PHASE III:
PROMOTION OF PHYSICAL ACTIVITY AMONG CHILDREN AND ITS IMPACT ON ANTHROPOMETRIC, BIOPHYSICAL AND BIOCHEMICAL PARAMETERS

The findings of former 3 phases stress the need to promote physical activity among students through a school based sports club. Phase 3 involves formation of a sports club and assessment of its feasibility and impact on nutritional status of school children.

METHODS AND MATERIALS

The methodology applied in phase 3 is presented under following sections.

- Rationale
- Objectives
- Study design
- School selection
- Active Sports Club and its schedule
- Subject selection
- Orientation program
- Compliance
- Nutritional status assessment
- Ethical approval
- Data management
- Experimental design

RATIONALE

NHE imparted through behavior change model, coupled with physical activity encompasses a holistic approach towards lifestyle intervention. Active living imbibed from childhood tracks into adulthood and can prevent chronic degenerative diseases (Toftager et al, 2011).

In present study more than 35% children had parental history of 2 or more chronic illnesses; 60% children consumed unhealthy, ready to eat food twice a week and were physically inactive. Hence even at current "normal nutritional status" majority of the children can develop metabolic abnormalities early in life.

Therefore the present phase of the study was planned with the hypothesis that initiation of Moderate to Vigorous Physical Activity (MVPA) (35-45min) through an "Active Sports Club" (ASC) pre or post school hours, within school premises will be beneficial in improving the health outcome and behavior of the participants.

OBJECTIVE

To assess the impact of MVPA performed under ASC on the nutritional status of the participants in the selected school.

STUDY DESIGN

Uncontrolled quasi-experiment study design was used for this phase. This study design is a powerful tool where a "true experiment" is not possible and can be integrated with individual case studies. This design is especially useful in epidemiological or on field studies and helps to assess the impact of intervention on several outcomes (Silva, 1999).

SCHOOL SELECTION

Out of 10 schools evaluated based on the CDC's guidelines (phase 1b), 8 schools did not have a sports club. One out of these schools was purposively selected for initiating the sports club, based on their consent and interest to improve their school activities as per the CDCs guidelines.

Prior initiating the ASC, a meeting was organized with the school management comprising of the director, Principle, coordinators and physical activity teachers; and the entire concept was explained along with the resources and time required. Once the concept was accepted, discussions were initiated on the timings and schedule for the MPVA under ASC.

Inclusion criteria:

1. Newly initiated sports club (as per results of phase 2)
2. Permission from the school management
3. Availability of qualified physical education **t**eachers
4. Basic infrastructure for establishing a sports club

ACTIVE SPORTS CLUB AND ITS SCHEDULE

Permission was granted to initiate the ASC for standard 5-8th students only. The time granted for the MVPA (ASC) was 45 min, which included 20 minutes of pre-school timings and 25 minutes exemption from the school assembly timings for the participants.

Thus the schedule for the ASC was planned for a period of 90 working days of the school, from November, 2011 to March, 2012. The MVPA activities were finalized in consultation with the physical education (PE) teachers (Table 6.1).

SUBJECT SELECTION

After getting the permission from the school management, all students of standard 5^{th} to 8^{th} (n=560) were given a lecture in the school regarding the MVPA under the ASC. Out of the 560 students, 180 students who were willing to come to school 30 min prior the regular timings and participate in the MVPA through the ASC were enrolled for the study.

ORIENTATION PROGRAMME

Since the feasibility of the ASC was dependent on the parents (permissions and sending their children 30 min prior school) and PE teachers (conducting the MVPA), an orientation program was organized.

The orientation program was conducted in the seminar room of the Department of Foods and Nutrition, Faculty of Family and Community Science, The M. S. University of Baroda (Image 6.1 and 6.2). They were oriented on physical, psychosocial and physiological benefits of regular sports and physical activity and the need to conduct such an activity within the school. After the lecture the researcher addressed all the queries raised by the parents and students regarding the ASC. All the interested participants submitted a consent form signed by their parents (Annexure 12).

Out of the 180 shortlisted students 175 volunteered and gave their consent for participating in the MVPA under ASC in their school. However, by the end of the intervention, 3% (n=6) dropout was observed and the final data is reported for 169 participants.

Table 6.1 Schedule under the Active Sports Club

<table>
<tr><th>Activity schedules</th><th>Duration</th><th>Week Days</th><th rowspan="6">PE Teachers and the Research Investigator</th><th>Compliance records</th></tr>
<tr><td>Aerobics</td><td>35 min</td><td rowspan="2">Monday
Wednesday
Friday</td><td rowspan="2">Attendance sheets</td></tr>
<tr><td>Yoga</td><td>10 min</td></tr>
<tr><td>Football / Basketball

Volleyball</td><td>Boys - 35 min

Girls - 35 min</td><td>Tuesday

Thursday</td><td rowspan="2">Attendance sheets</td></tr>
<tr><td>Yoga</td><td>10 min</td><td>Saturday</td></tr>
</table>

GLIMPSES OF ORIENTATION LECTURE GIVEN TO PARENTS AND STUDENTS IN THE FND, FFCSc (IMAGE 6.1 – 6.2)

6.1

6.2

COMPLIANCE

Daily attendance was taken by the researcher with the help of the PE teachers to record the compliance. On weekends and school holidays, the parents marked the attendance on a calendar that was (Annexure 13) provided to them. However the calendar markings were not included in the intervention duration of 90 days.

NUTRITIONAL STATUS ASSESSMENT

The nutrition status was assessed through anthropometric, biophysical and biochemical parameters. Details of each are given below.

ANTHROPOMETRIC PARAMETERS: Height, waist and hip circumference were measured using the methodology as described in Phase 1a. Whereas BMI for Age (BAZ) was calculated with help of WHO's Anthroplus software; while ratios such as Waist Hip Ratio (WHR) and Waist Height Ratio (WhtR) were calculated manually.

BIOPHYSICAL PARAMETERS: Total body fat (TBF %) percent and BP were measured as the biophysical parameters among the subjects. Table 6.2 gives the consolidated details on the cutoff values, reference and equipments used in assessing the biophysical parameters.

a. **WEIGHT AND PERCENT BODY FAT:** TANITA-076, Japan body fat analyzer was used to take weight and percent body fat of the selected subjects.

   Principle: TANITA Body Fat Monitor/Scales use the Bioelectrical Impedance Analysis (BIA) technique. In this method, a safe, low-level electrical signal is passed through the body. It is difficult for the signal to flow through fat in the human body, but easy to flow through moisture in the muscle and other body tissues. The difficulty with which a signal flows through a substance is called impedance. So, the more resistance, or impedance, the signal encounters, the higher the body fat reading.

Procedure: The subjects were asked to stand on the metal sole plates of the machine removing all the possible metals worn and extra clothing like tie/cardigan/ handkerchief from pocket, money, etc. The age, sex and height of the subject were fed in the machine and accordingly the machine exhibited the weight and TBF % of the subjects. Students were instructed to void urine before the measurements and efforts were made to take the measurements before recess hours.

b. BLOOD PRESSURE: The systolic and diastolic blood pressure was measured using OMRON HEM-650.

Principle: Omron digital blood pressure monitors use the oscillometric method of BP measurement. Oscillometric technology measures the vibration of your blood travelling through your arteries and converts the movement into digital readings.

Procedure: The student was asked to sit upright in a relaxed position. The BP monitor was then cuffed on the left arm and the student was asked to rest his/her hand on a table besides the chair. Three readings were taken for each child on the same day and the mean value was recorded. Efforts were made to measure the BP during first half of the school hours before the recess.

Table 6.2: Tools and techniques used to measure the biophysical parameters

Parameter	**Cutoff**	**Boys**	**Girls**	**Principle**	**Instrument**
Total Body Fat Percent (TBF %)* **McCarthy et al., 2006**	Low	≤ 14%	≤ 19.6%	BIA	TANITA (UM -076), Japan body fat analyzer
	Normal	≥ 14.1 – ≤ 19.1%	≥ 19.7 – ≤ 25.1%		
	High	≥ 19.2%	≥ 25.2%		
Systolic Blood pressure (SBP) (mmHg)** **Raj et al, 2010**	Low	≤ 100.4	≤ 101.4	Oscillometric method	Omron HEM-650 arm digital BP monitor
	Normal	≥ 100.5 – ≤ 111	≥ 101.5 – ≤ 113.2		
	High	≥ 111.1	≥ 113.3		
Diastolic Blood pressure (DBP) (mmHg)** **Raj et al, 2010**	Low	≤ 65.9	≤ 66.4		
	Normal	≥ 66 – ≤ 71.2	≥ 66.5 – ≤ 73.3		
	High	≥ 71.3	≥ 73.4		

McCarthy HD, Cole TJ, Fry T, Jebb SA, Prentice AM. Body fat reference curves for children Int J Obesity.2006; 30(4):598-602.
*****Raj M, Sundaram KR, Paul M, Kumar RK. Blood pressure distribution in Indian children. Indian Pediatrics. 2010; 47: 477- 485.***

BIOCHEMICAL PARAMETERS: All biochemical analysis was done in Toprani's advance laboratory systems, Vadodara, (Toprani Advanced Lab, 2012). Overnight fasting blood samples were collected by trained technicians during early school hours in the school premises.

a. **COMPLETE BLOOD COUNT (CBC):** Whole blood samples were collected in EDTA anti-coagulant vacutainer and analyzed for different components such as Hemoglobin (Hb), Red Blood Cells (RBC), Packed Cell Volume (PCV), Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH), Mean Corpuscular Hemoglobin Concentration (MCHC) and White Blood Cells (WBC) within 4 hours of collection using an Automatic Hematology Analyzer, Sysmex XT-4000i, Japan. Tables 6.3 and 6.4 describe the equipments used for CBC analysis and respective cutoffs used in the study.

Table 6.3: Details of equipments used for assessing hematological indices

Components of Blood	Tools and Technique Used	Equipment
Complete Blood Count	Automatic Hematology Analyzer, Sysmex XT-4000i, Japan	
WBC and Reticulocytes	Optical detector, based on fluorescence cytometry method	Semiconductor Laser
RBC and Platelet count	Hydrodyncamic focusing method	RBC Detector
Hemoglobin	SLS Hemoglobin determination method	HGB Detector
PCV, MCV, MCH, MCHC	Calculated using set equations	

Table 6.4: Cutoff used for hematological indices

Parameters	Cutoffs	Boys	Girls	Total
Haemoglobin(Hb.) (gm%)	Normal	≥ 13.1	≥ 11.5	NA
	Mild Anemic	≥ 10.1 – ≤ 13	≥ 10 - ≤ 11.4	
	Moderate Anemic	≥ 7.1 - ≤ 10	≥ 7.1 - ≤ 9.9	
	Severely Anemic	≤ 7	≤ 7	
Red Blood Cells (RBC)(mil/cmm)	Low	< 4.6	< 4.2	NA
	Expected	≥ 4.6	≥ 4.2	
Packed Cell Volume (PCV) (%)	Low	< 42	< 32	NA
	Expected	≥ 42	≥ 32	
Mean Cell Volume (MCV) (fl)	Low	NA	NA	< 78
	Expected			≥ 78
Mean Corpuscle Hemoglobin (MCH)(pg)	Low	NA	NA	< 27
	Expected			≥ 27
Mean Corpuscle Hemoglobin Concentration (MCHC)(%)	Low	NA	NA	< 32
	Expected			≥ 32
White Blood Cells (WBC) (per cmm)	Low	NA	NA	< 4000
	Expected			≥ 4000

***** *The cutoff values are as per the reference range used by Toprani Advanced lab systems, 2012 based on Automatic Hematology Analyzer, Sysmex XT-4000i. Hb ranges have been taken from WHO, 2011.*

b. HS-CRP AND LIPID PROFILE: Serum samples were used for estimating High Sensitive - C - reactive protein (HsCRP), Total Cholesterol (TC), High Density Lipoprotein-Cholesterol (HDL-C), Low Density Lipoprotein-Cholesterol (LDL-C) and Triglycerides (TG) using Cobas Integra 400/800, Roche (Table 6.5). Total cholesterol and HDL cholesterol ratio (C:HDL-C) and triglyceride and HDL cholesterol Ratio (TG:HDL - C) were calculated manually using Microsoft Excel, 2007.

High Sensitive C-Reactive Protein (HsCRP):

Equipment: IMMAGE Immunochemistry System and Calibrator 5 Plus

Principle: Quantitative determination of High Sensitive C-Reactive Protein concentration in human serum or plasma by rate turbidimetry

Method: The IMMAGE Immunochemistry System is based on the highly sensitive near infrared particles immunoassay rate methodology. An anti-CRP coated particle binds to CRP in the patient sample resulting in the formation of insoluble aggregates causing turbidity. The rate of aggregate formation is directly proportional to the concentration of CRP in the sample.

Type of Specimen: Serum samples on fasting condition. Samples should be assayed within 8 hours of collection or stored at 0°C to 4°C

Total Cholesterol:

Principle: Cholesterol esters are cleaved by the action of cholesterol esterase to yield free cholesterol and fatty acids. The colour intensity of the dye formed is directly proportional to the cholesterol concentration and is measured at 512 nm.

Method: Enzymatic colorimetric test

HDL-C:

Principle: In presence of magnesium ions and dextran sulfate, water-soluble complexes with LDL, VLDL and chylomicrons are formed which are resistant to PEG-modified enzymes. The cholesterol concentration of HDL-C is determined enzymatically by cholesterol esterase and cholesterol oxidase coupled with PEG to amino groups. The colour intensity of the blue quinoneimine dye formed is directly proportional to the HDL-C concentration measured at absorbance at 583 nm.

Method: Homogeneous enzymatic colorimetric assay.

LDL-C:

Selective micellarysolubilization of LDL-C by a nonionic detergent and the interaction of a sugar compound and lipoproteins. The combination of a sugar compound with detergent enables the selective determination of LDL-C in serum.

Triglycerides:

Principle: The TG undergoes enzymatic hydrolysis by lipase to glycerol and Free Fatty Acid. The glycerol released is phosphorylated to glycerol-3-phosphate which is further oxidized by glycerol phosphate oxidase producing dihydroxyacetone phosphate and hydrogen peroxide. Peroxidase catalyzes the redox-coupled reaction of H_2O_2 with 4-Aminoantipyrine (4-AAP) and N-Ethyl-N-(3-Sulfopropyl)-m-anisidine (ESPA) producing a brilliant purple colour measured at 540 nm

Method: Enzymatic colorimetric test.

Total Cholesterol:HDL Ratio:

The TC to HDL-C ratio helps in predicting atherosclerosis. A high ratio indicates a higher risk of heart attack. High TC and low HDL-C increases the ratio; conversely low TC and high HDL-C lowers the ratio. (Webmed, 2014).

Triglyceride HDL Ratio:

This ratio is an estimate of small, dense lowLDL-C, is an independent determinant of arterial stiffness in adolescents and young adults, and therefore can be used in identifying young adults requiring aggressive intervention to prevent atherosclerosis (Urbina et al., 2013).

Table 6.5: Reference range used for the lipid profile

Sr. No.	Parameters	Range	Cutoffs
1.	HsC-Reactive Protein (HsCRP) (mg/l)	Normal	< 1
		Moderate risk	1 – 3
		High risk	> 3
2.	Serum Cholesterol (TC) (mg/dl)	Normal	< 200
		Moderate risk	200 – 239
		High risk	> 240
3.	High Density Lipoprotein (HDL-C) (mg/dl)	Normal	≥ 40 - ≤ 60
		At risk	< 40
4.	Low Density Lipoprotein (LDL-C) (mg/dl)	Normal	< 100
		Moderate risk	100 - 159
		High risk	≥ 160
5.	Triglyceride (TG) (mg/dl)	Normal	< 150
		Moderate risk	150 – 199
		High risk	≥ 200
6.	Cholesterol / HDL (TC:HDL) (ratio)	Normal	< 3.5
		At risk	≥ 3.5
7.	TG/HDL (RATIO)	Normal	< 3.8
		At risk	≥ 3.8

HsCRP: (AHA):** ***Webmed, 2005. **ATP III** ***guidelines may 2001 modified by NCEP.*** **TC:HDL-C: TG:HDL-C:** ***Urbina et al. Triglyceride to HDL-C ratio and increased arterial stiffness in children, adolescents and young adults. Pediatrics. 2013; 131 (4): e1082 – e1090.***

c. BLOOD GLUCOSE PARAMETERS: Serum samples were used for estimating Fasting Serum Insulin (FSI), Fasting Plasma Glucose (FPG); while HOMA – IR (Homeostasis Model Assessment) was computed manually.

Fasting Serum Insulin (FSI):

Equipment: Elecsys 2010 and Cobas 411 immunoassay analyzers (ECLIA – ElectroChemiLuminescenceImmunoAssay)

Principle: Sandwich principle

Method: For first incubation insulin from 20µl sample, a biotinylated monoclonal insulin-specific antibody and a monoclonal insulin-specific antibody labeled with a ruthenium complex form a sandwich complex. At second incubation, streptavidin-coated microparticles are added and the complex becomes bound to the solid phase via interaction of biotin and streptavidin. The reaction mixture is aspirated into the measuring cell where the microparticles are magnetically captured onto the surface of the electrode. Unbound substances are then removed with ProCell. Application of a voltage to the electrode then induces chemi-luminescent emission which is measured by a photomultiplier.

Type of Specimen: Serum samples on fasting condition. Samples to be stored at 2°C to 8°C and assayed within 24 hours

Fasting Blood Glucose (FBG):

Equipment: Cobas Integra 400/800 Roche

Principle: Enzymatic reference method with hexokinase

Method: Hexokinase catalyzes the phosphorylation of glucose by ATP to form glucose-6-phosphate and ADP. To follow the reaction, a second enzyme, glucose-6-phosphate dehydrogenase is used to catalyze oxidation of glucose-6-phosphate by NADP to form NADPH. The concentration of the NADPH is directly proportional to glucose concentration and is determined by measuring the increase in absorbance at 340 nm.

Type of Specimen: Blood plasma from fasting individuals

HOMA IR

Insulin resistance represents a reduced physiological response of the peripheral tissues to the action of the normal levels of insulin. HOMA IR measures insulin resistance and provides an important link between insulin resistance and MetS. This model can be used in large epidemiologic investigations and as a surrogate measure of insulin resistance in vivo (Esteghamati et al., 2010).

Table 6.6: Reference range used for the blood glucose parameters

Sr. No.	Parameters	Range	Cutoffs
1.	Fasting Serum Insulin (FSI) (μ/ml)	Normal	6 – 27
		At risk	> 27
2.	Fasting Plasma Glucose (FPG) (mg/dl)	Normal	≤ 110
		At risk	≥ 111
3.	HOMA IR	Normal	< 3
		Moderate risk	3 – 5

FSI and FPG: ADA, 2010. HOMA IR: Mathews et al. Homeostasis Model Assessment: Insulin resistance and β-cell function from fasting plasma glucose and insulin concentration in man. Diabetologia. 1985; 28 (7): 412 – 9.

ETHICAL APPROVAL

This phase of the study was approved by the ethical committee of the Department of Foods and Nutrition (FCSc./FND/ME/49).

DATA MANAGEMENT

The questionnaires were checked for completeness and accurate information. The responses were coded and a separate coding sheet was prepared. Based on this coding, the data was entered in Microsoft Excel Sheet. Double cross entry of data was done for quality check. BAZ was computed using WHO's Anthroplus software, version 1.0.3 and IBM SPSS Statistics 20.Ink. Appropriate statistical tests such as frequency calculation, Independent T-test, Paired T-test, ANOVA and Chi-square and were applied for data analysis.

EXPERIMENTAL DESIGN

Figure 6.1: Experimental design for phase 3

Purposive selection of 1 out of 8 schools based on inclusion criteria

1. Newly initiated sports club
2. Permission from school management
3. Appropriate infrastructure
4. PE teachers willing to volunteer for the active sports club

All students willing to come to school 30 min prior school timings for participating in MVPA through ASC from 5th to 8th standard following consent from parents

N=169

MVPA Intervention
(Football, Volleyball, Basketball, Aerobics and Pranayam) for 90 days for 45 min daily
(20 min before school timings and 25 min during school assembly)

Pre-Post Assessment

1. **Compliance**
2. **Feedback**
3. **Nutritional status assessment (Anthropometry, Biophysical, Biochemical)**

RESULTS AND DISCUSSIONS

Rising trend of twin malnutrition among school children of Vadodara together with the growing obesogenic environment an low priority to school based PA makes it important to strategize PA within school setting. The results of an attempt to initiate an "Active Sport Club "and its feasibility in a school setting and its impact on the anthropometric, biophysical and biochemical indicators on the participants are presented in this section under following heads.

- Setting an "Active Sports Club"
- Details of the moderate to vigorous physical activities under the "Active Sports Club"
- Training
- Attendance and compliance
- Feedback
- Baseline data of the students enrolled for the "Active Sports Club"
- Impact of the intervention

SETTING AN "ACTIVE SPORTS CLUB"

The selected school was an English medium school, administered by private trust. It followed the Gujarat state board curriculum and had coeducational structure. The school had a students' strength of 1540 nurtured under 30 teaching and 12 non-teaching staff members.

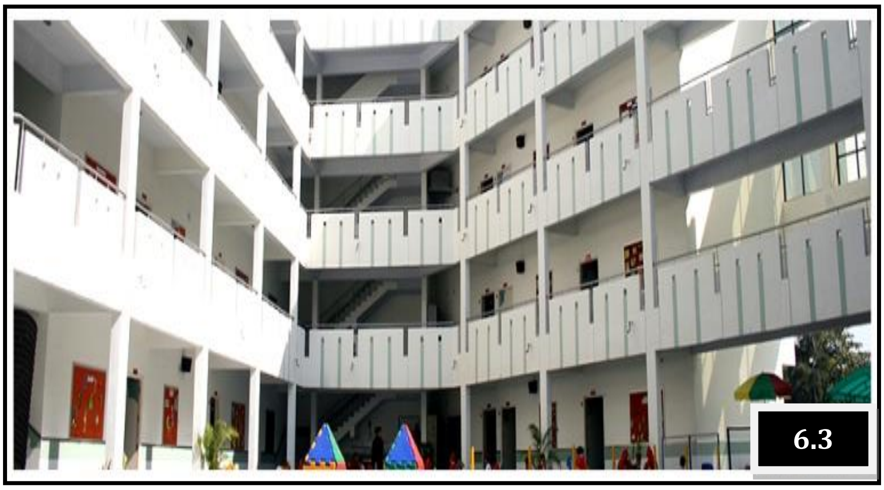
Table 6.7 describes the infrastructural details in the selected school. The school campus (Image 6.3 to 6.5) was developed in 2005, was spacious; had aesthetic surroundings and was efficiently developed to provide a variety of sports. The open space around the school was divided into 6 different precincts of which 3 areas were developed as basketball, volleyball and football field closely adhering to the high school standards (Sports, field and court dimensions, 2012). The remaining 3 regions were constructed as semi-open courts for undertaking yoga and karate.

The average capacity of each defined arena (field/ court) was nearly 30 students. This facility coupled with proportionate number of coaches, made it possible to perform 3 different sports with different groups of students at the same time. However, besides the schedule PT periods, there was no regular organized sports activity in the campus.

