury to the upper and lower extremities as well as the chest and back in the past two years were included.
3. The subjects not suffering from any medical conditions requiring treatment were included.
4. The subjects who agreed to co-operate throughout the course of the study were included.

### 3.1.4 Exclusion Criteria

Followings were the exclusion criteria of the subjects.

1. History of injury to upper extremity or lower extremity or chest or back in past two years.
2. History of surgery on the lower extremity or back in the past two years.
3. History of hypertension or any cardiac or breathing disorder.
4. Evidence of any deformity, ligament laxity of the lower extremity or limb length discrepancy.
5. Presence of pain on muscle contraction or during testing.
6. Children with special needs.

### 3.2 Data collection procedure

- Pre test screening
- Filling of informed consent*
- Assessment/test protocol administration

The data was collected in performa sheet.**

* Appendix - I
** Appendix – II and III
For the ease of data collection stations were designed and subjects were
categorized age-wise to collect data. On reporting to the test facility/sports room, each
subject went in the appended sequence of steps for the purpose of data collection, which
was obtained by the above mentioned procedures.

Step 1 = Station A  
Step 2 = Station B  
Step 3 = Station C  
Step 4 = Station D

3.3 Instrumentation

3.3.1 Apparatus: The following equipment was used for the present study.

i) Stadiometer - to measure standing height (in centimeters).

ii) Weighing machine – to compute weight in kilograms.

iii) Cones, stopwatch and beep test CD – to measure cardio-respiratory endurance

iv) Firm mattress – to measure curl-up and push up scores

v) Sit and reach box – to measure flexibility

vi) Harpendern skinfold caliper – to measure the skinfolds (i.e. biceps, triceps, 
suprailiac and subscapular).

vii) Measuring tape – to measure waist circumference

viii) Coopersmith Self-esteem Inventory Questionnaire (long form, for pupils 8 years 
and above).

3.3.2 Pre-assessment protocol

Subjects were familiarized with test protocols and the test procedure itself, i.e. 
beep test, sit and reach test, curl-up test and push-up test before the actual data collection. 
The self-esteem questionnaire was also explained to the children to minimize anxiety and 
control for errors. All the testing was conducted between 8.00am-12noon in the 
respective school premises. All the tests were performed under similar environmental 
conditions and free of significant external distraction. The school sports/physical 
evaluation rooms as well as the school playgrounds were used to collect data. All the 
necessary equipment and recording sheets/forms/questionnaires were arranged in
advance. The suitable space selected was clean, quiet and did not provide any hindrance to the tests undertaken. A day prior to the testing the subjects were informed to wear adequate clothing (tee shirt and track pants) and sport shoes. On the same day informed consent form was distributed to the randomly selected subjects (which were filled both by the subjects as well as their parents). On the next day, the subjects who gave their consent to participate in the study were subsequently assigned to various stations to undergo the assessment for the various variables. The station details were as follows:

1. Station A: Collection of informed consent form, demographic information collection and height and weight measurements.
2. Station B: Questionnaire filling and waist circumference and skinfold measurements.
3. Station C: Flexibility, push-up and curl-up measurements.
4. Station D: Beep test or shuttle run test measurement.

Each subject was explained the entire assessment protocol and the researcher demonstrated the physical performance tests to each subject. Subsequently the subject was asked to perform the same test for conceptual clarity and error minimization.

3.3.3 Assessment protocol

On the day of the assessment, subjects were instructed to consume food 2 hours prior to the test and arrived at 8:00 am at the sports room. Each participant was asked first to report at station A to submit the duly filled and signed informed consent form and the subject filled the data collection form with his/her demographic details (the subject’s date of birth was noted from the school records which in turn was obtained from the child’s date of birth certificate). Following this, the subject went to station B, gave the waist circumference measurement, skinfold measurement and filled the questionnaire. Subsequently, the subject went to station C, performed a 5 minutes warm-up (to minimize discomfort during the test session and to reduce the risk of injury) and underwent flexibility measurement using sit and reach test; following which the 1 minute curl-up and 1 minute push-up scores were recorded with a 15 minutes gap in between the tests (to aid recovery and minimize fatigue). Thereafter, the subject reported at station D for the shuttle run test to assess the cardio-respiratory endurance. Before the shuttle run
test, the subject was shown the beep test video and was allowed to listen to the beep test CD for several minutes to facilitate accurate measurements and minimize error. Subsequently each subject in a group of 4 was allowed to practice twice on the marked floor.