Table 6.7: Infrastructural description for the selected schools

Sr. No.	Facilities	Description	Capacity
1.	Playground/Fields	• 3 distinct playgrounds available	20 each
		• 2 grounds developed for volleyball and basketball respectively	
		• 1 plain ground (may be used for any sports)	35
2.	Court/Hall	• 2 covered shades with concreted floor	20 each
3.	Raised varanda	• 1 raised platform with concreted floor	20
4.	Equipments	• For games such as basketball, volleyball, football, cricket, badminton and tennis	4 sets for each game
5.	Expert personnel	• Female coach: expertise in yoga and kho-kho	1
		• Male coach: expertise in cricket, volleyball, football, karate and yoga	5

GLIMPSES OF THE SCHOOL INFRASTRUCTURE (IMAGE 6.3 – 6.5)



6.3

6.4

6.5

DETAILS OF THE MODERATE TO VIGOROUS PHYSICAL ACTIVITIES UNDER THE "ACTIVE SPORTS CLUB"

In this phase of the study, moderate to vigorous physical activities (MVPA) were planned under the ASC (Figure 6.2) initiated in the school to incorporate PA as a daily routine for the students.

The MVPA included 35 minutes of aerobics conducted three days a week followed by 10 minutes of cool down. The remaining three days, games (football, basketball or volleyball) were conducted for 35 minutes followed by 10 minutes of cool down. Hence aerobics and sports were performed on alternate days. The total time allotted for the MVPA under the ASC was 45 minutes.

This intervention of MVPA was conducted during the months of November, 2011 to March, 2012 for a period of 90 days excluding the holidays or any school based activity that may coincide with the sports schedule. During the holidays and weekends, the participants were motivated to undertake the aerobics at home.

In all 169 participants aged 9-14years (standard 5-8th) were enrolled for the ASC based on their informed consent. For ease of administration, they were divided into 4 groups. All groups repeated two activities for 2 days.

To save the students from missing their scheduled school academic timetable, activities were initiated 20 min prior to the scheduled school timing and extended for another 25 min which comprised of the school assembly. All students enrolled in the ASC were able to attend their regular classes post sports activities.

TRAINING

The ASC was moderated by the researcher daily for a period of 90 days and all activities were conducted with the help of 5 trained physical education (PE) teachers of the school.

ATTENDANCE AND COMPLIANCE

In order to improve the strength of the intervention, the 5 activity in charge PE teachers, maintained the attendance of all the participants of the ASC which was monitored by the researcher daily for 90 days. Extra days/week of trainings were organized for those students who remained absent during the training period due personal reasons.

On weekends or on national holiday, the parents maintained a record in the calendars (Annexure 14) provided to them during the training session. Weekly monitoring of the activity was done using mobile phones via SMSs by the researchers for all 169 students enrolled for the ASC.

Figure 6.2: Participants distribution within a group and schedule of the ASC

Activity	Time	Frequency	Details	Group type	Group strength
	30 min	Mon	Volleyball	Girls	15
		Wed	Basketball	Boys	14
		Fri	Football	Boys	14
	30 min	Tue	50 spring jumps	Mixed both Boys and Girls	21
		Thu	Joint movements		21
		Sat	Jogging		
	15 min	Every day	Pranayam	Mixed both Boys and Girls	21
			Meditation		21

**The described schedule is for one group. Three groups had 42 participants and one group had 43 participants. Similar pattern was followed by all four groups where pranayam and meditation was done by all the groups daily.*

GLIMPSES OF DIFFERENT SPORTS ACTIVITIES UNDER THE ASC (IMAGE 6.6 – 6.9)

6.6

6.7

6.8

6.9

**Image no. 6.6 and 6.7 are of activities done on Saturdays, while Image no. 6.8 and 6.9 are of activities done on weekdays.*

BASELINE DATA OF THE STUDENTS ENROLLED FOR THE "ACTIVE SPORTS CLUB"

As shown in table 6.8, 64% of the participants were boys which was nearly double as compared to the girl participants (36%) indicating that more boys gave consent for the ASC as compared to girls. This also underlines that it was easier for the boys to attend a 20 min early school via personal bicycles for participation in the ASC. These participants were studying in standards 5-8th and based on the age, 46% students belonged to age groups of 9-11 years and 54% in the age group of 12-14 years.

Table 6.8: General characteristics of the participants (n=169)

Parameters		Frequency (n)	Percentage (%)
Gender	Boys	108	64
	Girls	61	36
Age	9 – 11 years	78	46
	12 – 14 years	91	54
Standard	5th	43	23
	6th	56	33
	7th	53	31
	8th	17	10

ANTHROPOMETRIC INDICES – COMPARED BETWEEN GENDER AND AGE:

The mean height among the selected participants was 146.2 cm (range 113 - 169 cm) and mean weight was 38.7 kg (range 25 - 79kg). BMI for age (BAZ) was derived using the WHO Anthroplus Software; and the computed mean value was -0.27 ± 1.5 with a range of minimum -4.7 to maximum 3.1 (Table 6.9). Mean values of other anthropometric indices such as waist circumference (WC) was 66 ± 9cm (range 46 - 101 cm); waist hip ratio (WHR) was 0.87 ± 0.07 ranging from 0.7 to 1.6 and waist height ratio (WHtR) was 0.45 ± 0.05 (range 0.3 to 0.6).

Though the mean values of these parameters were in a normal range; yet the huge difference between minimum and maximum values clearly depicts the prevalence of extreme status of malnutrition coexisting in the selected population.

The anthropometric indices when compared across gender showed no significant difference (Table 6.9). The measurements of height (7, $p<0.001$, CI=95%), weight (4.9, $p<0.001$, CI=95%), waist (3.8, $p<0.001$, CI=95%) and hip circumference (4.5, $p<0.001$, CI=95%) were significantly different between the two age groups. The higher age group had significantly higher values as compared to the younger group (Table 6.9). The mean value of waist circumference was nearer to the "at risk" category among the children of older age group. Among all the anthropometric indicators, waist circumference and waist height ratio truly reveal a rising picture of dual burden of malnutrition (Table 6.9).

Table 6.9: Pre intervention anthropometric parameters compared across gender and age of the participants (n=169)

Sr. No.	Parameters	Range	Total (Mean ± SD)	Boys (n=108)	Girls (n=61)	t-Value	9 – 11 yr (n=78)	12 – 14 yr (n=91)	t-Value
1.	Height (cm)	113 - 169	146.2 ±9.4	146.3 ± 9	146 ± 9	0.18 NS	141.3 ± 8.7	150.4 ± 7.9	-7***
2.	Weight (kg)	15 - 79	38.7 ± 10.7	38.9 ± 11	38.4 ± 10	0.27 NS	34.6 ± 9	42 ± 10	-4.9***
3.	BAZ	-4.7 - 3.1	-0.27 ±1.5	-0.23 ± 1.6	-0.34 ± 1.4	0.44 NS	-0.3 ± 1.5	-0.2 ± 1.6	-0.4NS
4.	WC (cm)	46 - 101	66±9	66 ± 9	66 ± 8.9	0.005 NS	63.3 ± 8.5	68.5 ± 8.8	-3.8***
5.	HC (cm)	39 - 109	76±9.5	76 ± 9.8	77 ± 8.9	-0.7 NS	72.6 ± 9.2	79 ± 9	-4.5***
6.	WHR	0.7 - 1.6	0.87±0.07	0.87 ± 0.08	0.86 ± 0.05	1.27 NS	0.87 ± 0.08	0.89 ± 0.04	0.7 NS
7.	WHtR	0.3 - 0.6	0.45±0.05	0.45 ± 0.05	0.45 ± 0.04	-0.07NS	0.44 ± 0.05	0.45 ± 0.04	-0.9 NS

Gender	*Category*	*BMI for age (BAZ)*	*Waist Hip Ratio (WHR)*	*Waist Circumference (WC)*	*Waist Height Ratio (WHtR)*
		WHO AnthroPlus software 2010	*WHO, 2009 report*	*Kurian et al. 2011.*	
Overall	*Undernourished*	*< -2*	*NA*	*NA*	*NA*
	Normal	*≥ -2 to ≤ 2*	*NA*	*NA*	*NA*
	Over-nourished	*> 2*	*NA*	*NA*	*NA*
Boys	*Undernourished*	*NA*	*≤ 0.84*	*≤ 59.3*	*≤ 0.40*
	Normal	*NA*	*≥ 0.85 –<0.95*	*≥ 59.4 – <68.2*	*≥ 0.41 – < 0.44*
	Over-nourished	*NA*	*≥ 0.95*	*≥ 68.3*	*≥ 0.45*
Girls	*Undernourished*	*NA*	*≤ 0.79*	*≤ 60.1*	*≤ 0.41*
	Normal	*NA*	*≥ 0.80 – <1.18*	*≥ 60.2 – <69.1*	*≥ 0.42 - < 0.45*
	Over-nourished	*NA*	*≥ 1.18*	*≥ 69.2*	*≥ 0.46*

NS = Non-significant difference. p<0.05*, p<0.01** and p<0.001 at CI=95%.***

CLASSIFICATION OF NUTRITIONAL STATUS AS PER ANTHROPOMETRIC INDICES

Table 6.10, shows the distribution of nutritional status of the selected students as per BAZ, WC, WHR and WHtR. Overall, 82% had a normal nutritional status as per BAZ, 6% were overweight and 13% were underweight. However, based on WC, 35% students were overweight/obese/over-nourished when compared to WHR (2%) and WHtR (54%). Among all the anthropometric indices WC and WHtR are sensitive and reveal a true picture of nutritional status. However, no single indicator is a holistic marker.

Based on gender, more boys as compared to girls were overnourished. Wherein the BAZ boys 7% > 2% girls; WC: boys 38%>30% girls; WHR boys 4%> 0%girls and WHtR boys 52%>39% girls clearly indicating the gender bias.

BIOPHYSICAL PARAMETERS – COMPARED BETWEEN GENDER AND AGE:

The mean of TBF% was 19% with a wide range of 5-53.7%. Between genders, the mean values of TBF (2.1, $p<0.05$ 95% CI) was significantly different between boys and girls, with slightly higher values among girls (Table 6.11). Boys exhibited higher blood pressure (BP) values as compared to girls.

When the TBF was categorized based on Mc Carthy et al., 2006 cutoffs and the BP values based on Raj et al., 2010 cutoffs (BP values of Indian children), the mean values for both were found towards "higher or at risk" level with distinctly larger deviation. Boys had higher BP values, both systolic (113 ± 13 mmHg) and diastolic (74 ± 11 mmHg) as compared to the girls. When compared across age groups, significant difference was observed in the TBF% at 1.9 $p<0.05$, 95% CI where the higher age group had higher mean fat percent.

As shown in figure 6.3, 34% participants had high TBF%, elevated systolic (54%) and diastolic (59%) BP. Gender base comparison reveals that 33-35% participants had high TBF% and there was a difference of 10% and 15% in the systolic and diastolic BP of boys and girls respectively.

Table 6.10: Pre intervention nutritional status of the participants as per various anthropometric indices (n=169)

Parameter	Cutoffs	Nutritional status	Boys	Girls	Total
BAZ	<-2 SD	Under-nourished	16 (15)	6 (10)	22 (13)
	≥-2 to <2 SD	Normal	85 (79)	54 (89)	138 (82)
	≥ 2	Overweight	7 (7)	1 (2)	9 (6)
WC: Boys	≤ 59.3 cm	Undernourished	24 (22)		**UN**
	59.4 – 68.2 cm	Normal	43 (40)		37 (22)
	≥ 68.3cm	Over-nourished	41 (38)		**Nor**
Girls	≤ 60.1cm	Under-nourished	13 (21)		73 (43)
	60.2 – 69.1 cm	Normal	30 (49)		**ON**
	≥ 69.2 cm	Over-nourished	18 (30)		59 (35)
WHR: Boys	≤ 0.84 cm	Under-nourished	30 (28)		**UN**
	0.85 – 0.94 cm	Normal	74 (69)		39 (23)
	≥ 0.95 cm	Over-nourished	4 (4)		**Nor**
Girls	≤ 0.79 cm	Under-nourished	9 (15)		126 (75)
	0.80 – 1.80 cm	Normal	52 (85)		**ON**
	≥ 1.81 cm	Over-nourished	0		4 (2)
WHtR: Boys	≤ 0.40 cm	Under-nourished	20 (19)		**UN**
	0.41 – 0.44 cm	Normal	32 (30)		22 (13)
	≥ 0.45 cm	Over-nourished	56 (52)		**Nor**
Girls	≤ 0.41 cm	Under-nourished	10 (16)		56 (33)
	0.42 – 0.45 cm	Normal	27 (44)		**ON**
	≥ 0.46 cm	Over-nourished	24 (39)		91 (54)

**Cutoffs and references as documented below table no. 6.8; Values in paranthesis are the percentages. UN=Undernourished, ON=Overnourished and Nor=Normal*

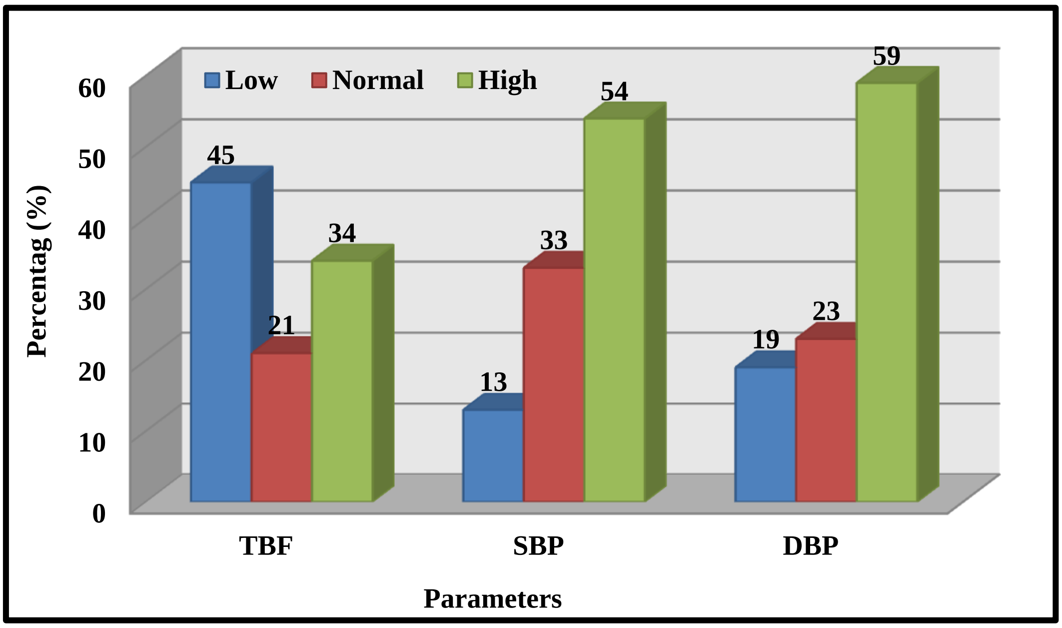
Table 6.11: Pre intervention biophysical parameters compared across gender and age of the participants (n=169)

Sr. No.	Parameters	Range	Total (Mean± SD)	Boys (n=108)	Girls (n=61)	t-Value	9 – 11 yr (n=78)	12 – 14 yr (n=91)	t-Value
1.	TBF (%)	5 - 53.7	19.2±10.2	17.9 ± 11	21.3 ± 7.5	-2.1*	17.5 ± 9.7	20.5 ± 10.5	-1.9*
2.	SBP (mmHg)	64 – 139	112.6±12.5	113 ± 13	111 ± 11	0.5NS	111.32 ± 12	113 ± 12.6	-1.2NS
3.	DBP (mmHg)	42 – 104	73.9±10.4	74 ± 11	73 ± 9	0.8 NS	74 ± 10	73 ± 10	0.16 NS

Parameters and reference	*Cutoffs*	*Boys*	*Girls*
Total Body Fat (TBF) Percent	*Low*	*≤ 14%*	*≤ 19.6%*
	Normal	*≥ 14.1 – ≤ 19.1%*	*≥ 19.7 – ≤ 25.1%*
Mc.Carthy et al., 2006	*High*	*≥ 19.2%*	*≥ 25.2%*
Systolic Blood Pressure (SBP) mmHg	*Low*	*≤ 100.4*	*≤ 101.4*
	Normal	*≥ 100.5 – ≤ 111*	*≥ 101.5 – ≤ 113.2*
Raj et al., 2010	*High*	*≥ 111.1*	*≥ 113.3*
Diastolic Blood Pressure (DBP) mmHg	*Low*	*≤ 65.9*	*≤ 66.4*
	Normal	*≥ 66 – ≤ 71.2*	*≥ 66.5 – ≤ 73.3*
Raj et al., 2010	*High*	*≥ 71.3*	*≥ 73.4*

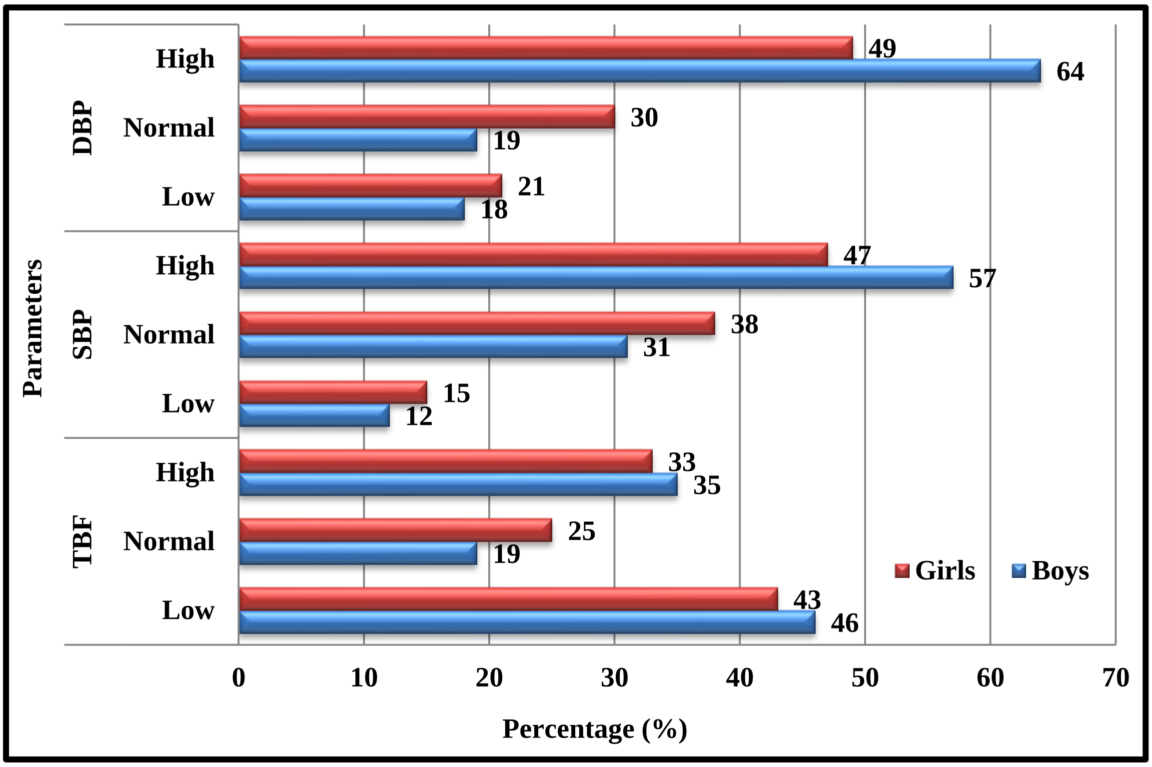
NS = Non-significant difference. p<0.05*, p<0.01 and p<0.001*** at CI=95%.BP values taken 3 times for each individual at different points of time*

Figure 6.3: Pre intervention biophysical parameters of the participants (n=169)



**Reference and cutoff range as mentioned below table no. 6.11*

Figure 6.4: Pre intervention biophysical parameters compared between boys and girls (n=169)



**Reference and cutoff range as mentioned below table no. 6.11*

BIOCHEMICAL PARAMETERS:

The results of biochemical parameters are divided into complete blood count (CBC), lipid profile and blood sugar.

a. **COMPLETE BLOOD COUNT (CBC):** The mean values of hemoglobin (Hb), Red Blood Cells (RBC), Mean Corpuscular Hemoglobin Concentration (MCHC) and White Blood Cells (WBC) adhered to the normal range; while Packed Cell Volume (PCV), Mean Corpuscular Volume (MCV) and Mean Corpuscular Hemoglobin (MCH) were below the expected range.

   Hb (2.2gm%, p<0.05 CI=95%) and MCHC (3.1%, p<0.01 CI=95%) were comparable among boys and girls, while rest of the parameters showed no significant difference (Table 6.12). Contrary to this the PCV (2.6%, p<0.01 CI=95%) and MCV (2.5fl, p<0.01 CI=95%) values were significantly different when compared between the two age groups and were more among the elder age group; which could be attributed to the growth spurt among the adolescents; while rest of the parameters showed no significant difference.

   As shown in figure 6.5, 14% had low RBC (<4.2 mil/cmm), 63% participants on whole had low PCV (<32%). MCV (<78fl) and MCH (<27 pg) were below normal among 47% and 55% participants; while only 8% participants had <32% MCHC values.

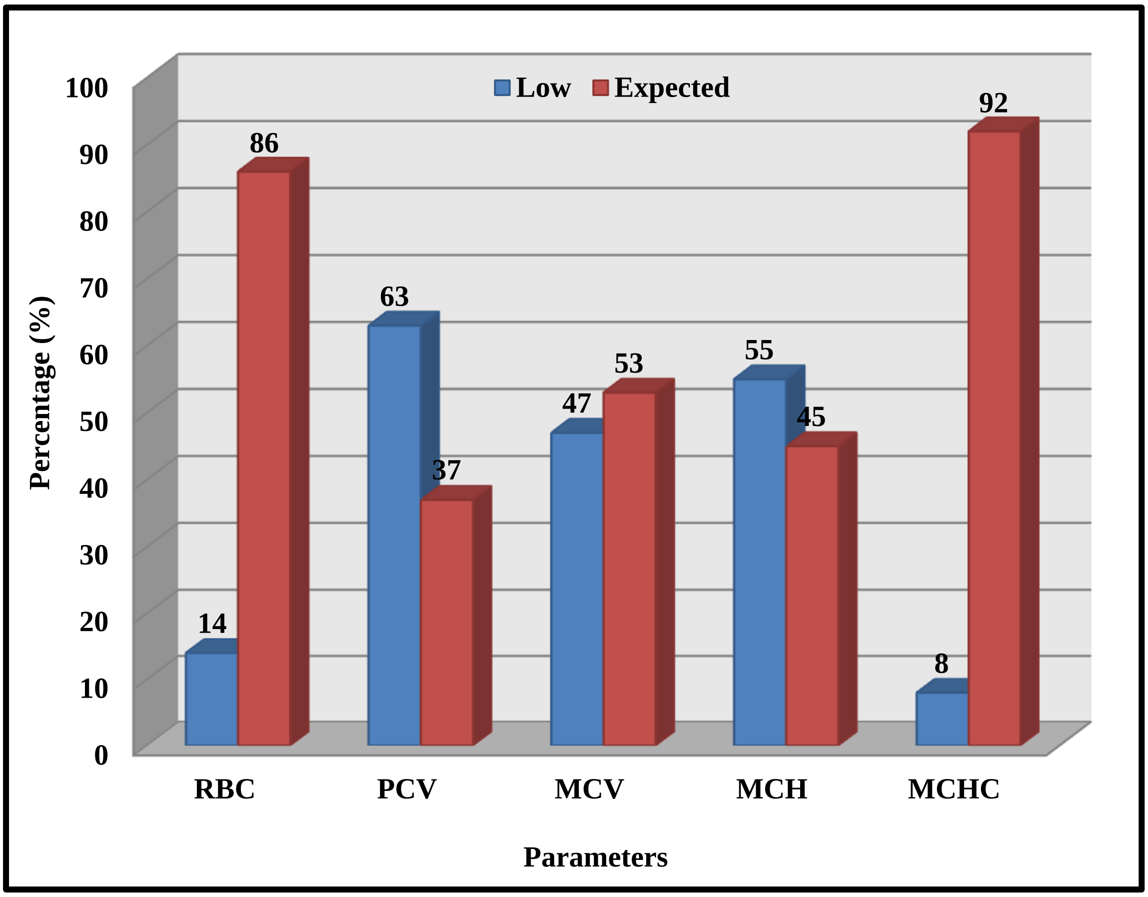
Table 6.12: Pre intervention complete blood count of the participants compared between gender and age (n=169)

Sr. No.	Parameters	Range	Mean± SD	Boys (n=108)	Girls (n=61)	t-Value	9 – 11 yr (n=78)	12 – 14 yr (n=91)	t-Value
1.	Hb (gm %)	6.3 - 14.9	12.5 ± 1	12.6 ± 0.9	12.2 ± 1.2	2.2*	12.4 ± 1.2	12.6 ± 0.9	-1NS
2.	RBC (mil/cmm)	4.08 - 6.34	4.8 ± 0.4	4.94 ± 0.4	4.8 ± 0.4	1.7NS	4.8 ± 0.4	4.8 ± 0.4	-0.07 NS
3.	PCV (%)	24.5 - 45	37.5 ± 2.5	37.7 ± 2.3	37 ± 2.7	-1.8 NS	36.9 ± 2.7	37.9 ± 2.2	-2.6**
4.	MCV (fl)	4.1 - 87.3	77.1 ± 8	76.7 ± 8.5	77.8 ± 6.9	-0.8 NS	75.4 ± 10	78.5 ± 4.6	-2.5**
5.	MCH (pg)	14.1 - 29.9	25.9 ± 2.3	26 ± 1.8	25.7 ± 2.9	0.8 NS	25.6 ± 2.7	26 ± 1.8	-1.3 NS
6.	MCHC (%)	25.4 - 36.5	33.4 ± 1.2	33.6 ± 0.9	33 ± 1	3.1**	33.5 ± 1.5	33.2 ± 1	1.3 NS
7.	WBC (per cmm)	4000 - 14000	7646 ± 1754	7707 ± 1628	7537 ± 1966	0.6 NS	7725 ± 1915	7578 ± 1610	0.5 NS

Parameter	*Range*	*Boys*	*Girls*
Hemoglobin (Hb) (gm%)	*Normal*	*≥ 13.1*	*≥ 11.5*
	Mild Anemic	*≥ 10.1 – ≤ 13*	*≥ 10 - ≤ 11.4*
	Moderate Anemic	*≥ 7.1 - ≤ 10*	*≥ 7.1 - ≤ 9.9*
WHO, 2011	*Severely Anemic*	*≤ 7*	*≤ 7*

NS = Non-significant difference. p<0.05*, p<0.01** and p<0.001 at CI=95%. The cutoff values of rest of the parameters are given below figure no. 6.4.***

Figure 6.5: Pre intervention blood count of the participants (N=169)



Parameter	*Ranges*	*Boys*	*Girls*	*Total*
Red Blood Cells (RBC) (mil/cmm)	*Low*	< 4.6	< 4.2	*NA*
	Expected	≥ 4.6	≥ 4.2	
Packed Cell Volume (PCV) (%)	*Low*	< 42	< 32	*NA*
	Expected	≥ 42	≥ 32	
Mean Cell Volume (MCV) (fl)	*Low*			< 78
	Expected	*NA*	*NA*	≥ 78
Mean Corpuscle Hemoglobin (MCH) (pg)	*Low*			< 27
	Expected	*NA*	*NA*	≥ 27
Mean Corpuscle Hemoglobin Concentration (MCHC) (%)	*Low*			< 32
	Expected	*NA*	*NA*	≥ 32
White Blood Cells (WBC) (per cmm)	*Low*			< 4000
	Expected	*NA*	*NA*	≥ 4000

**The cutoff values of rest of the parameters are as per the reference range used by Toprani Advanced lab systems based on Automatic Hematology Analyzer, Sysmex XT-4000i.http://www.topranilabs.com/contact/contact1.htm*

b. **LIPID PROFILE AND ATHEROGENIC INDICES:** The mean C-reactive protein (CRP) was 0.66 mg/l with a range of 0.2-6.62. Lipid profile data revealed that the mean cholesterol (TC) was 153.6 mg/dl, high density lipoprotein cholesterol (HDL-C) was 50.0 mg/dl, low density lipoprotein cholesterol (LDL-C) was 87.5 mg/dl and triglycerides (TG) 80.5 mg/dl.

The mean values of CRP (0.66 ± 1 mg/l, 1 – 3 mg/l) and TC: HDL ratio (3.1 ± 0.7, near to 3.5), were "at moderate risk" levels, while the mean values of remaining lipid parameters were within the normal range. Though mean values did not reveal unhealthy alterations, a broad range of difference was noted in the range of the lipid profile of participants. Remarkably wide range of difference gives a possibility of outliers falling in the risk category (Table 6.13).

Of all the cardiovascular biomarkers tested; TC and LDL-C showed a significant difference of 2.2 mg/dl and 2.1 mg/dl respectively at $p<0.005$, CI = 95% between boys and girls and the values were higher among boys. The mean values of CRP were within the normal range but were towards the level of moderate risk (1 – 3 mg/l) both among boys and girls (Table 6.13) The individual lipid parameters did not reveal any sign of threat, but the TC: HDL ratio was found at moderate risk (≥ 2.5) among the children.

The age based comparison showed a significant difference of 2.6 mg/dl ($p<0.01$, CI=95%) and -2 ($p<0.05$, CI=95%) in HDL-C and TC: HDL ratio (Table 6.13). Also among the higher age group children, the mean values, especially the CRP (0.96 ± 1.5) and HDL (48.9 ± 11) values were towards the risk category.

As shown in figure 6.6, CRP, TC, HDL, TG, TC: HDL and TG:HDL ratio reveals 5%, 1%, 12%, 3%, 27% and 5.3% respectively participants in the risk category; which indicates the trend of disrupting lipid profile among the children, attributed to unhealthy dietary habits and sedentary lifestyle along with parental history of cardio vascular disease.

C. **BLOOD GLUCOSE:** The mean values of all blood glucose parameters were found to be in the normal range. HOMA IR values were in the range of 0.4 to 12.3.

Fasting blood glucose (FPG) levels showed comparable difference of 2.3 at $p<0.05$, CI =95% between boys and girls (Table 6.14). All parameters of blood glucose values, except HOMA IR were significantly different between the two age groups and rest of the parameters increased with age (Table 6.14). However as shown in figure 3.6, 24% students were insulin resistant as calculated by HOMA IR (<3 – normal insulin resistance (IR), 3-5 - moderate IR and >5 - sever IR).

Table 6.13: Pre intervention lipid profile of the participants compared across gender and age (n=169)

Sr. No.	Parameters	Range	Total (Mean ± SD)	Boys (n=108)	Girls (n=61)	t-Value	9 – 11 yr (n=78)	12 – 14 yr (n=91)	t-Value
1.	CRP(mg/l)	0.2 - 6.62	0.66 ± 1	0.7 ± 1.1	0.5 ± 0.8	1.2NS	0.9 ± 0.89	0.96 ± 1.5	-0.8 NS
2.	TC (mg/dl)	84 – 253	153.6 ± 24	156.7 ± 26	148 ± 19	2.2*	155 ± 22	152 ± 26	0.7 NS
3.	HDL C (mg/dl)	28 – 87	50.9 ± 10.7	51.9 ± 11	49.1 ± 9	1.6 NS	53.2 ± 9.7	48.9 ± 11	2.6**
4.	LDL C (mg/dl)	35 – 171	87.5 ± 21	90.1 ± 22	82.9 ± 16	2.1*	86.9 ± 19	88 ± 22	-0.3 NS
5.	TC: HDL (ratio)	1.9 - 5.8	3.1 ± 0.7	3.1 ± 0.7	3.1 ± 0.7	0.57 NS	3 ± 0.6	3.2 ± 0.8	-2*
6.	TG (mg/dl)	25 – 290	80.5 ± 39	76.8 ± 38	87 ± 39	-1.6 NS	77.5 ± 39	83.2 ± 39	-0.9 NS
7.	TG:HDL (ratio)	0.46 - 7.84	1.7 ± 7.3	1.72 ± 1.1	1.71 ± 0.9	0.67 NS	1.73 ± 1.1	1.7 ± 1	0.14 NS

Parameters	*Range*	*Cutoffs*	*Parameters*	*Range*	*Cutoffs*
HsC-Reactive Protein (CRP)(mg/l)	*Normal*	*< 1*	*Low Density Lipoprotein (LDL-C) (mg/dl)*	*Normal*	*< 100*
	Moderate risk	*1 - 3*		*Moderate risk*	*100 - 159*
	High risk	*> 3*		*High risk*	*≥ 160*
Serum Cholesterol (TC)(mg/dl)	*Normal*	*< 200*	*Triglyceride (TG) (mg/dl)*	*Normal*	*< 150*
	Moderate risk	*200 – 239*		*Moderate risk*	*150 – 199*
	High risk	*> 240*		*High risk*	*≥ 200*
High Density Lipoprotein (HDL-C) (mg/dl)	*Normal*	*≥ 40 - ≤ 60*	*Cholesterol/HDL (TC: HDL) (ratio)*	*Normal*	*< 3.5*
	At risk	*< 40*		*At risk*	*≥ 3.5*
			TG/HDL (ratio)	*Normal*	*< 3.8*
				At risk	*≥ 3.8*

NS = Non-significant difference. p<0.05*, p<0.01** and p<0.001 at CI=95%. Hs-CRP –(AHA):www.webmd.com/heart-disease/guide/heart-disease-c-reactive-protein-crp-testing, Lipid profile - ATP III guidelines may 2001 modified by NCEP. TC: HDL-R: TG:HDL-R: Urbina et al., 2013.***

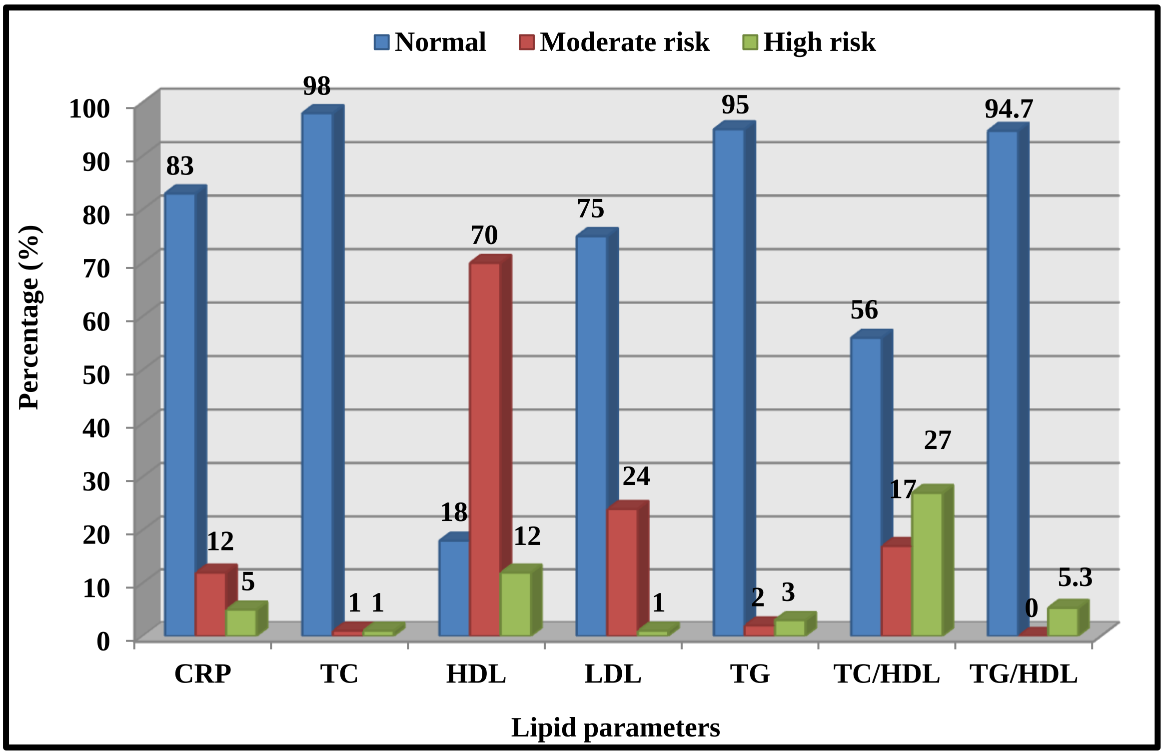
Table 6.14: Pre intervention blood glucose parameters of the participants compared across gender and age (n=169)

Sr. No.	Parameters	Range	Total (Mean± SD)	Boys (n=108)	Girls (n=61)	t-Value	9 – 11 yr (n=78)	12 – 14 yr (n=91)	t-Value
1.	FSI (µ/ml)	1.75 - 47.6	10.6 ± 6.9	10.3 ± 7.3	11.1 ± 6	-0.7NS	9.3 ± 7.5	11.7 ± 6	-2.2*
2.	FPG (mg/dl)	66 – 105	91.4 ± 5.9	92 ± 5.7	90.7 ± 6	2.3*	89.9 ± 5.7	92.9 ± 5.8	-3.4**
3.	HOMA IR	0.4 - 12.3	2.4 ± 11.9	2.5 ± 1.8	2.2 ± 1.3	0.7 NS	2.2 ± 1.1	2.6 ± 2	-1.4NS

Parameters	*Range*	*Cutoffs*
Fasting Serum Insulin (FSI) (µ/ml) ADA, 2010.	*Normal*	*6 – 27*
	At risk	*> 27*
Fasting Plasma Glucose (FPG) (mg/dl) ADA, 2010.	*Normal*	*≤ 110*
	At risk	*≥ 111*
HOMA IR Mathews et al., 1985	*Normal*	*< 3*
	Moderate risk	*3 – 5*

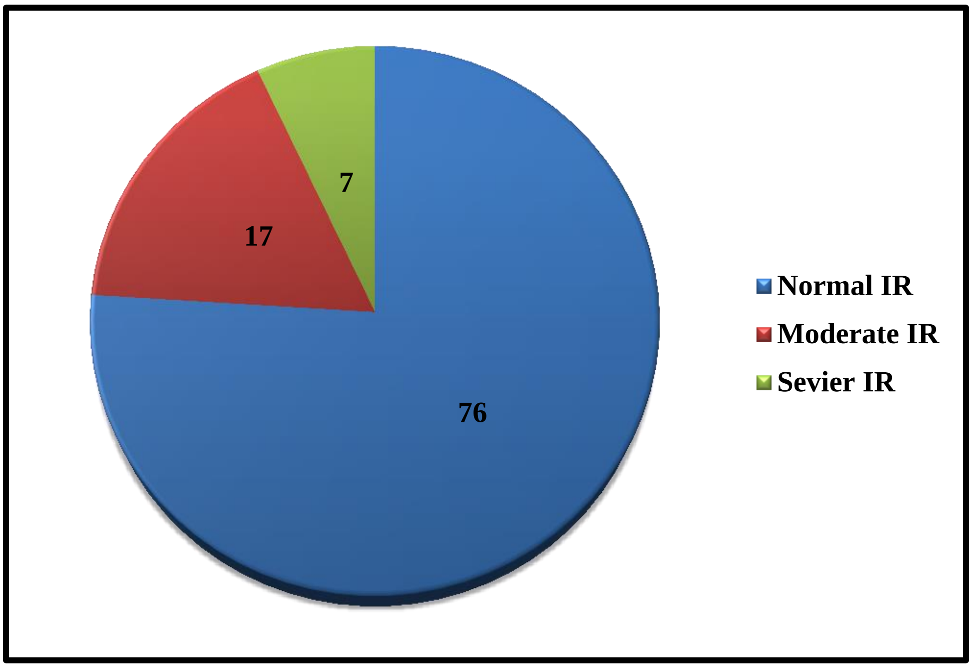
NS = Non-significant difference. p<0.05*, p<0.01** and p<0.001 at CI=95%.***

Figure 6.6: Pre intervention lipid profile of the participants (n=169)



**References and cutoffs are mentioned below table no. 6.12*

Figure 6.7: Percent distribution of students as per HOMA IR (n=169)



**References and cutoffs are mentioned below table no. 6.13*

RELATIONSHIP BETWEEN THE VARIOUS PARAMETERS OF NUTRITIONAL STATUS AMONG THE PARTICIPANTS:

The results of the comparison of various parameters revealed that a positive correlation was observed among WC, WHtR, TBF, CRP, LDL-C and TG: HDL ratio values. Table 6.15 reveals highly significant relation between the normal nutritional status (as per the BAZ values) of individuals who are categorized "at risk" as per the WC (n=51, X^2 = 51.4), WHtR (n=69, X^2 = 48.6), TF (n=50, X^2 = 42.9) and CRP (n=6, X^2 = 18.6) at $p<0.001$, CI=95% for the former 3 parameters.

As per the LDL-C 34 individuals who were normally nourished as per the BAZ, had borderline high values; while 7 children classified as normal were at risk as per the TG: HDL ratio. Thus cardiovascular aberrations initiate at a younger strange and even at normal BAZ values. BAZ alone may miss out on biochemical changes and wrongly interpret the "at risk" as normal.

Rest of the parameters such as WHR, SBP, DBP, CBC parameters, TC, HDL-C, TG, TC: HDL ratio and blood glucose parameters did not show any significant relation with the nutritional status of the students.

Table 6.15: Pre intervention association between the nutritional status and other parameters (n=169)

Parameters		Nutritional status (BAZ)			X^2– Value
		<-2 SD	≥-2 to <2 SD	≥ 2	
WC (cm)	≤ 59.3	16	21	0	51.4***
	59.4 – 69.1	6	66	1	
	≥ 69.2	0	51	8	
WHtR	≤ 0.40	14	16	0	48.6***
	0.41 – 0.45	6	53	0	
	≥ 0.46	2	69	9	
TBF (%)	≤ 14	22	53	1	42.9***
	≥ 14.1 – ≤ 19.1	0	35	0	
	≥ 19.2	0	50	8	
CRP (mg/l)	< 1	21	116	4	18.6**
	2 – 3	1	16	3	
	> 3	0	6	2	
LDL-C (mg/dl)	< 100	20	105	2	14.7***
	100 - 159	2	32	6	
	≥ 160	0	2	0	
TG:HDL	< 3.8	22	132	6	7.4**
	≥ 3.8	0	7	2	

NS = Non-significant difference. p<0.05*, p<0.01** and p<0.001 at CI=95%. The values mentioned are frequencies.***

Among all the anthropometric parameters assessed during the study, the WC and WHtR showed significant association with specific biophysical and biochemical parameters (Table 6.16 and 6.17). WC was significantly associated at $p<0.001$, 95% CI with WHtR, TBF, PCV, HDL-C, LDL-C, TG, TC: HDL ratio and FSI but SBP showed association at $p<0.01$, 95% CI. The remaining parameters especially BAZ, Hb, TC and HOMA IR showed no association with WC.

The mean values of SBP (113 mmHg ± 9) of participants with normal WC was towards the higher range, while mean values of TBF (16.3% ± 6.7) and TC: HDL ratio (3.58 ± 0.7) was moderately high among children with normal WC. Though WC shows considerable association with various parameters, yet SBP, TBF and TC and HDL ratio stand out to be good predictor of accumulating risk factors even at normal WC.

WHtR was significantly associated with WC, TBF, TC, LDL-C, TC: HDL ratio and FSI at $p<0.001$, 95% CI. While CRP and TG were related at significance level of $p<0.01$ and HDL-C level had minimum association at $p<0.05$, 95% CI. As compared to WC, WHtR have shown relation with more physiological parameters, thus making it a more sensitive measure. None of the hematological indices have shown any association with WHtR.

Table 6.18 evaluates nutritional classification of the participants as per TBF against selected parameters. CRP and TC values were associated with TBF at $p<0.01$, while other demonstrated parameters were associated at $p<0.001$, 95% CI. Surprisingly, the CRP values among participants having TBF (2.9 mg/l ± 0.6) were higher than those having normal TBF.

Table 6.16: Pre intervention association of waist circumference with other parameters (n=169)

Parameters	Nutritional status as per WC categories			F-value
	Under-nourished (n=37)	Normal (n=73)	Over-nourished (n=59)	
WHtR	0.4 ± 0.02	0.4 ± 0.02	0.5 ± 0.04	117.9***
TBF (%)	9.7 ± 4.6	16.3 ± 6.7	28.5 ± 8.9	86.2***
SBP (mmHg)	107 ± 13	113 ± 9	114 ± 14	3.9**
PCV (%)	36.8 ± 2.9	37 ± 2	38.4 ± 2	7***
HDL-C (mg/dl)	56.5 ± 12	52.4 ± 9.4	45.6 ± 8.7	14.9***
LDL-C (mg/dl)	79.9 ± 16	84.5 ± 21	95.9 ± 21	8.4***
TC : HDL ratio	2.75 ± 0.6	2.95 ± 0.6	3.58 ± 0.7	21.1***
TG(mg/dl)	69.5 ± 33	73.9 ± 28.8	95.7 ± 48	7.4***
FSI (/ml)	7.3 ± 5.1	9.5 ± 5	13.9 ± 8.5	13.3***

NS = Non-significant difference. p<0.05*, p<0.01** and p<0.001 at CI=95%**

Table 6.17: Pre intervention association of waist to height ratio with other parameters (n=169)

Parameters	Nutritional status as per WHtR categories			F-value
	Under-nourished (n=30)	Normal (n=59)	Over-nourished (n=80)	
WC (cm)	55.7 ± 4	62.6 ± 4	72.5 ± 8	91.8***
TBF (%)	9.5 ± 5.4	15 ± 7	49 ± 10	57.8***
CRP (mg/l)	0.4 ± 0.9	0.4 ± 0.6	0.9 ± 1.2	5.2**
TC (mg/dl)	149.8 ± 21	144.6 ± 21	161.6 ± 25	9.2***
HDL-C (mg/dl)	54.9 ± 12	51.8 ± 10	48.8 ± 10	3.9*
LDL-C (mg/dl)	82.3 ± 16	78.8 ± 17	95.8 ± 22	13.9***
TC : HDL ratio	2.85 ± 0.6	2.8 ± 0.6	3.4 ± 0.7	13***
TG(mg/dl)	67.3 ± 28	74 ± 32	89.8 ± 44	4.7**
FSI (μ/ml)	7.5 ± 5.4	9.25 ± 4.4	12.8 ± 8	8.8***

Note: NS = Non-significant difference. p<0.05*, p<0.01** and p<0.001 at CI=95%**

Table 6.18: Association of total body fat with other parameters (n=169)

Parameters	Nutritional status as per TBF categories			F-value
	Low fat (n=76)	Normal (n=35)	Excess (n=58)	
WC (cm)	59.7 ± 5	65.6 ± 4	74.7 ± 7	95.6***
WHtR (ratio)	0.41 ± 0.02	0.45 ± 0.02	0.49 ± 0.04	85.3***
SBP (mmHg)	110 ± 11	110 ± 12	117 ± 13	7.2***
DBP (mmHg)	71 ± 11	73 ± 8.6	76 ± 9.6	9.5***
CRP (mg/l)	0.52 ± 1	0.44 ± 0.3	0.97 ± 1.2	4.1**
TC (mg/dl)	148 ± 21	152.8 ± 28	161 ± 24	5**
LDL-C (mg/dl)	80.8 ± 17	85.8 ± 23	97 ± 20	11.2***
TC : HDL ratio	2.8 ± 0.5	2.9 ± 0.6	3.6 ± 0.8	22.8***
TG (mg/dl)	68.7 ± 30	74.6 ± 26	99.7 ± 48	12.2***
FSI (μ/ml)	8.4 ± 5.2	9.4 ± 5	14.2 ± 8.3	14***

Note: NS = Non-significant difference. p<0.05*, p<0.01** and p<0.001 at CI=95%***

IMPACT OF THE INTERVENTION

The ASC comprised of 90 days of schedule of MVPA for 45 minutes daily before regular classroom teaching. These activities acted as a warm-up beginning of the day for the children and exhibited much more than just health benefits. The results of the nutritional status post 90 days of activity are presented in this section.