3.3.3.1 Measurement of body mass index (BMI):

BMI was measured by computing the subject’s height (in meter) and weight (in kilogram) as describe below:

**Height**

The measurement was taken using a wall mounted stadiometer. It consists of a vertical board attached to a metric rule and horizontal (sliding) head board (to make contact with the vertex of the head). As the individual’s height varies throughout the day depending upon the hydration of the inter-vertebral discs and the level of physical activity, the measurements were taken in the morning with the subject barefoot, standing erect with both feet together, his/her heels, buttocks, upper back against a wall on a leveled surface. With the subject’s head in Frankfort plane and arms relaxed by the sides and the vertex of the head at right angles to the wall mounted stadiometer. The subject was instructed to inhale and stretch up. Thereafter, the sliding stadiometer head board was allowed to contact with subject’s vertex and the results were recorded (in centimeter) up to the nearest 0.1 centimeter.

**Body weight**

The measurement was taken using a calibrated beam-type balance. The subject in minimal clothing and barefoot was weighted on the balance and measurements were recorded to the nearest 0.1 kg.

Following the above measurements, the BMI was calculated as follows:

\[
\text{BMI} = \frac{\text{Body mass (kg)}}{\text{Height (m}^2)}
\]

Subsequently, the individual’s BMI percentile was calculated as per the CDC guidelines (BMI percentile calculator) and the subject was categorized into either underweight, normal weight, overweight or obese category.
3.3.3.2 Waist circumference:

The measurement was taken following World Health Organization guidelines (WHO, 2008b). The subject was asked to stand erect with arms hanging by the side, both feet close together and bearing equal weight. The lower margin of the last palpable rib was palpated and a point midway between the rib margin and the iliac crest on the same side was marked with a washable felt pen. The same procedure was undertaken for the contra-lateral side of the trunk. Subsequently, a stretch resistant tape was snug around the waist crossing these two marked points and was parallel to the floor. The subject was asked to expire normally and the circumference measurement was noted to the nearest 0.1 cm.

3.3.3.3 Skinfold measurement

Triceps skinfold

The measurement was taken using the Harpenden skinfold caliper. The subject was asked to stand erect with the hands hanging freely side by side. It was obtained at the level of the midway between the acromion process and the olecranon of the right arm. The thumb and the middle finger of the researcher were moved along the vertical axis of the upper arm of the subject until they were at the level about 1.0 cm above the marked mid-point. The skinfold was then lifted away from the underlying muscle fascia and the trigger of the Harpenden skinfold caliper was placed at the level marked. Then the trigger of the skinfold caliper was allowed to exert its complete pressure (i.e. 10gm/mm2) on the skinfold. Few seconds after the complete pressure was exerted, the results were recorded in millimeters.

Biceps skinfold

The measurement was taken using the Harpenden skinfold caliper. It was obtained at a position which was exactly opposite of the triceps skinfold. The subject was asked to stand erect with the hands hanging freely side by side. From the right arm of the subject, the skinfold was lifted in the same manner as that of the triceps i.e. 1.0 cm above the marked mid-point on the biceps muscle. The Harpenden skinfold caliper was applied to the lifted fold and was allowed to exert the complete pressure on the fold. The results were recorded in millimeters.
Subscapular skinfold

The measurement was taken using the Harpenden skinfold caliper, measured below the inferior angle of scapula. The subject was asked to stand erect hanging the arms freely by the side. The subscapular skinfold was picked below the inferior angle of scapula and the jaws of the caliper applied on the fold. Results were recorded from the circular reading scale of the skinfold caliper in millimeter.

Suprailiac skinfold

It was measured about 1cm above and 2cm medial to anterior superior iliac spine, using the Harpenden skinfold caliper. The subject was asked to stand erect, the suprailiac skinfold on the anterior superior iliac spine was picked up and the jaws of the caliper applied on the fold. Results were recorded from the circular reading scale of the skinfold caliper in millimeter.

3.3.3.4 Flexibility assessment

The classic sit and reach test was employed to assess the subject’s flexibility. The assessment required a sturdy box approximately 12 inches high. A measuring scale was placed on top of the box with the 9-inch mark parallel to the face of the box against which the subject’s foot would rest. The “zero” end of the ruler was nearest the subject. The subject was asked to sit erect on the floor with both the legs straight and stretched out, shoes removed. The soles of the feet were placed flat against the sit and reach box. Both the knees were extended, locked and pressed onto the floor. With the arms stretched out and palms facing the floor, and one hand on top of the other (as in reinforcing position), the subject was instructed to extend the arms forward over the measuring scale with the hands placed one on top of the other. With palms down, the subject reached directly forward (keeping back straight and the head up) with both hands along the scale four times and was asked to hold the position of the fourth reach for at least 1 second. The number of centimetres on each side of the midline to the nearest 0.1cm, to a maximum score of 50 centimetres (12 inches), was recorded. The test was repeated thrice and the best score was recorded.
3.3.3.5 1 minute Sit-up test/curl-up test