ANTHROPOMETRIC MEASUREMENTS COMPARED AMONG BOYS AND GIRLS:

The results reveal a significant increase in the anthropometric parameters among the boys and girls. Height, weight, waist and hip circumference increased significantly; which is expected and can be attributed to the normal process of growth in the adolescents (Table 6.19). The nutritional status of the children reveals nominal improvement as computed by BAZ, based on the WHO, 2010 cut offs. Children having under-nourished nutritional status prior the intervention shifted to a normal nutritional status, but none of the students turned overweight or obese.

The mean values of WC showed a significant increase of 2.1 cm ($p<0.05$, 95% CI) among girls. With the increase in WC, 2% boys and 7.4% girls shifted to "over nourished" category as per the cutoff Kurian et al. (2011) of WC (Figure 6.8 and 6.9). Proportionately the WHR (Table 6.19) also showed significant difference across the gender; where it increased by 7.6 at $p<0.001$, 95% CI among boys and reduced among girls by 2.4 ($p<0.01$ 95% CI). The mean values of WHtR showed a positive drift only among the children of elder age group (2.6, $p<0.01$ 95% CI).However, huge shift can be observed in the frequency graphs (Figure 6.10) of both boys and girls.

The short stature of Indians in combination with increasing WC makes WHtR more sensitive and one of the early indicators of over-nutrition. 52% boys and

47% girls showed to be over-nourished as per WHtR as compared to WHR (1.9% boys "0" girls, Figure 6.8 and 6.9).

ANTHROPOMETRIC MEASUREMENTS COMPARED ACROSS THE TWO AGE GROUPS:

With increasing age, the height, weight, waist and hip circumference showed a significantly proportionate increase in both the age groups. Nutritional status as per the mean values of BMI for age was within the normal range (Table 6.19). The WC did not show any alteration in the younger age group, but it increased by 4.6 cm ($p<0.001$, 95% CI) among the children of elder age group. However, the HC showed a significant increase in both the age groups at $p<0.001$, 95% CI. The mean values of WHR increased by 1.9 and 2.2 among children of younger and elder group respectively at $p<0.05$, 95% CI; whereas the WHtR increased only among children of elder group and it remained unaltered among the younger age group of children.

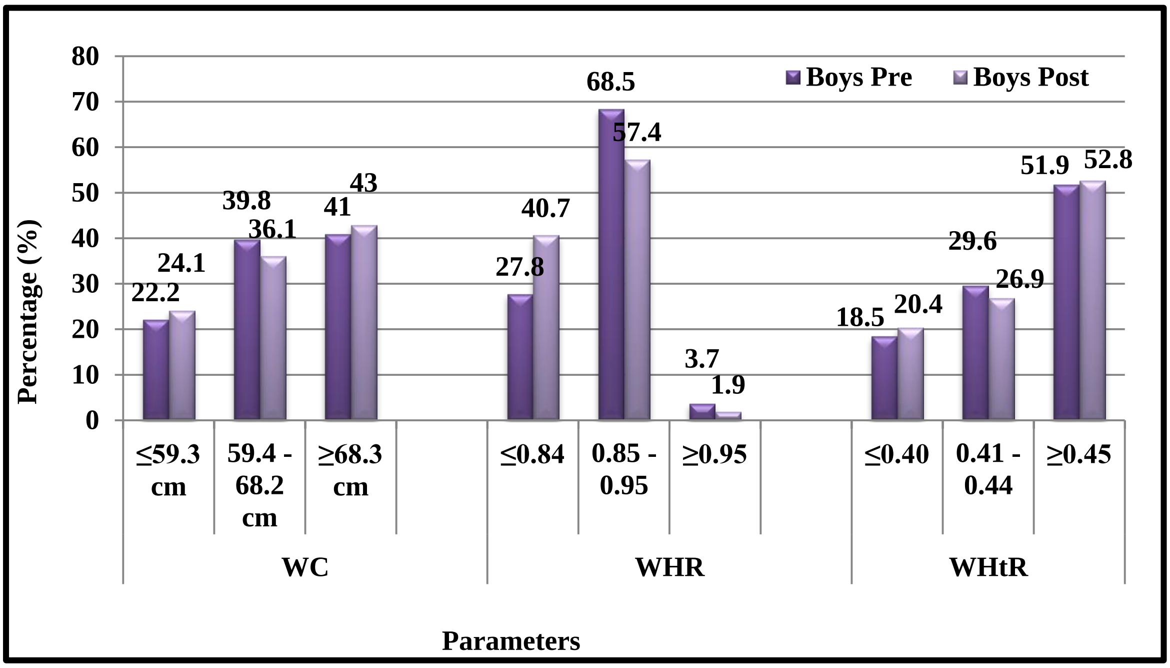
As shown in figure 6.10 and 6.11, WC, WHR and WHtR, both have increased more among the 12-14 year old children as compared to the 9-11 year old. This change may be attributed to the dynamic physical, biological and physiological changes among this age group; but such a large shift in "over-nourished" or "at risk" category is also due to the increasing exposure and monetary independence among this group of children.

Table 6.19: Post intervention impact on anthropometric parameters among the participants (n=169)

Parameters	**Boys (n=108)**		**Girls (n=61)**		**9–11 yr (n=68)**		**12-14 yr (n=101)**		**Total**	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
Height (cm)	146 ± 9	148 ± 9	146 ± 9	147 ± 9	140.7 ± 8	142 ± 9	149.8 ± 7	151.7 ± 7	146 ± 9	147.9 ± 9
t-Value	-7.8***		-7.2***		-4.9***		-9***		-9.9***	
Weight (kg)	38 ± 11	40 ± 10	38 ± 10	39 ± 10	33.9 ± 8	35.1 ± 9	42 ± 10	42.9 ± 10	38.7 ± 10	39.8 ± 10
t-Value	-3.4***		-0.9 NS		-2.9**		-2*		-3.2***	
BAZ	-0.25 ± 1	-0.23 ± 1	-0.34 ± 1	-0.48 ± 1	-0.38 ± 1	-0.32 ± 1	-0.22 ± 1	-0.33 ± 1	-0.28 ± 1	-0.32 ± 1
t-Value	-2.3 NS		0.9 NS		-0.5NS		1.1 NS		0.5 NS	
WC (cm)	66.1 ± 9	67.8 ± 10	66.1 ± 8	67.6 ± 10	62.6 ± 8	63.6 ± 9	68.4 ± 8	70.6 ± 9	66.1 ± 10	67.7 ± 9
t-Value	-0.8 NS		-2.1*		-1.6 NS		-4.6***		-4.5***	
HC (cm)	75.7 ± 9	78.9 ± 9	76.7 ± 8	80.6 ± 9	72 ± 8	75 ± 8	78.7 ± 8	82.3 ± 8	76 ± 9	79.4 ± 9
t-Value	-4.2***		-8.4***		-4.9***		-11.6***		-11***	
WHR	0.87 ± 0.08	0.85 ± 0.04	0.86 ± 0.05	0.83 ± 0.06	0.87 ± 0.1	0.84 ± 0.05	0.86 ± 0.04	0.85 ± 0.05	0.87 ± 0.07	0.85 ± 0.05
t-Value	-7.6***		2.4**		1.9*		2.2*		2.8**	
WHtR	0.45 ± 0.05	0.45 ± 0.05	0.45 ± 0.04	0.45 ± 0.06	0.4 ± 0.04	0.4 ± 0.05	0.45 ± 0.05	0.46 ± 0.05	0.45 ± 0.05	0.45 ± 0.05
t-Value	-1.8 NS		-1.4 NS		-0.4 NS		-2.6**		-2.3*	

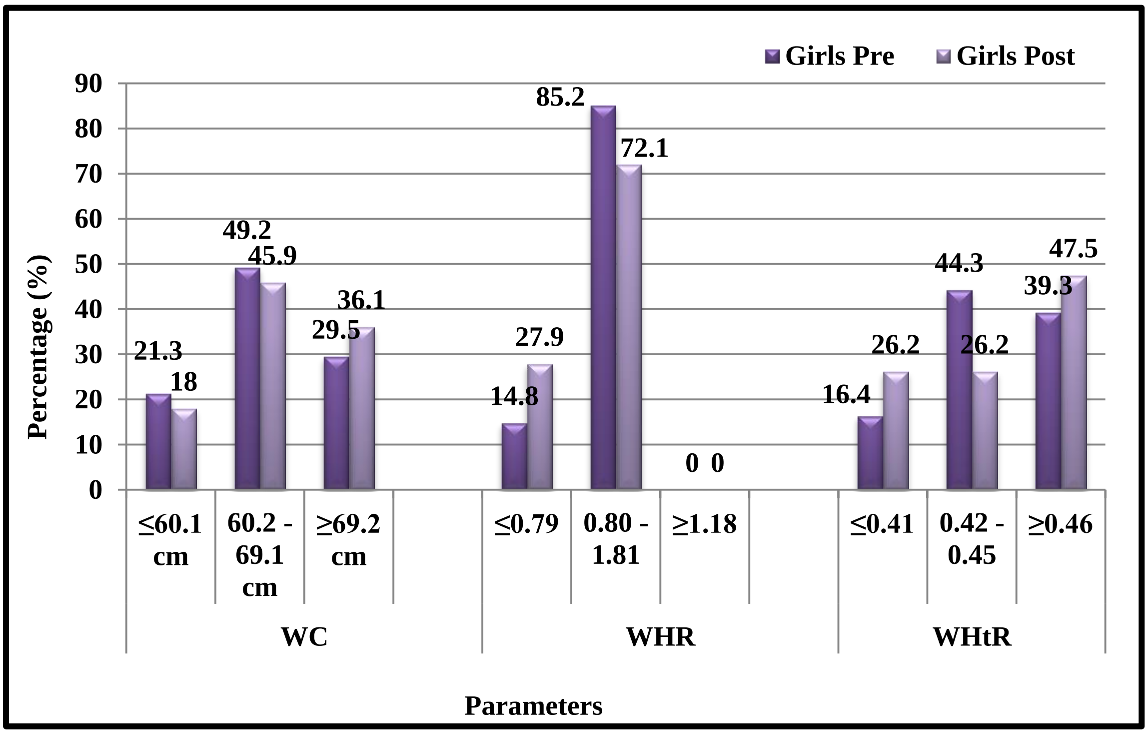
NS = Non-significant difference. p<0.05*, p<0.01** and p<0.001 at CI=95%. Cutoff and references given below table no.6.8***

Figure 6.8: Pre-post shift in the anthropometric parameters of the male participants (n=108)



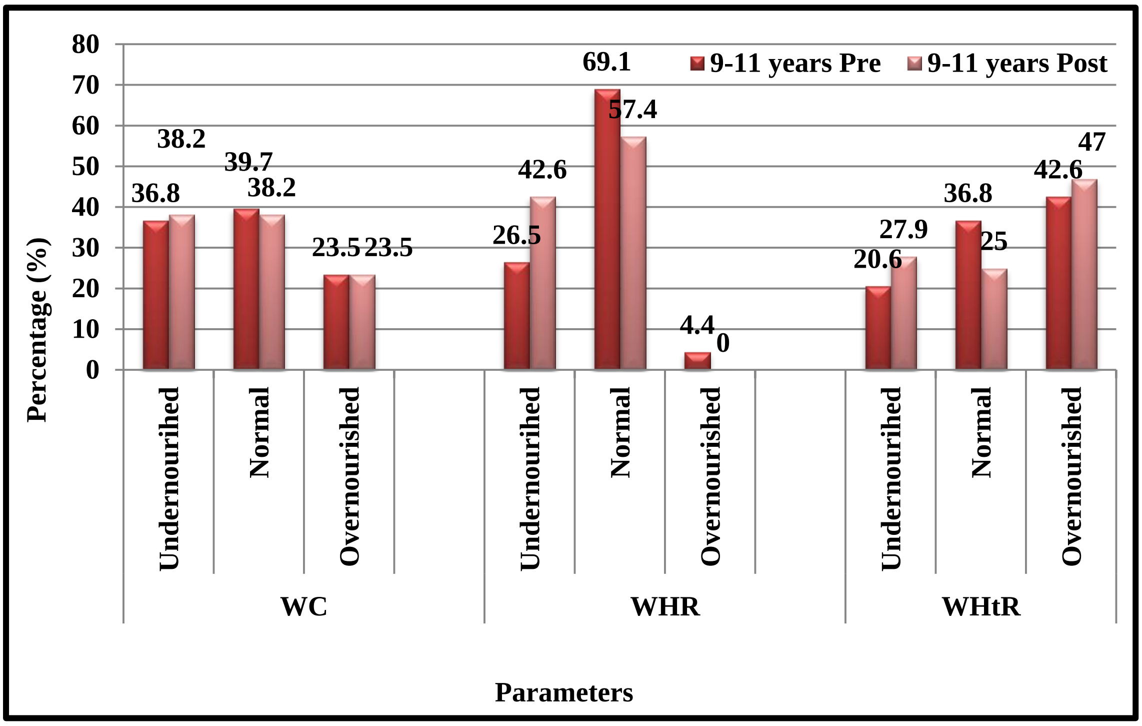
**Cutoff and references given below table no.6.8*

Figure 6.9: Pre-post shift in the anthropometric parameters of the female participants (n=61)



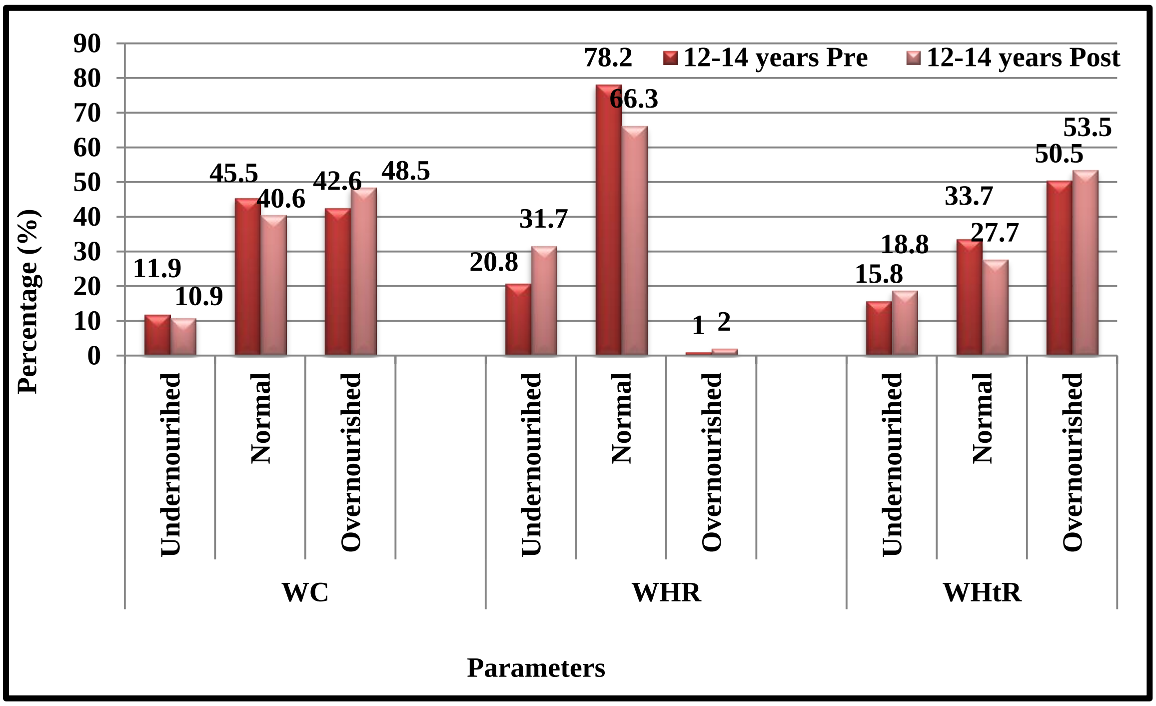
**Cutoff and references given below table no.6.8*

Figure 6.10: Pre-post shift in the anthropometric parameters among the participants of younger age group (n=68)



**Cutoff and references given below table no.6.8*

Figure 6.11: Pre-post shift in the anthropometric parameters among the participants of older age group (n=101)



**Cutoff and references given below table no.6.8*

BIOPHYSICAL PARAMETERS COMPARED AMONG BOYS AND GIRLS:

The mean values of TBF among boys and girls were in the normal range as per the cut offs stated by McCarthy et al (2006), and increased after the intervention. Though there was a significant positive shift in TBF among girls (2.7 at $p<0.01$, 95%CI); yet the mean values were in the normal range (Table 6.20) post intervention. More than 35% boys and nearly 32% girls had higher TBF percent which increased by 1.5% among boys and 7.5% among girls after the intervention.

The mean values of BP among the participants were near to the risk category as per the cut offs given by Raj et al (2010). DBP was uniformly high across the participants irrespective of gender and age groups. As much as 60 - 65% boys (systolic ≥ 111.1 mmHg and diastolic ≥ 71.3 mmHg) and 47 – 50% girls (systolic ≥ 113.1 mmHg and diastolic ≥ 73.4 mmHg) had high BP which reduced by 17 – 20% post physical activity intervention (Figure 6.12), showing its positive impact. The SBP values showed significant reduction among boys by 2.2 mmHg, $p<0.05$ 95% CI and among girls by 2.4 mmHg, $p<0.01$ 95% CI. Of the two, DBP reduced uniformly among boys and girls at $p<0.001$, 95% CI.

BIOPHYSICAL PARAMETERS COMPARED ACROSS THE TWO AGE GROUPS:

The mean values of TBF were found in the normal range and showed significant increase among the participants of the younger age group by 2.7 mmHg at $p<0.001$, 95% CI after the intervention (Table 6.20); attributed to the normal growth process. As shown in figure 6.14 and 6.15, 23% participants of younger age group and 41% participants of the elder age group had high percentage of TBF which increased by 7% among 9-11 year old children, while remained almost similar among 12-14 year old children.

Contradicting to the TBF, alarmingly high values of both systolic and diastolic BP were found among the participants of both the age group. After the intervention, these values reduced dramatically by 40% among the children of younger age group and by 15% among the children of elder age group.

Though there was an increase in TBF% among the participants, the intervention helped to maintain it in the normal range. Results have also shown a reduction in the elevated values of both systolic and diastolic BP among children and have been consistent across gender and both the age groups.

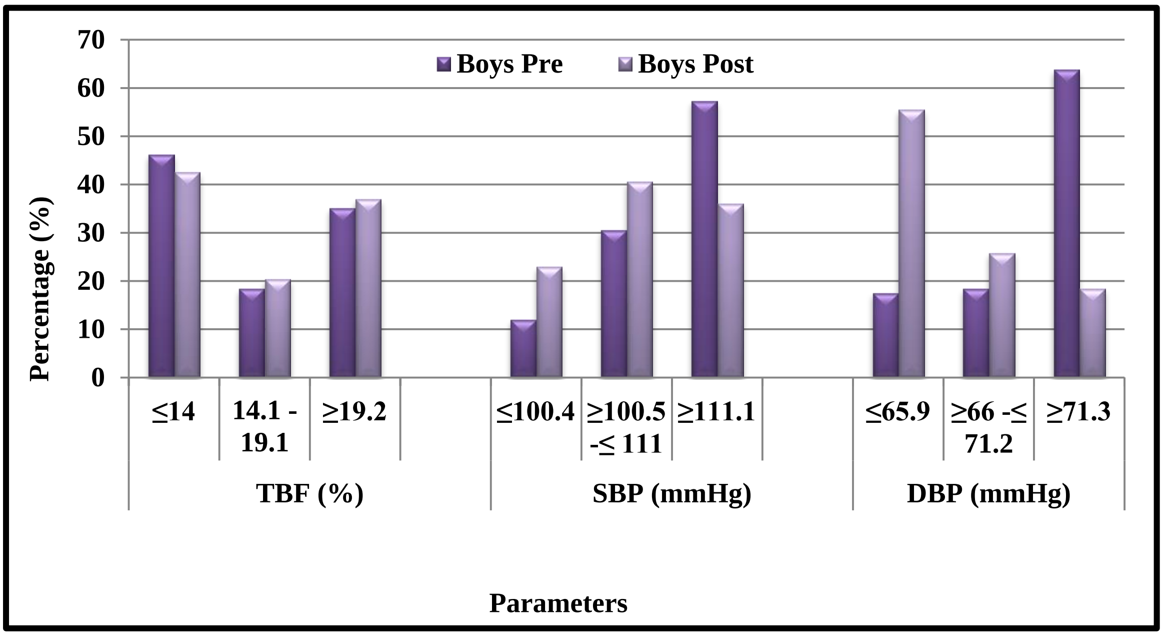
Daily physical activity of moderate intensity coupled with pranayam would act as a protective strategy against nutrition transition and stress induced aberrations. Such a blend would control and preventing unhealthy fat deposition and maintain the BP.

Table 6.20: Post intervention impact on biophysical parameters of the participants (n=169)

Parameters	Boys (n=108)		Girls (n=61)		9–11 yr (n=68)		12-14 yr (n=101)		Total	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
TBF (%)	17.9 ± 11	18 ± 10	21.3±7	23.4±8	17.1 ± 9	18.8 ± 10	20.5 ± 10	20.7 ± 10	19.1 ± 10	19.9 ± 10
t-Value	-0.2 NS		-2.7**		-2.7**		-0.4 NS		-2.15*	
SBP (mmHg)	113 ± 13	109 ± 12	111±11	107± 12	110 ± 12	103 ± 12	114 ± 12	112 ± 11	112 ± 12	108 ± 12
t-Value	2.2*		2.4**		3.5***		1.3 NS		3.2***	
DBP (mmHg)	74.4 ± 11	65.2 ± 11	73±9	65±9	73 ± 10	64 ± 12	74 ± 10	65 ± 9	73 ± 10	65 ± 10
t-Value	6.8***		5.1***		4.9***		7***		8.6***	

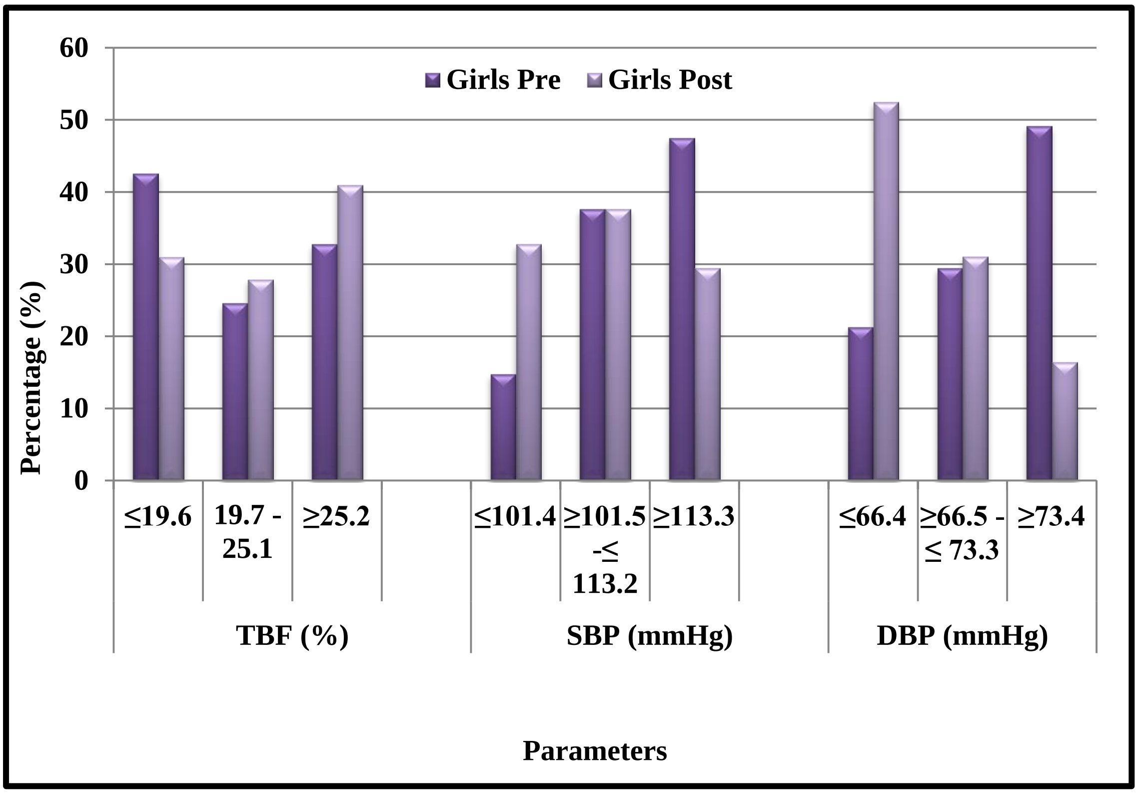
NS = Non-significant difference. p<0.05*, p<0.01** and p<0.001 at CI=95%. Cutoff values and references given below table no.6.4***

Figure 6.12: Pre-post shift in the biophysical parameters among the male participants (n=108)



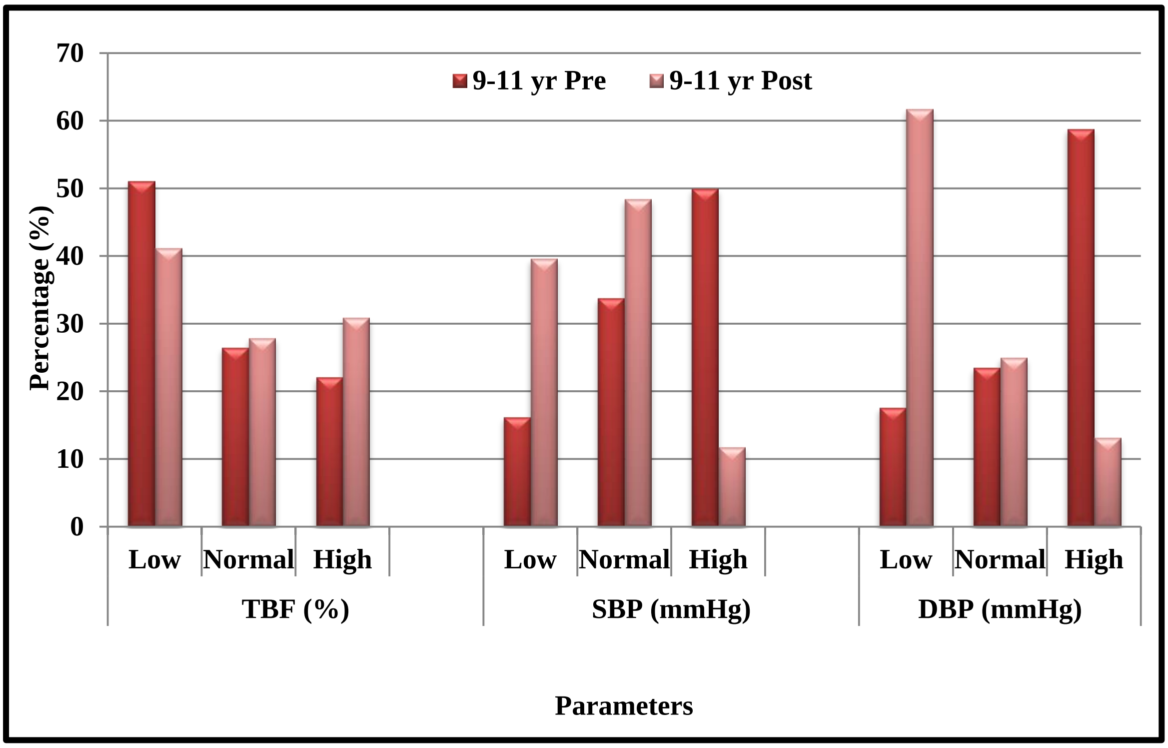
**Cutoff values and references given below table no.6.10*

Figure 6.13: Pre-post shift in the biophysical parameters among the female participants (n=61)



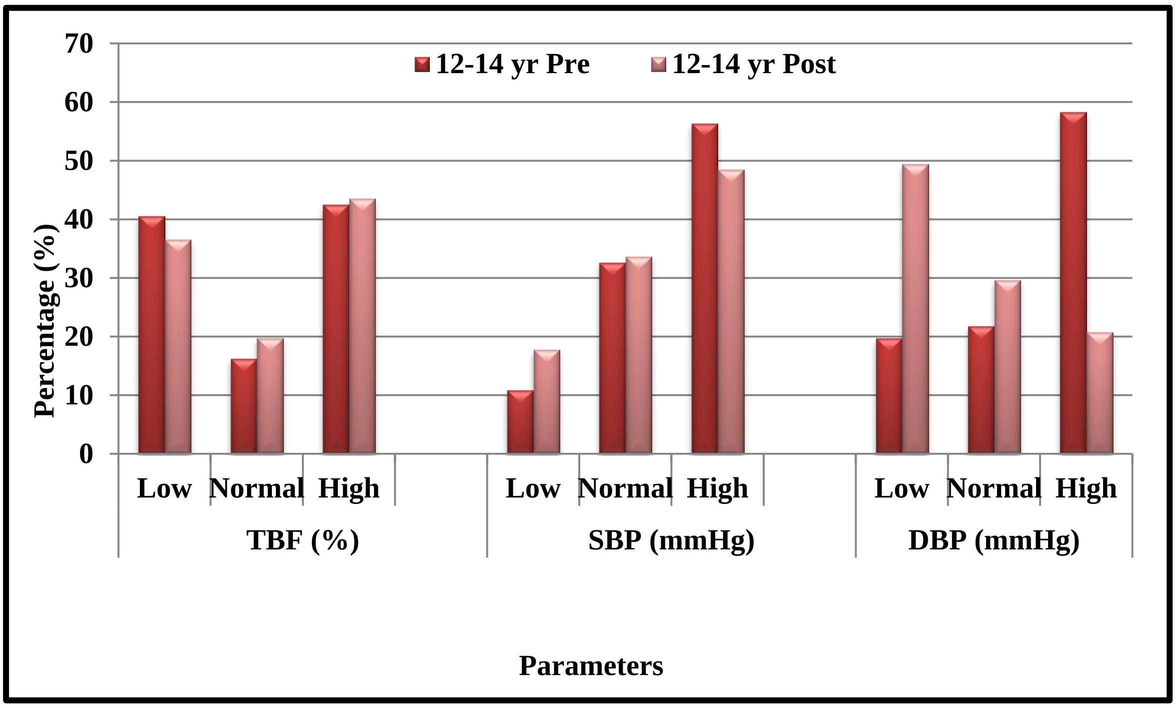
**Cutoff values and references given below table no.6.10*

Figure 6.14: Pre-post shift in the biophysical parameters among participants of the younger age group (n=68)



**Cutoff values and references given below table no.6.10*

Figure 6.15: Pre-post shift in the biophysical parameters among participants of the older age group (n=101)



**Cutoff values and references given below table no.6.10*

COMPLETE BLOOD COUNT COMPARED AMONG BOYS AND GIRLS:

The mean Hb and RBC values were within normal range before the intervention. The Hb values improved among the boys at 2.9gm% ($p<0.01$, 95% CI), while RBC showed a minor change after the intervention. As shown in table 6.21, PCV (<42%) were below the normal range for boys and MCV (<78fl) values were low for both boys and girls before the intervention.

There was a significant improvement in the PCV at $p<0.001$, but the mean values did not shift to the normal range; while MCV increased to the normal range. The MCH values, that were marginally low (24 – 26 pg) prior intervention, increased significantly among boys by 7.8pg at $p<0.001$, 95% CI. Post intervention MCHC values reduced significantly at $p<0.001$, 95% CI and WBC count which was normal prior intervention, remained unchanged among both boys and girls.

COMPLETE BLOOD COUNT ACROSS THE TWO AGE GROUPS:

Similar to the gender, the mean hemoglobin values were in the normal range and shifted positively among participants of 12-14 year after the intervention at significance level of $p<0.001$ (Table 6.21). In the age based category PCV and MCV values exhibited a significant change among both the age groups after the intervention; where PCV increased at $p<0.001$ and MCV increased marginally.

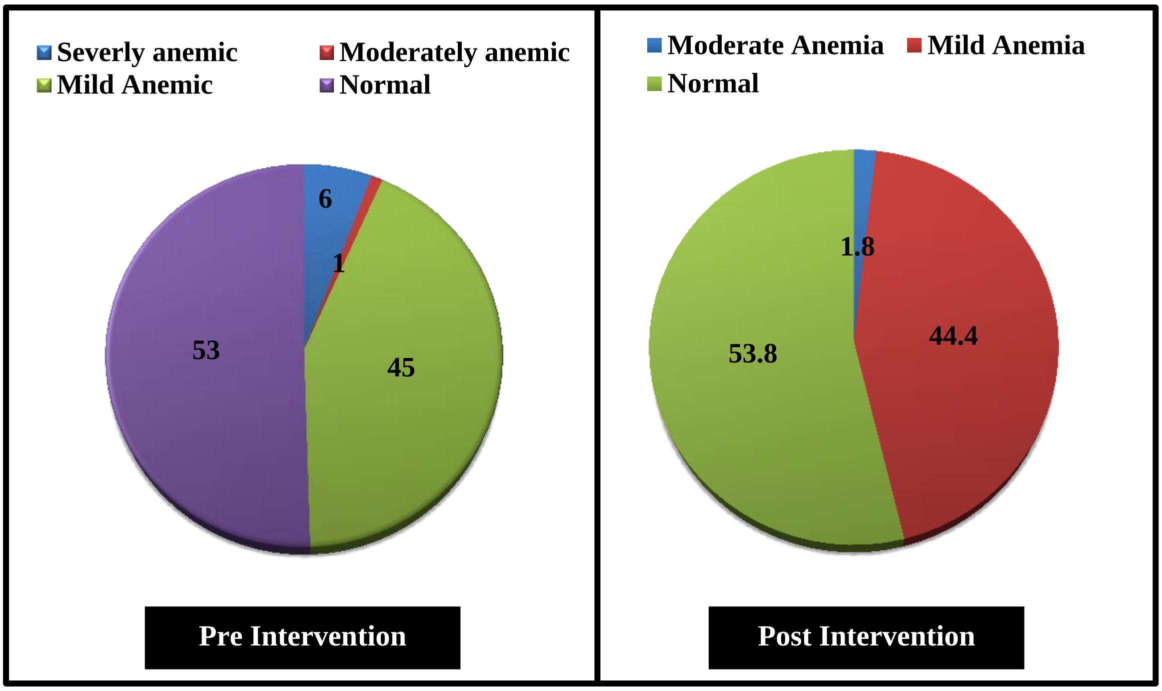
Figure 6.16, shows an improvement by 3.8% in the Hb Levels before (50%) and after (46.2%) the intervention. Prevalence of severe anemia reduced to "0" from 6%. Improvement was also observed in the PCV values (Figure 6.17) among boys by 14% and among participants of 12-14 years by 5%. The changes observed in MCH, MCHC and WBC were similar as those in boys and girls (Figure 6.18 and 6.19). MCV and MCHC showed more sensitive and rapid shifts towards the healthier end among all the participants.

Table 6.21: Post intervention impact on blood parameters among the participants (n=169)

Parameters	Boys (n=108)		Girls (n=61)		9–11 yr (n=68)		12-14 yr (n=101)		Total	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Hb (gm%)	12.6 ± 0.8	12.8 ± 0.8	12.2±1	12.3±1	12.4 ± 1	12.5 ± 1	12.5 ± 0.8	12.7 ± 0.9	12.5 ± 1	12.6 ± 1
t-Value	-2.9**		-1.5 NS		-1 NS		-3.7***		-3**	
RBC(mil/cmm)	4.8 ± 0.3	4.8 ± 0.3	4.7±0.3	4.7 ± 0.3	4.8 ± 0.4	4.8 ± 0.4	4.8 ± 0.3	4.8 ± 0.3	4.8 ± 0.3	4.8 ± 0.3
t-Value	1NS		1.9*		2.2*		0.7 NS		2*	
PCV(%)	37.7 ± 2	39 ± 2	36.9±2	38.2±2	36.9 ± 2	38.2 ± 2	37.8 ± 2	39 ± 2	37.4 ± 2	38.7 ± 2
t-Value	-9.3***		-4.6***		-5***		-8.8***		-9.6***	
MCV(fl)	76.7 ± 8	80 ± 5	77.8±6	81.4±6	75.2 ± 11	79.8 ± 6	78 ± 4.7	81 ± 4.9	77 ± 8	80.7 ± 5.7
t-Value	-5.4***		-13***		-4.3***		-27.9***		-8.3***	
MCH(pg)	26±1.8	28.3± 1.9	25.7±2.9	26.1±4.3	25.6 ± 2.7	26 ± 4.1	26 ± 1.8	26.5 ± 1.9	25.9 ± 2	26.3 ± 3
t-Value	-7.8***		-1 NS		-0.9 NS		-8.7***		-2.5**	
MCHC(%)	33.5± 0.9	32.8±0.9	32.9±1.6	32.4±1.4	33.5 ± 1.5	32.8 ± 1.2	33 ± 0.9	32.6 ± 1	33.3 ± 1	32.6 ± 1
t-Value	12.3***		4.8***		6.4***		11.3***		11.8***	
WBC(per cmm)	7707±1628	7551±1746	7537±1966	7493±2162	7719 ± 1842	7566 ± 2076	7597 ± 1699	7506 ± 1783	7646 ± 1754	7530 ± 1901
t-Value	0.9NS		0.1 NS		0.6 NS		0.5 NS		0.8 NS	

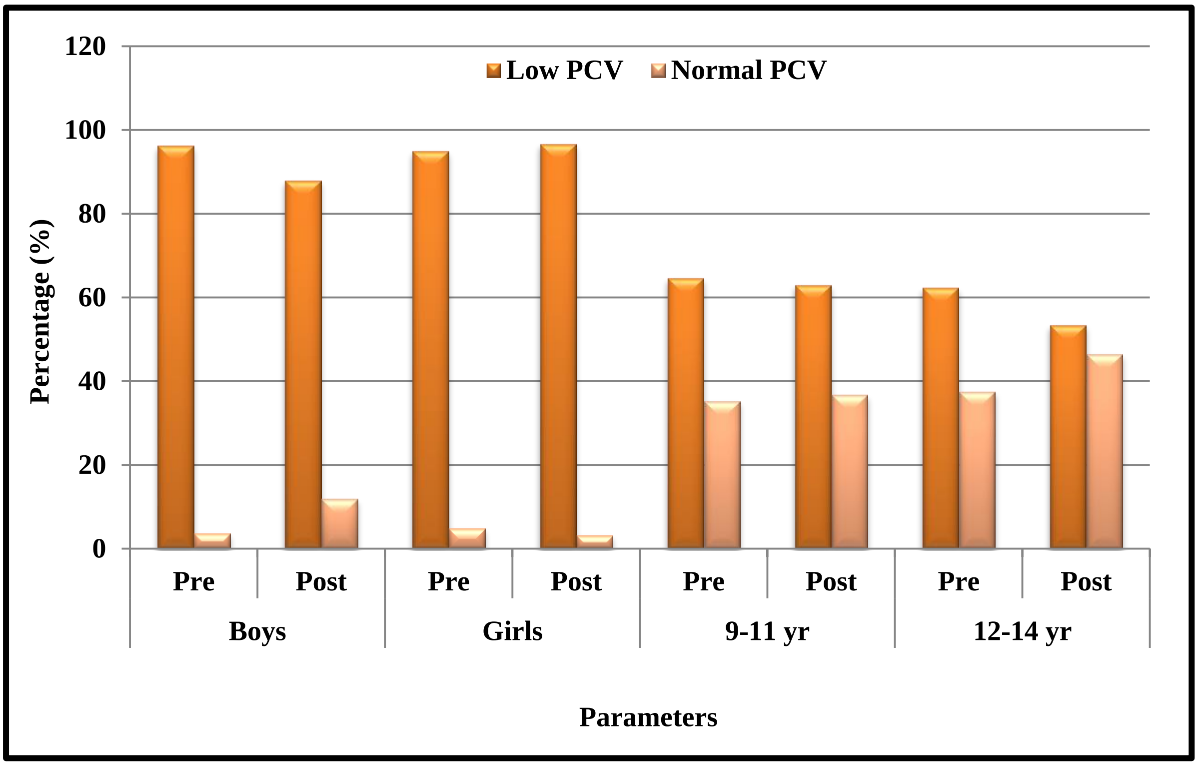
NS = Non-significant difference. p<0.05*, p<0.01** and p<0.001 at CI=95%. Cutoffs and reference given below table no.3.5 and figure no. 6.4.***

Figure 6.16: Pre-post prevalence of Anemia among the participants (N=169)



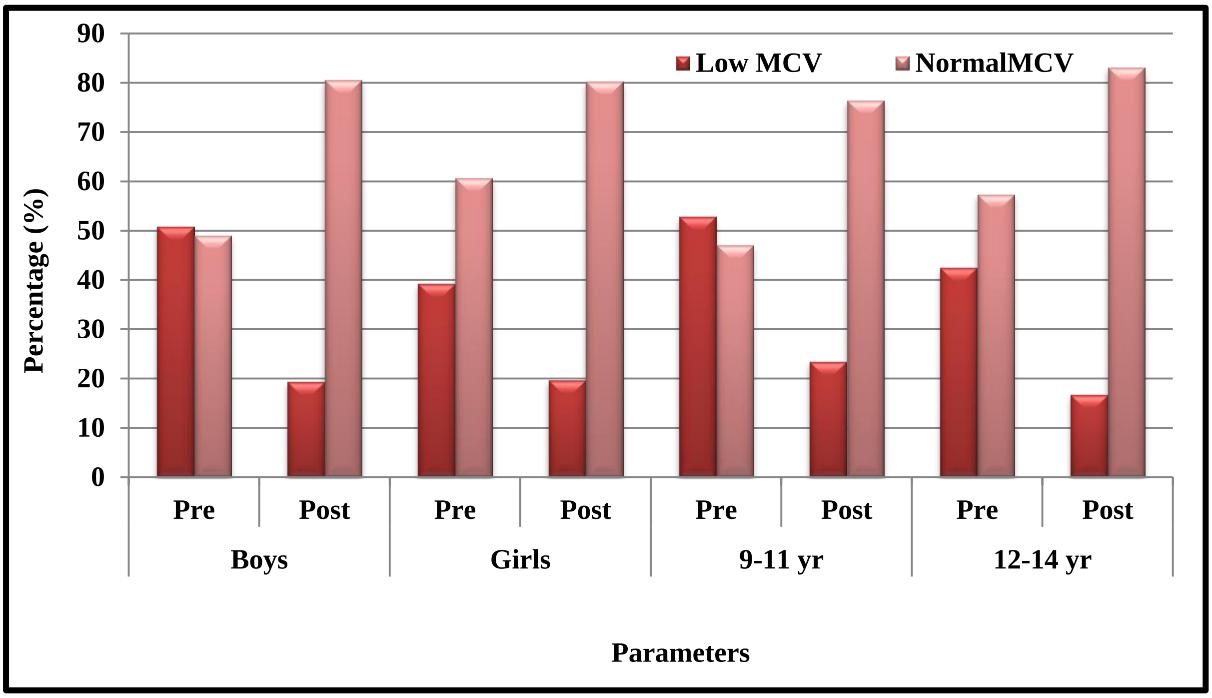
**Cutoffs and reference given below table 6.11*

Figure 6.17: Pre-post shift in the PCV values across the age and gender (n=169)



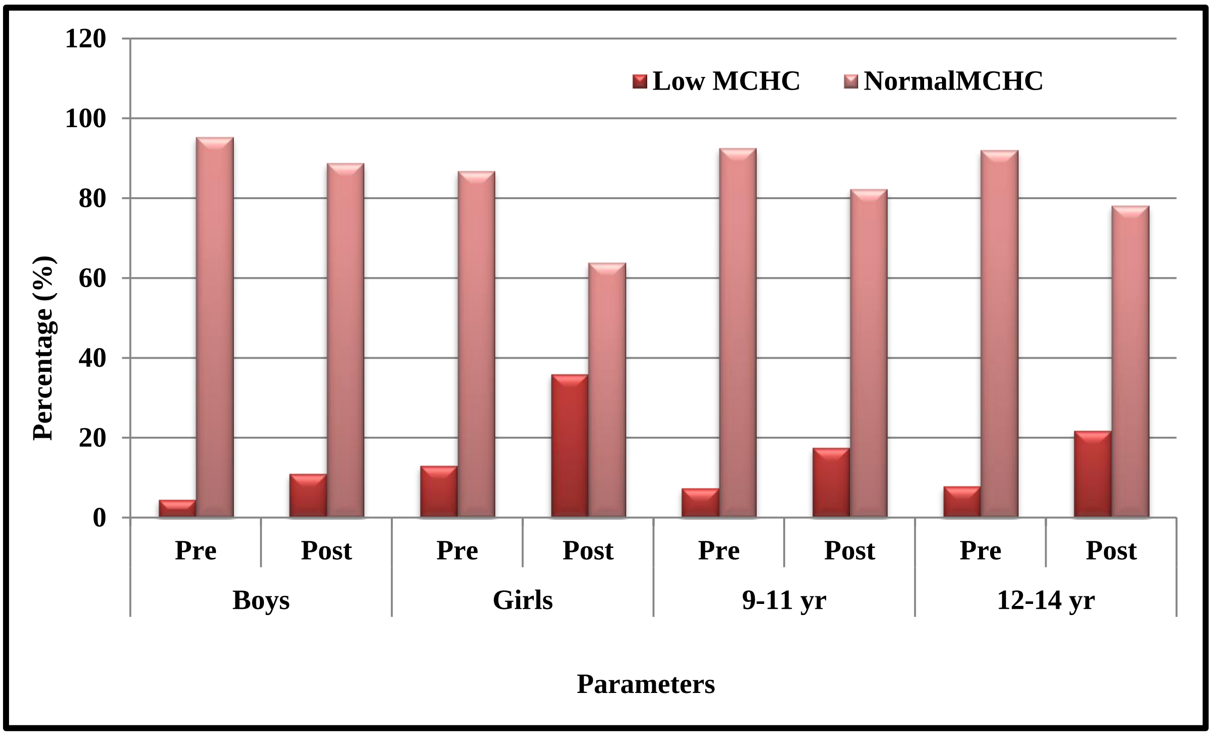
**Cutoffs and reference given below figure 6.5*

Figure 6.18: Pre-post shift in the MCV values across the age and gender (n=169)



**Cutoffs and reference given below figure 6.5*

Figure 6.19: Pre-post shift in the MCHC values across the age and gender (n=169)



**Cutoffs and reference given below figure 6.5*

LIPID PROFILE COMPARED AMONG BOYS AND GIRLS:

Mean CRP values before intervention were in the normal range, but nearer to the "moderate risk" category among boys 0.73 ± 1 mg/l (1-3 mg/l, AHA). These values increased among boys (0.97 mg/l) and reduced among the girls by 0.03 mg/l after the intervention, though the change was not significant.