The 1 minute President’s challenge curl-up test or the 1 minute curl-up test was the recommended test to measure abdominal strength and endurance. Test administration required little or no equipment (except a testing mat). Test objective was to complete as many curl-ups as possible in 1 minute. As the subject performed the test, the number of curl ups performed in 1 minute, using a stop watch, was recorded. The subject was in supine lying on the mat with hands placed behind the head at the level of the occiput, fingers interlocked elbows flexed and arms abducted, the knees flexed and feet approximately 12 inches away from the buttocks. A partner stabilized at the ankle. With the test commencement, the subject pushed off the mat, raised the trunk curling up to touch the knees with the elbows and then lowered the trunk and upper body back to the floor, to bring the scapulae in contact with the ground. This was counted as 1 curl up. The subject repeated the test in the similar fashion until 1 minute or until exhaustion which ever occurred 1st. If the subject stopped in the middle of the test to rest and/or was bouncing-off the floor with each repetition and/or was not maintain correct upper extremity, trunk and lower extremity posture throughout the test and/or did not keep his/her hands behind the head during the test; the test was stopped. The score was counted as the number of curl-ups successfully performed during 1 minute of the test.

3.3.3.6 1 minute Push-up test

The 1 minute 90° push-up with elbows at an angle of 90° was the recommended test for upper body strength and endurance. Test administration required little or no equipment (except a testing mat). Test objective was to complete as many 90° push-ups as possible in 1 minute, using a stop watch. As the subject performed the test, the numbers of push up done in 1 minute were recorded. The correct technique required the subject to bend the elbows to 90° and the upper arm and body parallel to the floor. The subject was in prone lying on the mat with hands shoulder width apart and the palms in contact with the mat. The trunk, hip, knees and ankles were in a straight line With the test commencement, the subject pushed off the mat, raised the trunk, hip, knees and ankle as a log, parallel to the floor, by extension at the elbows and upper arm and then lowered the trunk and lower extremity towards
the floor, but not in contact with the ground. This was counted as 1 push-up. The subject repeated the test in the similar fashion until 1 minute or until exhaustion which ever occurred 1st. If the subject stopped in the middle of the test to rest and/or was flexing at the trunk or the hip with each repetition and/or was not maintain correct upper extremity, trunk and lower extremity posture throughout the test, the test was stopped. The score was counted as the number of push-ups successfully performed during 1 minute of the test.

3.3.3.7 Beep test/Shuttle run test/PACER test

The test measured the individual’s aerobic capacity/cardio-vascular endurance. It was a multistage fitness test adapted from the test published by Leger and Lambert (1982), subsequently revised by Leger in 1988. The test had multiple stages with each stage having a given number of laps. The stages were progressive in intensity (easy at the beginning and difficult as the stages progressed, to aid warm-up and help the adolescents to pace themselves). The test objective was to complete as many stages/laps as possible with continuous back and forth running across a 20-meter space at a given velocity, which increased every minute. A beep test CD and non-slippery track of 20 meters was selected for test conduction. Two horizontal lines (line A and line B) were drawn 20 meters apart (marked with tape and chalk powder). Additionally, another two horizontal lines were drawn 16 meters apart and at a distance of 2 meters respectively, from line A and line B, and were labelled as line C and line D. Following a 5 minute warm up, the subject stood behind line A and was instructed to run up to line B, 20 m apart, at the sound of the 1st beep at moderate pace and touched the line with his/her foot (with full weight) as he/she heard the next beep sound. Immediately after the beep sound, at a specified time interval, the subject turned around and ran back from line B to line A, at a specified pace. If the subject reached either of the lines before the beep, the subject was instructed to stop and run only after the beep sound. The purpose of the line C and line D was to check for mistakes. If the subject ran slowly and lagged behind the beep and either failed to reach either line A or line B or was between line A and line C or between Line B and Line D at the sound of the beep, it was calculated as a mistake. The test was stopped if the subject made two mistakes or was exhausted and failed to run any further to
complete the lap. As the subject ran between lines A and B with the help of beep test software and CD, the last stage and the last lap the subject successfully completed was recorded, this helped to determine the subject’s maximum speed attained during the test. Following which the data including the subject’s age was entered into the appended equation developed by Leger to calculate the aerobic capacity:

$$\text{VO}_2 \text{ peak} = 31.025 + (3.238 \times \text{speed}) - (3.248 \times \text{age}) + (0.1536 \times \text{speed} \times \text{age})$$

Where, speed = maximal speed (in km.h\(^{-1}\)) attained during the PACER test and age = age of participant (in years).

### 3.3.3.8 Academic performance

The academic performance was measured as the total Grade Point Average (GPA) scores attained by the subject in the last academic session, from the school record.

### 3.3.3.9 Self-esteem

The measurement of self-esteem was done using Self-esteem Inventory Questionnaire. The questionnaire was developed by Coopersmith in 1976, to evaluate the self-esteem of pupils 8 years onwards. The questionnaire consisted of 58 items, all of which had to be answered by the subject in order to successfully complete the inventory. Each item had two options, viz., like me and unlike me. The subject was required to put a tick on the options he/she felt was correct for the subject. The subject was instructed not to lie and to attempt all the items. Once all the items were answered a stencil with the correct options was then placed over the test sheet in such a manner that the items on the stencil lined up with the items on the test sheet. The items marked by the subject which correspond with the marked boxes on the stencil were counted. The subscales did not have to be scored separately with the exception of the lie scale. The score obtained on the test sheet was then multiplied by 2 to calculate the overall self-esteem score which was comprised of the total number of correct responses in all scales excluding lie (a maximum of 50).

### 3.4 Statistical Analysis

The data was analyzed for statistical significance by using the Statistical Package for Social Sciences (SPSS 14.0) software. The following statistical tools were used:
3.4.1 Descriptive Statistics

The mean, standard deviation and standard error were calculated to describe the data.

1. Arithmetic Mean

Arithmetic mean is the most common measure of the central tendency and may be defined as the value which we get by dividing the total of the values of various given items in a series by the total number of items. It can be worked out as under:

\[ \bar{X} = \frac{\sum X}{N} \]

Where, 
- \( \bar{X} \) = arithmetic mean
- \( \sum X \) = Sum of scores
- \( N \) = Total number of items

2. Standard Deviation (SD)

The standard deviation is the most stable index of variability and can be calculated by the following formula:

\[ S.D. = \sqrt{\frac{\sum (X - \bar{X})^2}{N}} \]

Where,
- \( S.D. \) = Standard deviation
- \( X \) = Individual items
- \( \bar{X} \) = Mean of items

3. Standard Error (S.E.)

The standard error gives an idea about the reliability and precision of a sample. The smaller the standard error, the greater the uniformity of the sampling distribution and hence, greater is the reliability of the sample. It can be worked out as under:

\[ S.E. = \sqrt{\frac{S.D.}{N}} \]

Where,
- \( S.E. \) = Standard error
- \( S.D. \) = Standard deviation
- \( N \) = Total number of items
**Student’s t-test**

Student’s t-test is used when the population from which the sample has been taken is normal or approximately normal. It can be worked out as follows:

\[ t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{(S.E.1)^2 + (S.E.2)^2}} \]

Where

- \( t \) = t-test
- \( \bar{X}_1 \) = Mean of first sample
- \( \bar{X}_2 \) = Mean of the second sample
- \( S.E.1 \) = Standard error of first sample
- \( S.E.2 \) = Standard error of second sample

**One-way ANOVA test**

It is a parametric test used to compare results from 3 or more conditions, with same, matched subject groups in each condition. It only tells if there are general or specified differences in the results from the 3 or more conditions. Under the one–way ANOVA, only one factor is considered and it is observed that the reason for said factor to be important is that several possible types of samples can occur within the factor.

\[ F\text{-ratio} = \frac{MS\text{ between}}{MS\text{ within}} \]

Where,

- MS between = Mean square between samples
- MS within = Mean square within samples

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Squares</th>
<th>‘f’ ratio</th>
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<tbody>
<tr>
<td>Between Conditions</td>
<td>SS_{bet}</td>
<td>df_{bet}</td>
<td>MS_{bet}</td>
<td>F_{bet}</td>
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<td>SS_{error}</td>
<td>df_{error}</td>
<td>MS_{error}</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>SS_{tot}</td>
<td>df_{tot}</td>
<td></td>
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</tr>
</tbody>
</table>
Multiple comparisons Bonferroni (Post Hoc Test)

It compares the mean scores from each condition to see, if the difference between them is significant. It can only be carried out after on ANOVA has been performed and results are significant. It cannot be used independently. Since significant differences were found (p<0.05) multiple comparisons Bonferroni (Post Hoc Test) was applied to test for significant differences between pairs of dosages.

4. Correlation

To find the relationship of one variable to another we use correlation technique. Karl Pearson’s coefficient of correlation helps to study the numerical expression and describes the extent to which the variables are related. The formula for computing the Pearson correlation coefficient is given below:

\[ r = \frac{\sum XY}{N \sigma X \sigma Y} \]

Where

\[ X = (X - \bar{X}) \]
\[ Y = (Y - \bar{Y}) \]
\[ \sum XY = \text{Sum of the product of deviation in } X \text{ and } Y \text{ scores calculated with reference to their arithmetic means} \]
\[ \sigma X = \text{Standard deviation of scores } X \]
\[ \sigma Y = \text{Standard deviation of scores } Y \]

Linear regression

It is measure of the strength of the relationship between the two variables in linear form. This is expressed by the following equation

\[ y = a + bx \]

Where

\[ y = \text{Dependent variables} \]
\[ x = \text{Value of independent variables} \]
\[ a = \text{Line of intercept} \]
\[ b = \text{Slop of the line} \]