The mean TC values of boys (156 ± 26 mg/dl) and girls (148 ± 19 mg/dl) that were in the normal range as per the ATP III guidelines, prior intervention reduced significantly by 6.6 mg/dl in boys and 4 mg/dl in girls at $p<0.001$, 95% CI. Thus daily physical activity of moderate intensity among the participants has shown a profound effect on the TC values.

The HDL-C values were in the normal range (40 – 60 mg/dl) for both boys and girls and did not change significantly after the intervention. Mean values of LDL-C that were in the normal range (up to 130 mg/dl), slightly increased among girls by 2.1 mg/dl at $p<0.05$, 95% CI. The TC: HDL ratio values were within the normal range prior intervention among both boys and girls (3.1 ± 0.7).

These values varied among the participants post intervention, with significant reduction of 5 ($p<0.001$, 95% CI) in boys and an increase of 3.2 ($p<0.01$, 95% CI) in girls. With this shift, the girls entered the "at risk" category (≥ 3.5) after the intervention (Table 6.16). This may be attributed to the increased percent of body fat among girls, however further studies to understand this shit needs to be done.

The mean values of both TG and TG: HDL ratio values were within the normal range but towards the border. The TG values reduced significantly among boys by 3.7 mg/dl ($p<0.001$, 95% CI) and by 2.94 mg/dl ($p<0.01$, 95% CI) among girls. Similarly the TG: HDL ratio reduced among boys by 2.9 and among girls by 2.5 at $p<0.001$ and $p<0.01$ respectively after the intervention.

The overall lipid profile did not vary significantly between boys and girls (Figure 6.20 and 6.21).

LIPID PROFILE COMPARED ACROSS THE TWO AGE GROUPS:

The mean CRP values of children of older age group were towards the moderate risk category (0.7 ± 1.1 mg/l) and after the intervention the CRP values showed a non-significant increase in both the age groups (Table 6.22). On the contrary, the mean TC values which were in the normal range, showed a significant reduction in both younger and elder age group with a difference of 6 mg/l and 5 mg/l at $p<0.001$, 95% CI respectively. The HDL-C and LDL-C values showed no significant change in the pre-post values in either of the age groups.

Though the HDL-C values did not change due to the intervention, the dramatic reduction in post intervention TC values affected the TC: HDL ratio. TC: HDL ratio significantly decreased in the younger age group and increased in the older age group by 3.3 ($p<0.001$, 95% CI) and -1.8 ($p<0.01$, 95% CI) respectively.

Such a variation can be explained by the dynamics of developing biology and associated body composition. As shown in table 6.22, the triglyceride values reduced significantly in both the age groups, more so among the elder age group by 3.7 mg/dl at $p<0.001$ and so did the TG:HDL values by 3.9, $p<0.001$ 95% CI.

The prevalence of “at risk” individuals as categorized by TC (5%), LDL-C (23%), TC: HDL ratio (33%) and TG (10%) were higher among the elder age group (Figure 6.22 and 6.23). Whereas among the younger age group, 23% participants were categorized to be at risk as per the LDL-C and showed no change post intervention. There was a significant difference between the TG: HDL-C ratio pre-post intervention.

BLOOD GLUCOSE PARAMETERS BETWEEN GENDER AND AGE GROUP:

The mean values of blood glucose parameters were in the normal range (Table 6.23) among the participants across age and gender. The parameters did not reveal any significant variations post intervention. Except the FSI values, rest of the parameters increased among the younger age group by 2μ/ml at $p<0.05$, 95% CI after the intervention.

Table 6.22: Post intervention impact on lipid profile of the participants (n=169)

Parameters	Boys (n=108)		Girls (n=61)		9–11 yr (n=68)		12-14 yr (n=101)		Total	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
CRP(mg/l)	0.73 ± 1	0.97 ± 1	0.52±0.7	0.49±0.8	0.5 ± 0.8	0.7 ± 0.9	0.7 ± 1.1	0.8 ± 1.3	0.6 ± 1	0.8 ± 1
t-Value	-1.9 NS		0.25 NS		-1.4 NS		-0.8 NS		-1.5 NS	
TC(mg/dl)	156 ± 26	147 ± 24	148±19	141±22	154.8 ± 23	145 ± 22	152.7 ± 25	145.9 ± 24	153 ± 24.7	145 ± 23.9
t-Value	6.6***		4***		6***		5***		7.77***	
HDL-C(mg/dl)	51.9±11	51.6±11	49 ±9	49±10	53.5 ± 9	53.2 ± 10	49 ± 10	49 ± 10	50.9 ± 10	50.8 ± 10
t-Value	0.58 NS		-0.2NS		0.2 NS		0.2 NS		0.3 NS	
LDL-C(mg/dl)	90±22	91±21	82.9±16	85.5±20	86.3 ± 19	87.2 ± 20	88 ± 22	90 ± 21	87.5 ± 21	89 ± 21
t-Value	-0.9 NS		-2.1*		-0.7 NS		-1.9 NS		-1.96*	
TC: HDL	3.1±0.7	2.9±0.7	3.1±0.7	6.3±26	2.9 ± 0.6	2.8 ± 0.6	3.2 ± 0.8	5 ± 20	3.1 ± 0.7	4.1 ± 15
t-Value	5***		-3.2**		3.38***		-1.8**		-0.88 NS	
TG(mg/dl)	76.8±38	67.2±32	87.2±39	76.7±34	75.8 ± 35	66.3 ± 32	83.8 ± 41	73.6 ± 33	80.5 ± 39	70.6 ± 33
t-Value	3.7***		2.94**		2.9**		3.7***		4.76***	
TG:HDL	1.7±1	1.5±0.9	1.7 ±0.9	1.3 ±0.8	1.7 ± 1	1.5 ± 1	1.6 ± 1	1.4 ± 0.8	1.7 ± 1	1.5 ± 0.9
t-Value	2.9***		2.58**		1.7 NS		3.9***		3.94***	

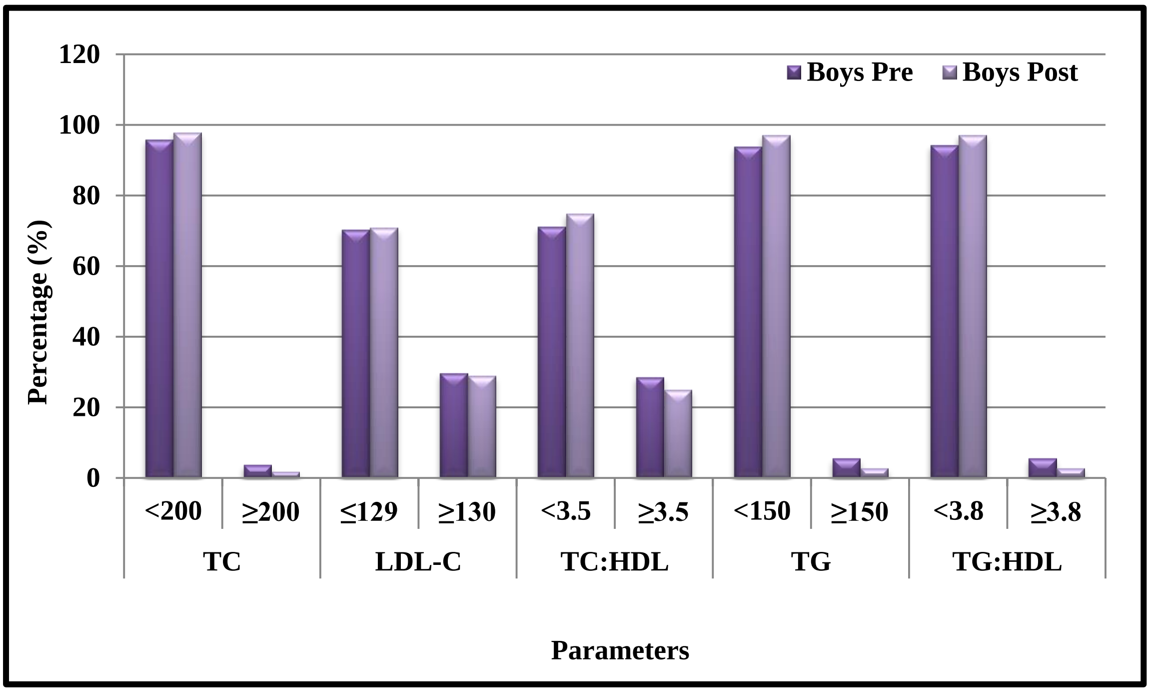
NS = Non-significant difference. p<0.05*, p<0.01** and p<0.001 at CI=95%. Cutoffs and references given below table no.6.6***

Table 6.23: Post intervention impact on blood glucose parameters of the participants (n=169)

Parameters	Boys (n=108)		Girls (n=61)		9–11 yr (n=68)		12-14 yr (n=101)		Total	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
FSI(μ/ml)	10.3 ± 7	9.6 ± 6	11.1 ± 6.2	12.5 ± 7.2	8.6 ± 5.4	10.3 ± 7.5	11.9 ± 7.5	10.8 ± 6	10.6 ± 6	10.6 ± 6
t-Value	0.96 NS		-1.68 NS		-2*		1.4 NS		-0.12 NS	
FPG(mg/dl)	92 ± 5	92 ± 5	90 ± 6	91 ± 6	89.8 ± 5	90 ± 6	92.6 ± 5	93 ± 5	91.4 ± 5	91.9 ± 5
t-Value	-0.19 NS		-1.85 NS		-6.8 NS		-1 NS		-1.22 NS	
HOMA IR	2.5 ± 1.8	2.4 ± 1.8	2.2 ± 1.3	2.3 ± 1	2.2 ± 1.1	2.3 ± 1.6	2.5 ± 1.9	2.4 ± 1.5	2.4 ± 1.6	2.4 ± 1.5
t-Value	0.15 NS		-0.44 NS		-0.74 NS		0.5 NS		-0.37 NS	

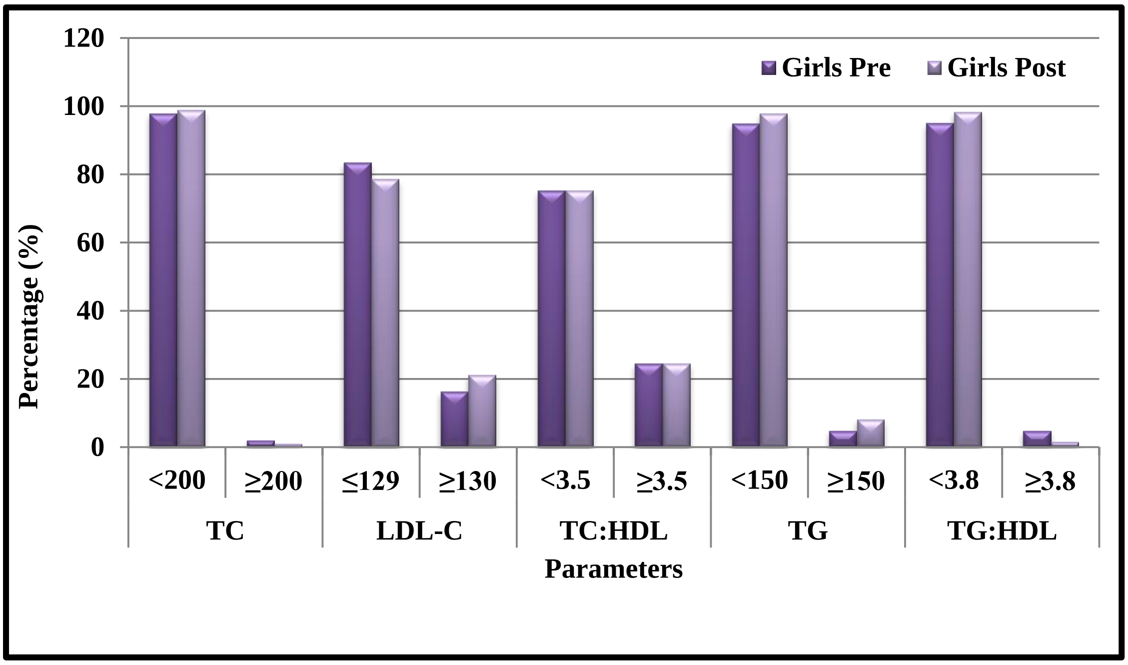
***** NS = Non-significant difference. p<0.05*, p<0.01** and p<0.001*** at CI=95%. Cutoffs and references given below table no.6.7*

Figure 6.20: Pre-post shift in selected parameters of lipid profile among the male participants (n=108)



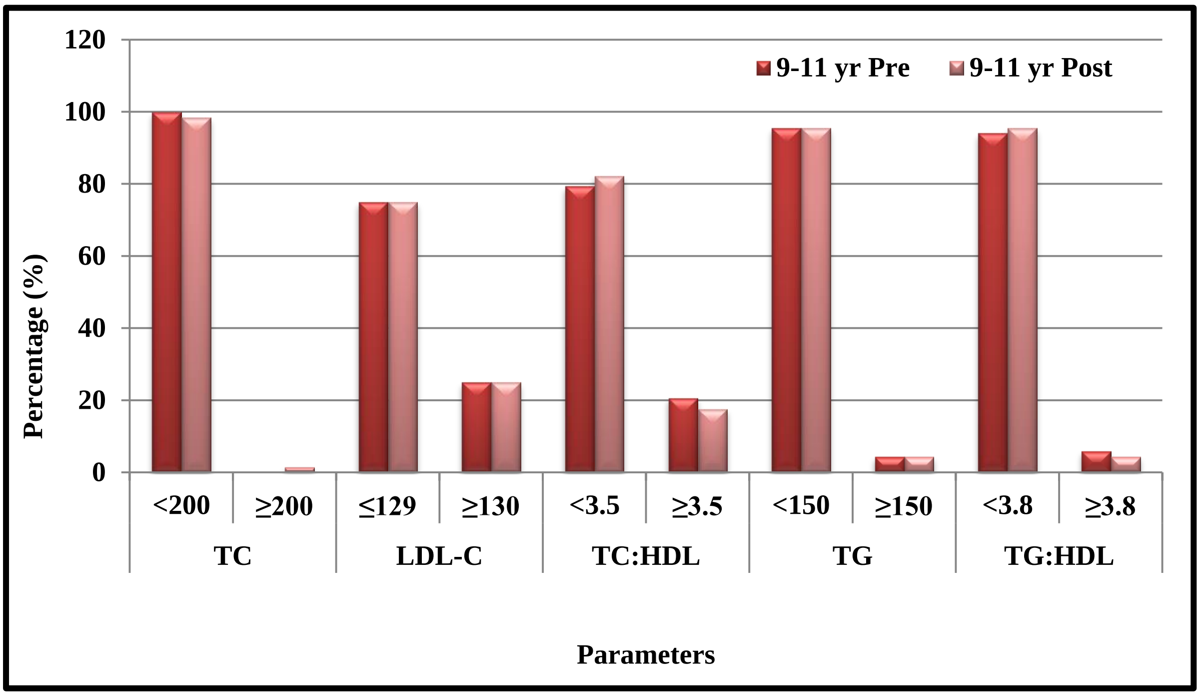
**Cutoffs and references given below table no. 6.12*

Figure 6.21: Pre-post shift in selected parameters of lipid profile among the female participants (n=61)



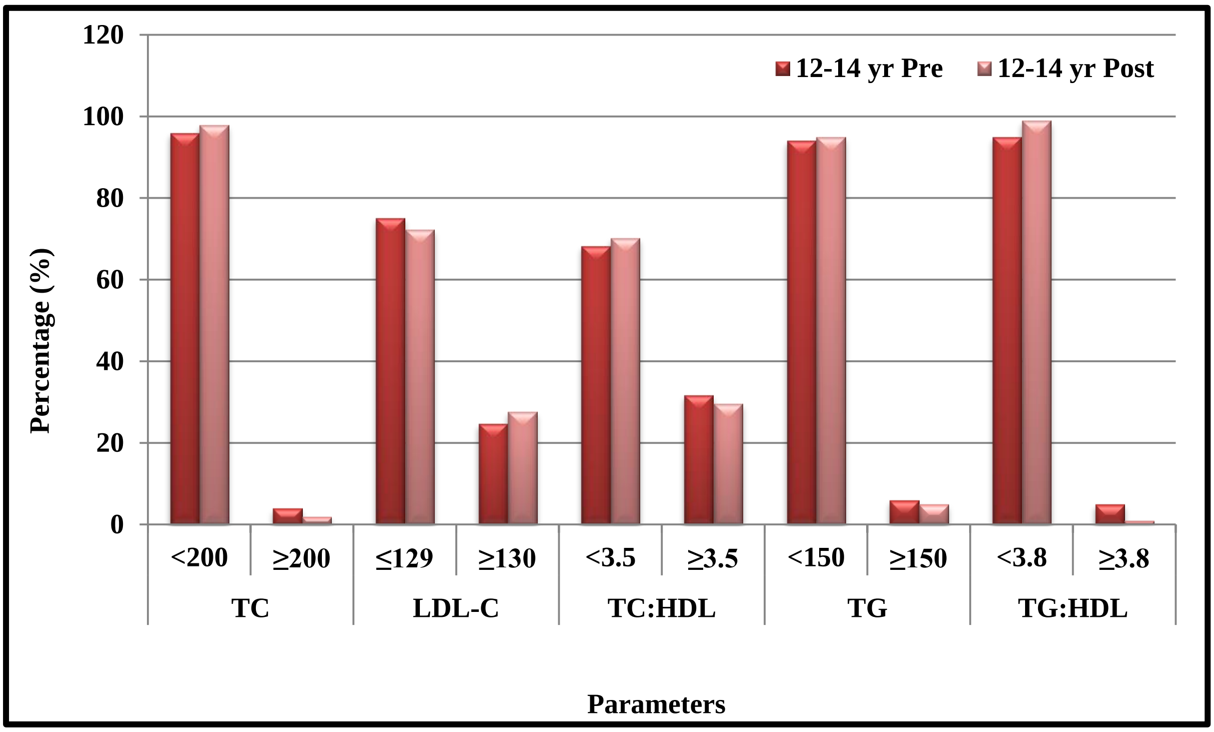
**Cutoffs and references given below table no. 6.12*

Figure 6.22: Pre-post shift in selected parameters of lipid profile among the participants of younger age group (n=68)



**Cutoffs and references given below table no. 6.12*

Figure 6.23: Pre-post shift in selected parameters of lipid profile among the participants of older age group (n=101)



**Cutoffs and references given below table no. 6.12*

IMPACT OF INTERVENTION ON ASSOCIATION OF DIFFERENT PARAMETERS:

In the earlier section, efforts were made to have a pre intervention association among selected parameters. The results revealed that certain anthropometric, biophysical and biochemical parameters are significantly associated with each other and could be used as a sensitive measure to understand a clear picture of nutritional status. WC was closely related to WHtR, TBF, LDL-C, TC: HDL ratio, TG and FSI.

NUTRITIONAL STATUS AS PER WAIST CIRCUMFERENCE AND OTHER PARAMETERS:

As stated in Table 6.15, WHtR, TBF, TC: HDL ratio, TG and FSI were associated with WC of the children before the intervention at $p<0.001$, 95% CI and remained associated even after the intervention

After the intervention, however WC showed new association with WHR and Hb status (Table 6.24). WHR varied significantly among boys, girls and children of younger age group. Individuals having high WC, were still in the normal range of WHR.

Before the intervention, SBP was high even among participants having normal WC and showed no association with WC. However after the intervention 12-14 years boys having normal WC got normal SBP. The mean values showed significant reduction among boys by 13 mmHg at $p<0.001$, 95% CI and by 5.7 mmHg ($p<0.001$, 95% CI) among the older age group.

The mean Hb values were in the normal range among all children having low, normal and high WC prior the intervention. After the intervention, however these values increased slightly by 3.4 gm% at $p<0.05$, 95% CI among children of 9-11 years age group having low or normal WC. Similarly the PCV values showed significant improvement of 3.6% among 9-11 year old children having low, normal and high WC.

The HDL values among 12-14 year old children increased their significant association post intervention by 9.5 mg/dl, $p<0.001$ at 95% CI. Individuals having low or high WC showed a reduction in HDL-C values; while those having normal WC improved their HDL-C values after the intervention.

Thus regular PA brings gradual changes within biochemical parameters such as Hb, PCV, LDL-C and HDL-C which has reflected on biophysical parameters such as SBP. On a whole, these parameters vary in close association with WC and WHR. These changes are more sensitively observed among boys and children of younger age group. Therefore it is important to encourage children of older age group, especially girls to continue with some sort of moderate – vigorous intensity of physical activity.

Table 6.24: Post intervention significant association of WC with other parameters among the participants

Parameters			Nutritional status as per WC			F-Value
			UN	Normal	ON	
Boys	WHR	Pre	0.87 ± 0.1	0.86 ± 0.04	0.88 ± 0.32	0.6NS
		Post	0.81 ± 0.02	0.85 ± 0.03	0.89 ± 0.03	41.7***
	SBP (mmHg)	Pre	108 ± 11	114 ± 8	113 ± 16	1.9NS
		Post	101 ± 8	108 ± 12	115 ± 11	13***
	LDL (mg/dl)	Pre	79 ± 16	88 ± 22	97 ± 23	5.3**
		Post	83 ± 16	89 ± 22	96 ± 22	3***
Girls	WHR	Pre	0.88 ± 0.05	0.85 ± 0.04	0.87 ± 0.04	3*
		Post	0.82 ± 0.05	0.80 ± 0.04	0.88 ± 0.06	16.5***
9-11 yr	WHR	Pre	0.87 ± 0.1	0.86 ± 0.05	0.88 ± 0.03	0.9NS
		Post	0.81 ± 0.04	0.84 ± 0.04	0.9 ± 0.05	18.4***
	Hb (gm%)	Pre	12 ± 1	12.4 ± 1	12.9 ± 0.9	2.3NS
		Post	12.1 ± 1	12.6 ± 1	12.9 ± 0.01	3.4*
	PCV (%)	Pre	36 ± 2	37 ± 2	38 ± 2	2.7NS
		Post	37 ± 2	38 ± 2	39 ± 2	3.6*
12-14 yr	SBP (mmHg)	Pre	111 ± 11	114 ± 9	114 ± 15	0.2 NS
		Post	102 ± 14	111 ± 11	115 ± 10	5.7***
	HDL (mg/dl)	Pre	56 ± 11	52 ± 11	45 ± 9	8**
		Post	54 ± 9	53 ± 11	44 ± 8	9.5***

UN=Under-nourished and ON= Over-nourished. NS = Non-significant difference. p<0.05*, p<0.01** and p<0.001 at CI=95%. Cutoffs and references mentioned below table no. 6.2, 6.4, 6.5, 6.6 and figure no. 6.4.***

WAIST HEIGHT RATIO AND OTHER PARAMETERS:

Parameters such as WC, TBF, TC: HDL ratio and TG were associated with WHtR before the intervention (Table 6.25) and continued to remain associated at $p<0.001$ even after the intervention.

The WHtR was found to be associated with WHR, SBP and PCV after the intervention. The WHtR showed significant association across age and gender categories of the participants (Table 6.24). Children categorized as overweight still had normal WHtR values (0.87 – 0.89); though slightly on border. A significant difference (at $p<0.001$, 95% CI) of 0.3-0.4 in the measure of WHR was observed among individuals having low and normal WHtR; while an increase of 0.1 in measures of WHR was observed among individuals having more WHtR.

WHtR was closely related to SBP as well. SBP was high among boys, children of 12-14 years and among individuals having normal WHtR prior the intervention. There was a significant reduction in the measures of BP among boys by 5.7 mmHg ($p<0.01$, 95% CI) and among children of 12-14 years by 3.5 mmHg ($p<0.05$, 95% CI) after the intervention. After the intervention individuals having normal WHtR got normal SBP values, but it continued to remain high among overweight individuals.

The mean values of CRP and FSI were in normal range among all the subjects and varied significantly post intervention. Individuals having more WHtR continued to get higher values of both the parameters. The low PCV values improved to normal among children of 12-14 years of age. WHtR therefore stands out to be more sensitive marker of nutritional status especially for Indian school children. Proportionate bi-dimensional growth can bring down the percent of over-nourished children; which may be achieved by initiating active sports from young age and continued at least till adulthood.

Table 6.25: Post intervention significant association of WHtR with other parameters among the participants

Parameters			Nutritional status as per WHtR			F-Value
			UN	Normal	ON	
Boys	WHR	Pre	0.84 ± 0.05	0.88 ± 0.1	0.88 ± 0.03	1.3^{NS}
		Post	0.81 ± 0.02	0.83 ± 0.03	0.89 ± 0.03	48***
	SBP (mmHg)	Pre	110 ± 12	114 ± 9	113 ± 13	0.6^{NS}
		Post	103 ± 5	108 ± 15	113 ± 11	5.7**
Girls	WHR	Pre	0.84 ± 0.04	0.86 ± 0.03	0.87 ± 0.05	1.6^{NS}
		Post	0.79 ± 0.05	0.81 ± 0.03	0.87 ± 0.06	10.7***
	CRP (mg/l)	Pre	0.56 ± 1.3	0.35 ± 0.4	0.59 ± 0.7	0.4^{NS}
		Post	0.2 ± 0.06	0.2 ± 0.1	0.7 ± 1	4***
	FSI(µ/ml)	Pre	7.9 ± 4.3	11.8 ± 6.4	12.5 ± 6.4	3.2*
		Post	9.5 ± 5.6	10.6 ± 3.6	15 ± 8	4.3**
9-11 yr	WHR	Pre	0.8 ± 0.05	0.88 ± 0.2	0.88 ± 0.04	1^{NS}
		Post	0.8 ± 0.04	0.82 ± 0.03	0.87 ± 0.05	16***
12-14 yr	WHR	Pre	0.85 ± 0.04	0.86 ± 0.03	0.87 ± 0.04	2.4 ^{NS}
		Post	0.8 ± 0.03	0.83 ± 0.03	0.88 ± 0.04	32***
	SBP (mmHg)	Pre	112 ± 11	115 ± 7	114 ± 14	0.2 ^{NS}
		Post	106 ± 12	111 ± 12	114 ± 10	3.5*
	PCV (%)	Pre	38 ± 1	37 ± 2	37 ± 2	1.6 ^{NS}
		Post	40 ± 3	39 ± 2	40 ± 2	4**

****UN=Under-nourished and ON= Over-nourished. NS = Non-significant difference. p<0.05*, p<0.01** and p<0.001*** at CI=95%. Cutoffs and references mentioned below table no. 6.2, 6.4, 6.5, 6.6 and figure no. 6.4.***

TOTAL BODY FAT IN ASSOCIATION WITH OTHER PARAMETERS:

Table 6.17, shows that WC, WHtR, DBP, TC, LDL-C, TC: HDL ratio, TG, FSI were associated with TBF at $p<0.001$, 95% CI and did not change after the intervention. Anthropometric parameter such as WHR and blood components such as Hb and PCV exhibited positive association with TBF after the intervention. The WHR was in normal range (0.82 – 0.89) among the participants having low, normal and high body fat both before and after the intervention. It showed an average difference of 0.4 after the intervention at $p<0.001$, 95% CI; 0.1 among boys of 9-11 years with high TBF and increased by 0.1 among 12-14 year old children.

The SBP values were normal (110 ± 11 mmHg) among individuals having low and normal fat percentage; and were high (117 ± 13 mmHg) among over-nourished boys and 12-14 year old children before the intervention. After the intervention the BP reduced among individuals with low and high TBF, but was still in the higher range for the latter group. However boys having normal SBP continued on the same values; while it increased to higher category among 12-14 year old having normal TBF.

The CRP values reduced significantly only among subjects having low fat; instead it increased to the category of "moderate risk" (1 – 3 mg/L) among subjects having normal and high TBF even after the physical activity intervention.

Body fat deposition is a natural process occurring rapidly among adolescents due to the growth spurt. This coupled with increased WC initiates the accumulation of risk factors. More so, even normal body fat causes elevated SBP especially among 12-14 year individuals. Among all, CRP exhibited high sensitivity with the TBF and may vary due to minor changes in the fat percent.

Table 6.26: Post intervention significant association of TBF with other parameters among the participants

Parameters			Nutritional status as per TBF			F-Value
			UN	Normal	ON	
Boys	WHR	Pre	0.87 ± 0.1	0.86 ± 0.07	0.88 ± 0.03	0.6 NS
		Post	0.83 ± 0.04	0.84 ± 0.04	0.89 ± 0.03	21***
	SBP (mmHg)	Pre	110 ± 10	109 ± 15	117 ± 13	4.7**
		Post	105 ± 9	109 ± 15	114 ± 12	7.3***
	CRP (mg/l)	Pre	0.5 ± 1	0.3 ± 0.4	1.1 ± 1.2	3.8*
		Post	0.4 ± 0.4	1.3 ± 2	1.3 ± 1.2	7.1***
Girls	HDL (mg/dl)	Pre	54 ± 8	48 ± 9	46 ± 9	4.2**
		Post	55 ± 9	48 ± 10	45 ± 8	7.3***
9-11 yr	WHR	Pre	0.88 ± 0.1	0.85 ± 0.07	0.88 ± 0.03	0.5 NS
		Post	0.83 ± 0.05	0.82 ± 0.04	0.87 ± 0.05	4.2**
	Hb (gm%)	Pre	12 ± 1.4	12 ± 1.1	12 ± 0.9	1.5 NS
		Post	12 ± 1.2	12 ± 0.8	12 ± 0.8	4.4**
	PCV (%)	Pre	36 ± 3	37 ± 2	37 ± 2	1.7 NS
		Post	37 ± 2	39 ± 2	38 ± 2	4.3**
	CRP (mg/l)	Pre	0.46 ± 1	0.4 ± 0.2	0.75 ± 0.9	1 NS
		Post	0.32 ± 0.2	1 ± 1.4	0.9 ± 0.2	4.1**
12-14 yr	WHR	Pre	0.86± 0.04	0.86 ± 0.05	0.87 ± 0.03	1.8 NS
		Post	0.83± 0.04	0.84± 0.05	0.88 ± 0.05	9.8***
	SBP (mmHg)	Pre	111±8	111±16	117± 12	3.3*
		Post	106 ± 10	115±9	115± 11	7.3***
	CRP (mg/l)	Pre	0.6± 1.2	0.3±0.3	0.9±1.2	2.3 NS
		Post	0.4±0.4	1± 2	1.1±1	3.4*

UN=Under-nourished and ON= Over-nourished. NS = Non-significant difference. p<0.05*, p<0.01** and p<0.001 at CI=95%. Cutoffs and references mentioned below table no. 6.2, 6.4, 6.5, 6.6 and figure no. 6.4.***

TC:HDL RATIO IN ASSOCIATION WITH OTHER PARAMETERS:

Before the intervention no association was found between the TC: HDL ratio and any of anthropometric, biophysical and biochemical parameters. However post intervention association of TC: HDL ratio was observed with WC, WHR, WHtR, TC, TG, TBF and CRP.

All the anthropometric parameters were towards higher category among individuals having ≥ 3.5 ratio and exhibited an increasing trend post intervention. WC increased among girls and 9-11 year old children especially those categorized as at risk as per the TC: HDL ratio.

Mean value of WHR was 0.88 among participants having higher ratio and it remained consistent among boys; while increased by 0.3 among children of 12-14 years of age after the intervention. Similarly the waist height ratio increased by 0.02 at $p<0.01$ among 9-11 year old children having ≥ 3.5 TC: HDL ratio.

TBF increased by 4% at $p<0.001$ among girls having high TC: HDL ratio even after the intervention. The TG (108 ± 63 mg/dl, range = 84.7-122.1 at 95% CI) and TC (166 ± 27 mg/dl) values were on higher range among girls and 9-11 year old children having high ratio before intervention. However, post intervention the triglyceride values reduced to 95 ± 46 mg/dl (range = 72 – 104, at 95% CI) and TC valued reduced to 161 ± 23 mg/dl at $p<0.001$.

This relation explains the biochemical changes that might be initiating with increase in parameters such as WC, TG, TC and CRP values. Thus a sequence of interdependent action continuously takes place in the body gradually leading to development of frank signs and symptoms of metabolic aberrations early in life.

Table 6.27: Post intervention significant association of TC: HDL ratio with other parameters among the participants

Parameters			Nutritional status as per Cholesterol :HDL Ratio		F-Value
			Normal (<3.5)	At Risk (≥3.5)	
Boys	WHR	Pre	0.86 ± 0.1	0.88 ± 0.04	1.3NS
		Post	0.84 ± 0.04	0.88 ± 0.04	6.3***
Girls	CRP (mg/l)	Pre	0.4 ± 1	0.6 ± 1	0.6 NS
		Post	0.68 ± 1	0.9 ± 1	3.5*
	TG(mg/dl)	Pre	77 ± 23	108 ± 63	4.6**
		Post	68 ± 25	95 ± 46	5.2***
	WC (cm)	Pre	64 ± 7	70 ± 11	2.5 NS
		Post	65 ± 7	72 ± 14	3.1*
	TBF (%)	Pre	19 ± 8	24 ± 7	4.1*
		Post	20 ± 6	28 ± 11	6***
9-11 yr	TC (mg/dl)	Pre	150 ± 21	166 ± 27	2.8NS
		Post	140 ± 20	161 ± 23	6.1***
	WC (cm)	Pre	61 ± 7	66 ± 10	1.9 NS
		Post	61 ± 8	69 ± 12	3.6***
	WHtR	Pre	0.43 ± 0.04	0.46 ± 0.06	1.5 NS
		Post	0.44 ± 0.05	0.48 ± 0.05	4.1**
12-14 yr	WHR	Pre	0.85 ± 0.04	0.84 ± 0.05	0.5NS
		Post	0.88 ± 0.04	0.87 ± 0.05	3.4*

UN=Under-nourished and ON= Over-nourished. NS = Non-significant difference. p<0.05*, p<0.01** and p<0.001 at CI=95%. Cutoffs and references mentioned below table no. 6.2, 6.4, 6.5, 6.6 and figure no. 6.4.***

RELATIONSHIP BETWEEN TOTAL BODY FAT WITH OTHER PARAMETERS:

TBF has interesting relationships with anthropometric, biophysical and biochemical parameters. As shown in figure 6.24a, 10-12% participants having normal WC and 3% having low WC had excess TBF. Nearly 7% students who have “at risk” WC had either low or normal fat percent in the body. Thus increase of TBF% and WC is quiet discrete.

The finding can be further confirmed as >50% participants having normal WHR had high TBF (Figure 6.24b). Nearly 9% individuals had low TBF, 20% had normal and 55-60% had excess body fat who were categorized as “at risk”, as per the WHtR (Figure 6.24c). Thus TBF distribution may be influenced by age, gender, hereditary, dietary habits and level of physical activity.

Looking into the biophysical markers, the TBF is high among individuals having low, normal as well as high BP; both systolic and diastolic (Figure 3.24 and 3.25). There is a decrease in the BP values post intervention, but not much significantly in relation with TBF. Biochemical markers such as HDL-C, LDL-C, TC: HDL ratio and CRP have shown association with TBF. Excess TBF is observed among 45-50% subjects having normal HDL-C, 35-38% subjects having normal LDL-C, 30-38% having normal TC: HDL ratio and 40-43% subjects having normal CRP values.

Therefore the increasing body weight among children mainly comprises of body fat; which goes unnoticed and erupts as a metabolically disrupted health condition during young adulthood.

Figure 6.24a, b and c: Association of TBF with WC, WHR and WHtR after the intervention

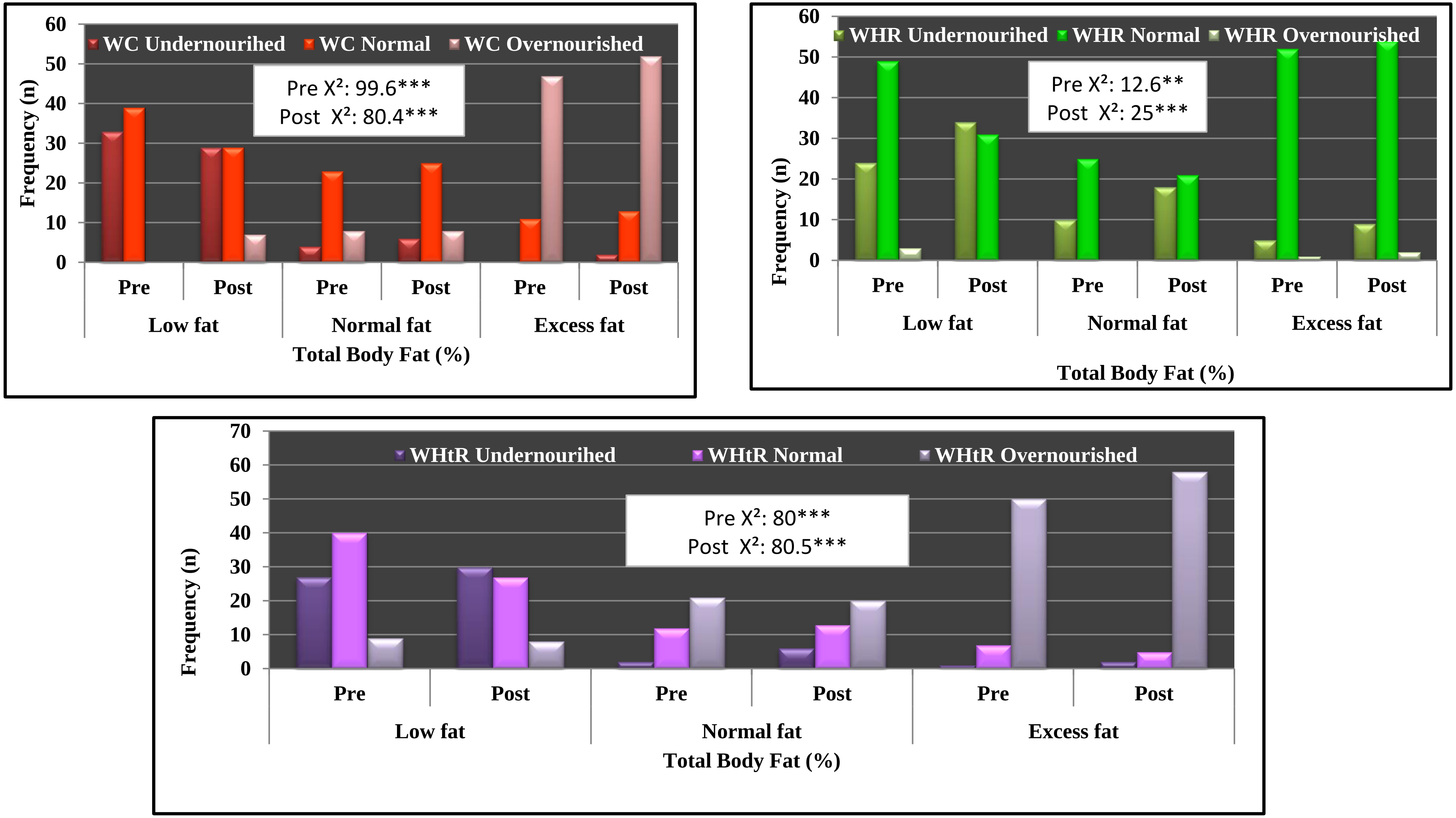


Figure 6.25: Association of TBF with SBP before and after the intervention

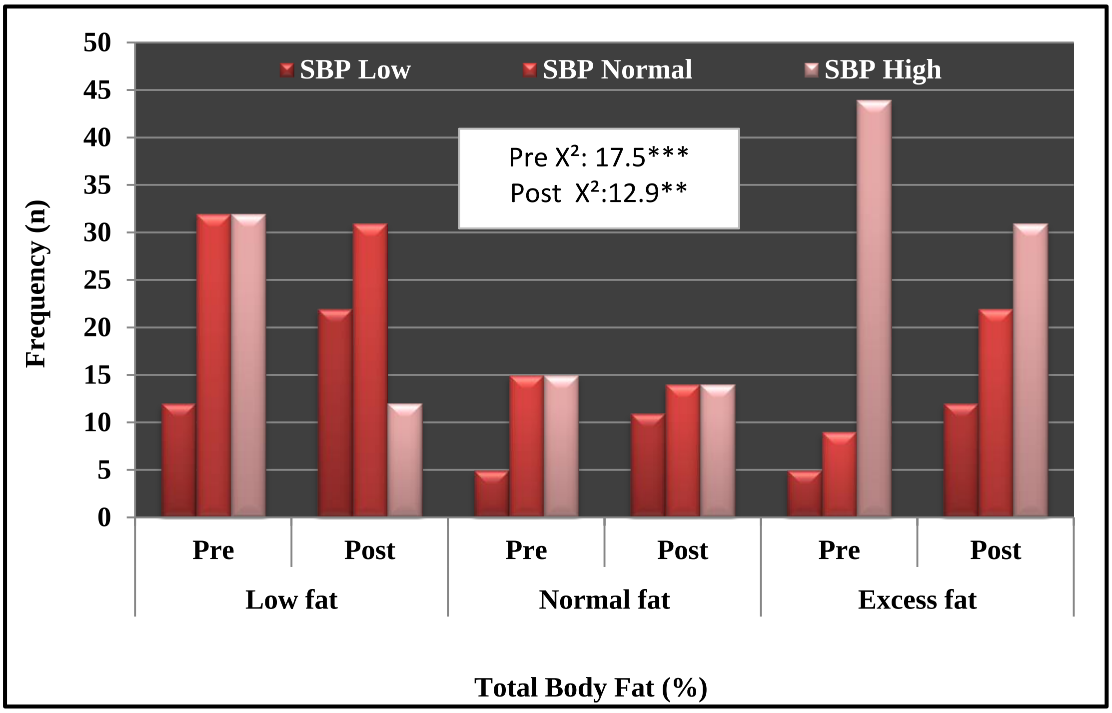


Figure 6.26: Association of TBF with DBP before and after the intervention

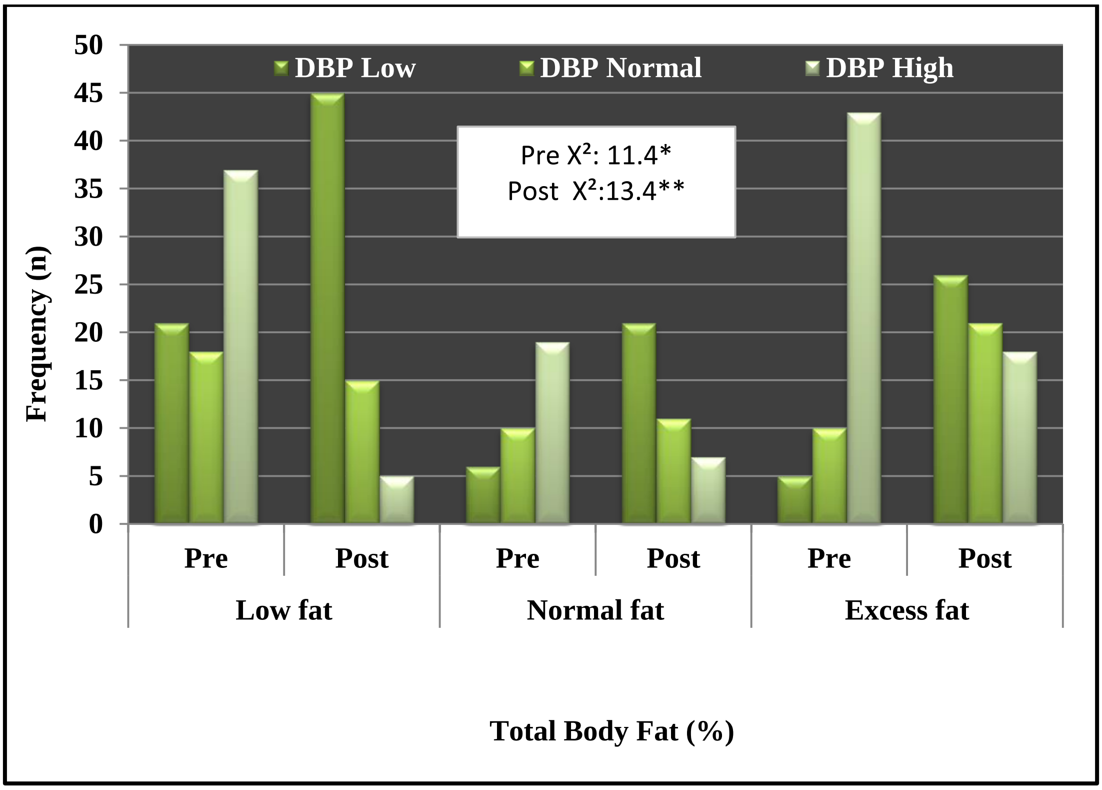


Figure 6.27: Association of TBF with HDL-C before and after the intervention

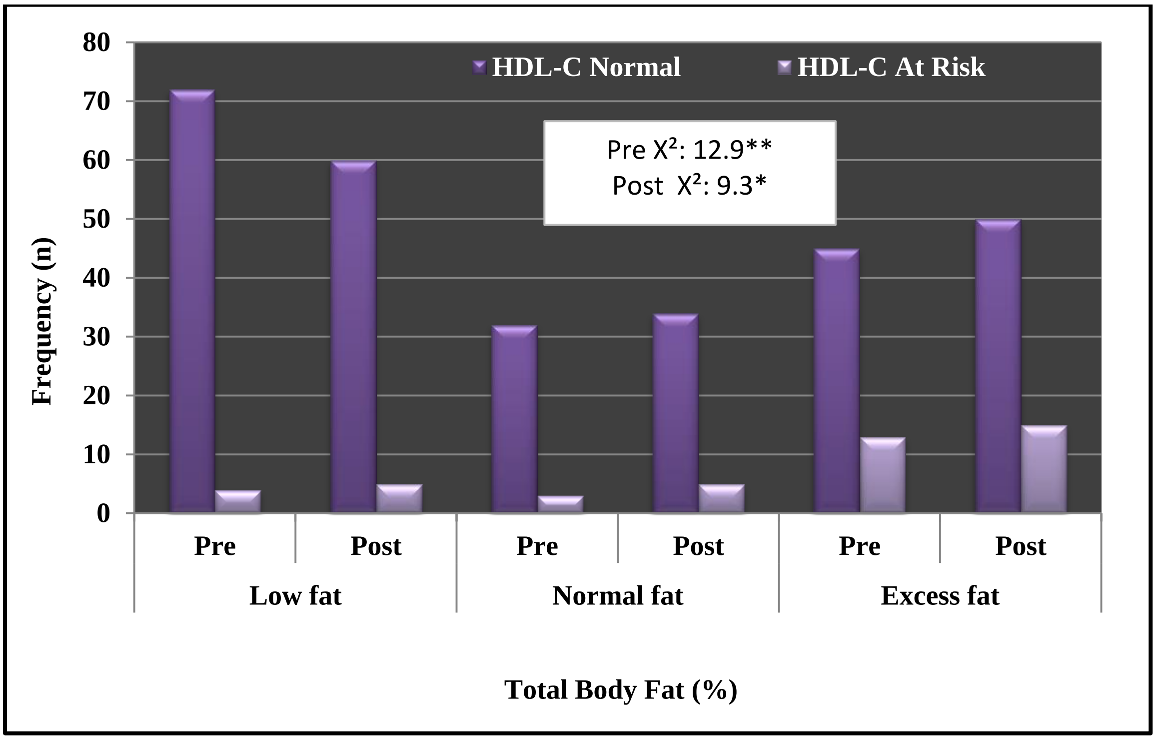


Figure 6.28: Association of TBF with LDL-C before and after the intervention

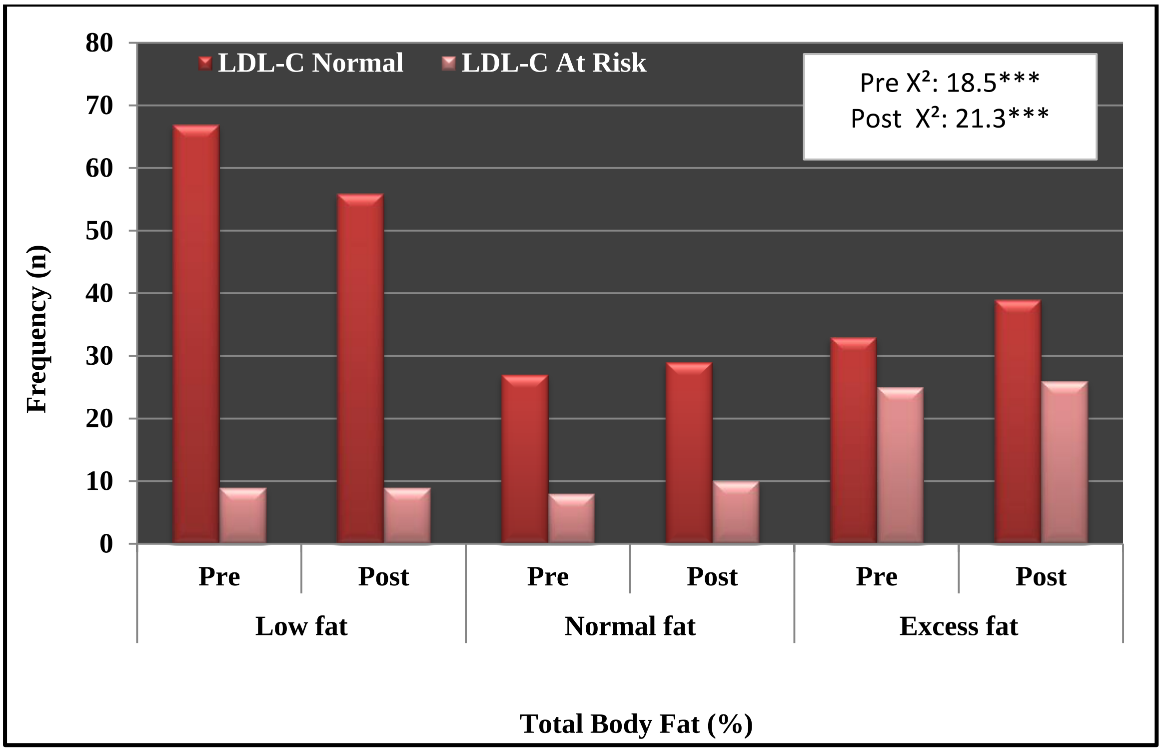


Figure 6.29: Association of TBF with TC: HDL ratio before and after the intervention

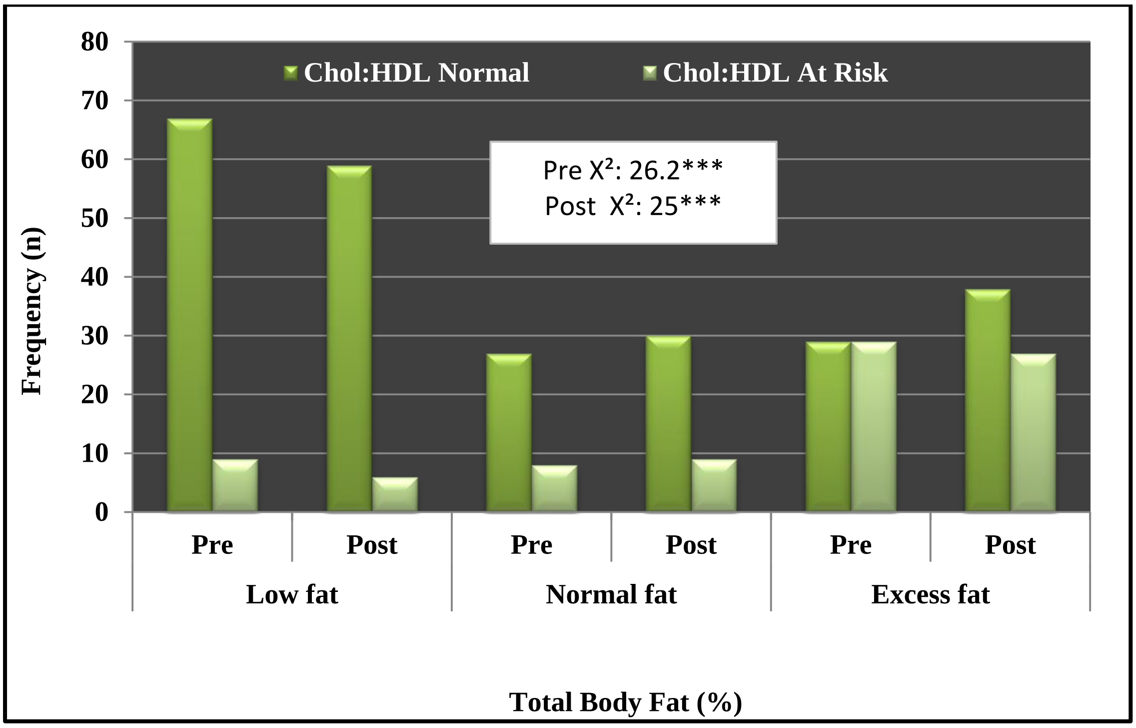
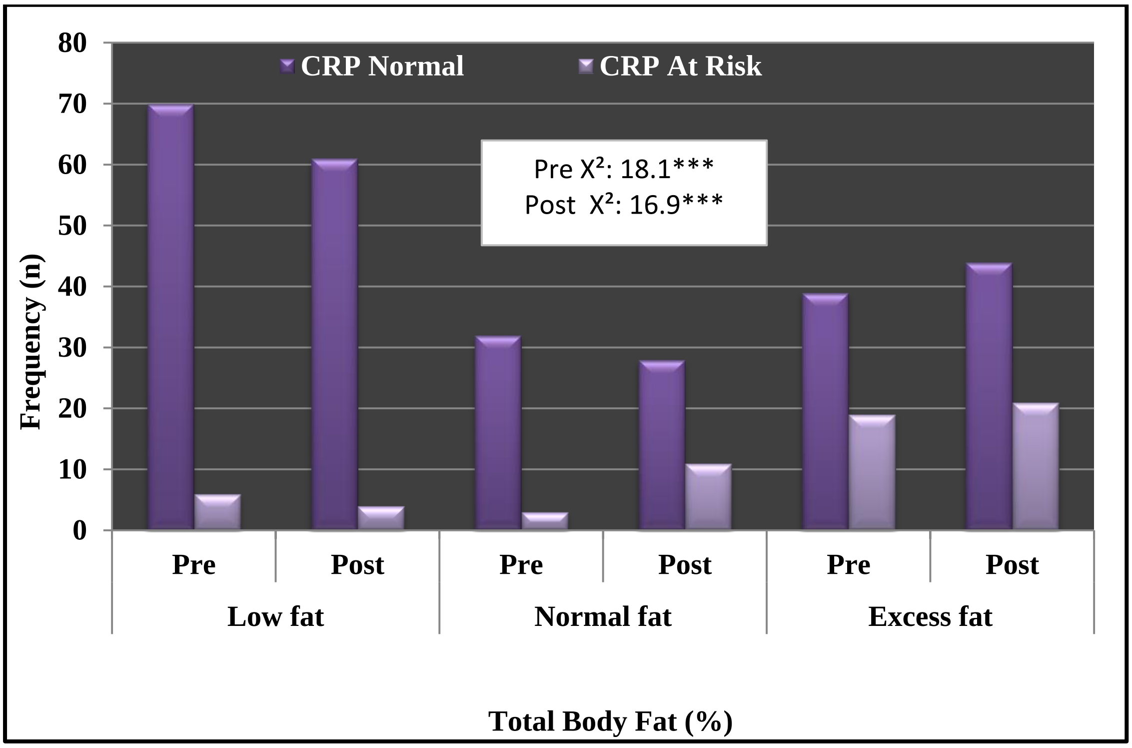


Figure 6.30: Association of FBF with CRP before and after the intervention



FEEDBACK

At the end of the 1st week, a feedback was taken from the participants, parents and the trainers and was repeated at the end of 1st, 2nd and 3rd month. The examples of the verbatim of the parents, teachers and students are listed in the table 6.28 and indicate the positive influence of the ASC.

Table 6.28: Verbatim on the feedback of the parents, participants and school authorities

Feedback	Verbatim
Parents	*"My child has become more active than before"*
	"My daughter has started eating more since she has joined active sports club"
	"My son enjoys attending the sports club and has developed interest in being active"
	"Such activities should be conducted on a regular basis in the school"
	"It will be good if children get to learn different sport in the school itself during the school hours"
	"My daughter spends less time in front of the television and has started playing outdoor even after school"
Participants	*"Though I have to come to school a bit early, I am enjoying the activities taught under the sports club"*
	"I have learnt more about games after joining the sports club than what we learn during our P.T. periods"
	"We used to have free period in the name of our P.T. periods and used to get very less chance to play, now I am enjoying my games of volleyball "
	" I feel fresh after the morning participation in the active sports club"
	"Beginning the day with games motivates me to come to school"
School authorities	*"The participants of the sports club have started showing more alertness in the class as compared to their counterparts"*
	"We thought it would be difficult to operate the sports club, but now we can incorporate the idea for other students also"
	"We have got requests from parents to initiate a sports club for other students also on regular basis"
	"If this is going to improve the academic performance, we would like to scale it up on a larger basis"

TO SUM UP

1. "Active Sports Club" intervention was feasible in one school and included 35 minutes of activities (football/basketball/volleyball for three days and aerobic exercise of moderate intensity for other 3 days/week) followed by pranayam for 10 minutes, monitored by 5 school teachers and the researcher for 90 working days. The participant (n=169, 64% boys) reporting time, based on informed consent, was 30 minutes prior school and continued till 20 min of school assembly.

2. At baseline, 82% students had a normal nutritional status as per BAZ, 6% were overweight and 13%underweight. As per all other indicators, boys showed higher prevalence of overnutrition.

3. The mean of TBF was 19% with a wide range of 5-53.7%. Between genders, the mean values of TBF (2.1, $p<0.05$ 95% CI) were significantly different between boys and girls, with slightly higher values among girls. Boys exhibited higher BP values as compared to girls.

4. The mean Hb value was 12.5 and was different between boys and girls by 2.2, $p<0.05$ 95% CI. 14% had low RBC (<4.2 mil/cmm), 63% had low PCV (<32%). MCV (<78 fl) and MCH (<27 pg) were below normal among 47% and 55% participants; while only 8% participants had <32% MCHC values.

5. CRP, TC, HDL, TG, TC: HDL and TG:HDL ratio reveals 5%, 1%, 12%, 3%, 27% and 5.3% respectively participants in the risk category; which indicates the trend of disrupting lipid profile among the children,

6. The mean values of all blood glucose parameters were found to be in the normal range. HOMA IR values were in the range of 0.4 to 12.3. Based on the HOMA IR values (<3 – normal insulin resistance, 3-5 - moderate IR and >5 - sever IR), 24% students were insulin resistant.

7. Nutritional status (BAZ) of students showed association with WC, WHtR, TBF% and LDL-C at $p<0.001$, 95% CI. Even normally nourished children were in the "risk" category as per either of the listed parameters.

8. WHtR was found to be more sensitive parameter because it was closely associated with more physiological parameters than the WC.

9. TBF was commonly associated with WC and WHtR; while HDL-C, LDL-C, TG, TC: HDL ratio and FSI were commonly related among both the anthropometric indices. WC was more closely associated with the HDL-C values at $p<0.001$. Students who were categorized as over-nourished as per WC, had high levels of TBF% (25.8 to 28.5±3.9), TG levels (89.8 – 95 mg/dl) and low levels of HDL-C (45 – 48 mg/dl).

10. Subjects with higher TBF percent had significantly higher SBP, HDL-C, LDL-C, TC: HDL ratio, TG and FSI at $p<0.001$.

11. Post intervention, there was a significant improvement in most of the biophysical and biochemical markers. Based on BAZ, children having under-nourished nutritional status prior the intervention shifted to a normal nutritional status, but none of the students turned overweight or obese.

12. With increasing age, the height, weight, WC and HC showed a significant increase, especially among 12-14 year old children as compared to the 9-11 year old. However proportionately short stature and rapid increase in weight and WC carries the risk of turning children into "overweight" category; thus making WHtR more sensitive and reliable early marker of nutrition transition.

13. 32-35% children across gender, 23% 9-11 year and 41% 12-16 year old children had high TBF% before intervention which increases by 1.5% among boys, 7% among girls and children of younger age group. Girls and

9-11 year old children are more vulnerable for early, rapid and high body fat deposition. Thus MVPA should target these vulnerable groups and should be coupled with nutrition behaviour intervention.

14. Alarmingly high values of both systolic and diastolic BP were found among the participants across gender and age groups. Boys were more susceptible as 60-65% had high BP. Post intervention it reduced dramatically by 20% among gender, 40% among the children of younger age group and by 15% among the children of elder age group.

15. Across the gender and age groups, there was a positive shift in the hemoglobin, PCV, MCV as well as MCH values at $p<0.001$ at 95% CI.

16. The CRP values were at "moderate risk" among boys which increased significantly after intervention and reduced among girls. Similarly the CRP values increased among both age groups after the intervention. A significant reduction was observed in the cholesterol and TG values. The TG values reduced significantly among boys by 3.7 mg/dl ($p<0.001$, 95% CI) and by 2.94 mg/dl ($p<0.01$, 95% CI) among girls.

17. Similarly the TG: HDL ratio reduced among boys by 2.9 and among girls by 2.5 at $p<0.001$ and $p<0.01$ respectively after the intervention. As compared within age group, TC and TC:HDL-C ratio values reduced after MVPA.

18. Post intervention WC showed improved association with SBP, Hb, PCV and HDL-C, especially among boys and children of younger age group. WHtR showed positively novel association with WHR, SBP and PCV after intervention.

19. CRP values reduced significantly among boys ($p<0.001$), 9-11 year old (4.1, $p<0.01$) and 12 -14 year old (3.4, $p<0.05$) among subjects having low TBF%

and increased to moderate risk among those having "normal" and high TBF%.

20. TC:HDL-C ratio showed association with WC, WHR, WHtR, TC, TG, TBF% and CRP. Individuals having ≥ 3.5 ratio were in the "risk" category as per the enlisted parameters and continued to remain high even after the intervention.

21. TBF% distribution is greatly influenced by age, gender, hereditary, dietary habits and PAP. Thus increase in TBF% is discrete with other biochemical, anthropometric and biophysical parameters.

22. Parents, participants and teachers gave a positive feedback and requested school authorities working towards regularizing the 'Active Sports Club" in their school setting.

23. The school infrastructure reveals enough space, well developed in playgrounds, but little emphasis was given on Physical Training aspect and the PE class was usually looked as an extra class for teachers to complete the syllabus. Physical activity is a major and modifiable component of energy expenditure. Considering the existing education system and rising prevalence of coexisting dual malnutrition MVPA promotion via "Active Sports Club" can be a feasible and sustainable model if adapted by the school management.

LIMITATIONS

1. School PE teachers had to be constantly motivated along with the participants and their parents to report early to school for the "Active Sports Club"
2. Cancellation of the MVPA due to other extracurricular activity of the school lead to several rescheduling.
3. Managing 4 groups of students by 5 PE teachers was a challenging task.

4. Though school had playgrounds for volleyball, basketball and football, many students did not know the rules of the games, thus additional days were spent on teaching the sport.

FUTURE SCOPE OF WORK

1. A longitudinal study to assess the sustainability of "Active Sports Club" in private and government school settings and its impact on the nutritional status and risks of metabolic syndrome needs to be undertaken.
2. National guidelines on physical activity for promoting health across all segments of the population, especially school going children and youth need to be implemented in all schools and PE periods should not be merely free periods for children.
3. Efforts to establish "preventive physical activity pattern" in terms of frequency, duration, intensity, type and total amount for managing the increasing prevalence of dual burden of malnutrition.
4. Further data on the specificity of kind, frequency and intensity of physical activity on the biochemical parameters needs to be generated for Indian children.

DISCUSSION

The present study attempted to conduct MVPA for 35 minutes daily through "Active Sports Club", because statistics reveal that the children are not only being sedentary, but also their participation in any organized sports or physical activity is reducing both in and out of school (CDC, 2003). In spite of the documented psychological and physiological health benefits of physical activity, more than 60% children and adolescents do not partake in any form of physical activity (Nader, 2003; CDC, 2013).

Similar trend was found even in a demographically small city of India, Vadodara as reported by (Iyer and Gandhi, 2004; Kanani and Saxena, 2008; Dhruv and Bhatt, 2010; Kanani and Jain, 2010) in schoolchildren as well as university students. Moreover, Misra and Vikram, 2004 have consistently reported high prevalence of excess body fat, adverse body fat patterning, hypertriglyceridemia, and insulin resistance among young Indians thus suggesting a need for early primary prevention strategies.

The data, thus gives an essential reason to mandate moderate to vigorous physical activity for minimum of 23 minutes per day, within a school setting (Basset et al., 2013). This could be taken up as a part of classroom activity, school break, after-school activity program, before school activity as it reduces the sedentary time of children (Chen et al., 2014). School based physical activity needs encouraging support from the family and community (Florentino, 2002). The "Active Sports Club" incorporated with these fundamentals proved a feasible intervention under present study.

The MVPA intervention was supervised regularly by trained personnel and enough measures were taken for compliance; because presence of a well-trained role model of physical activity, suitable environment (Mc Cambridge et al., 2006) and training subgroups to promote physical activity (Whitt-Glover et al., 2009; Dudley et al., 2011).

Indian phenotype explains the coexistence of dual malnutrition (Barker, 1995); justifying the importance of being physically active Indian adolescent and school going children (Bhargava et al., 2004). The baseline statistics reveals dual burden of malnutrition among schoolchildren of Vadodara with 82% students having normal nutritional status, 6% being overweight and 13% being underweight; driven by intensifying epidemic of inactivity (Misra, 2009; Subramanian et al., 2007).

However school based intervention (McCambridge et al., 2006) of ASC resulted in a positive shift as children having under-nourished nutritional status turned to become normally nourished and none of the students turned overweight or obese. An average of 30 minutes of MVPA per day performed for minimum 2 to 12 months (Marcus et al., 2006; Kappan, 2012) affects different measures of body composition such as BMI, waist circumference, skinfolds showing health benefits among overweight as well as non-overweight children, especially of 9 – 10 year old (Groffik et al., 2012).

Growth spurt among the schoolchildren under the study explains the increase in body dimensions and a concomitant increase in fat fold thickness (Robinson, 1999; Carrel et al., 2011). However, such a large shift in "over-nourished" or "at risk" category (as per WC and WHR) could be attributed to the progressive increase in mechanization that has led to a steep reduction in physical activity among Indian youth (Ramchandran, 2011; Tremblay et al., 2003). This shift can however be arrested or reversed by undertaking MVPA for 45 – 60 min per days at home or at school (Florentino, 2002; WHO/FAO, 2003).

Measure of adiposity and impact of physical activity on the same have given mixed results due to the complexity in its distribution pattern, lifestyle and hereditary influence (McLanahan et al., 2006); similar results were recorded among participants of present study. Hence, efforts to increase PA among girls can delay the onset of unhealthy aberrations, and deposition of the percent body fat (Best, 2010).

Dudley et al. (2011) has reported cardio-respiratory benefits of aerobic physical activity of moderate intensity. In the present study, alarmingly high values of systolic and diastolic blood pressure reduced dramatically by 40% among the children of younger age group and by 15% among the children of elder age group. Reddy et al., 2012 has reported 3.5% and 5.1% prevalence of hypertension in girls and boys respectively; which is also associated with higher BMI and family history of hypertension. MVPA increases musculo-skeletal flexibility and fitness; manages the BMI (Tremblay et al., 2009). This helps in reducing the risk of joint injuries and muscle sprains in later life and keeps the hereditary risk factor away. These health benefits tracks down from adolescence to adulthood (Mikkelsson et al., 2006).

Regular physical activity have shown to reduced the disturbance in blood acid-base balance, neuro-muscular facilitation and has improved metabolic health biomarkers among children and youth aged 5–17 years (Robergs et al., 1990; Khan et al., 2011). Hematological indices such as Hb., PCV, MCV as well as MCH and lipid parameters such as TC, TG and TG : HDL ratio; reduced significantly across gender and age groups. This improvement can be credited not only to physical activity but also to the ongoing nutrition health education intervention “MARG”.

Similarly many other studies have also document positive effect of regular aerobic exercise on the blood lipid levels and blood pressure; thus explains its cardiovascular benefits, including a reduction in incidence of mortality from coronary artery disease (Mersy, 1991). Urbina et al. (2013) have stated that TG/HDL-C, an estimate of small, dense low-density lipoprotein cholesterol, is an independent determinant of arterial stiffness in adolescents and young adults which was recorded to be high among the participants and showed slight reduction after the intervention (Savitha and Sandeep, 2011; Bhuiyan et al., 2013).

Another pursuit of dual malnutrition is its effect on compromised immune function. CED and micronutrient deficiency such as vitamin B_6, B_{12} and folic acid lead to homocysteinamia, thrombosis and arterial damage (Welch et al., 1998); deficiency of amino acids like arginine affects the arterial function (Wu et al., 2000) thus predisposing the children to “chronic disease” as well as communicable disease. Micronutrients like and phytochemicals required from a spectrum of foods for at least their antioxidant that have properties to protect tissues from chronic disease (Wahlqvist et al., 1998). Apart from nutrition, a combination of moderate physical activity and Pranayam encourages parasympathetic drive, allowing the body to slow down and attain the mind and body back into balance (Tummers, 2009).

On-site afterschool physical activity intervention focusing on fitness improved body composition, cardiovascular fitness in elementary school children (Khan et al., 2014), percent fat mass and prevented accumulation of central fat mass among pre-pubertal children both obese and non-obese with varying adiposity levels (Carrel et al., 2011). Thus, the findings of the study and related review provide support for daily physical activity recommendations to prevent excess fat mass accumulation in childhood. Moreover, parent supported - preventive intervention in form of physical activity effectively improves not just health and biomarkers, but also motor skills and cognition levels in childhood (Graf et al., 2005).

School based physical activity interventions have reported certain inherent limitations (Marcus et al., 2006). However, school-based multi-level programs, environmental approaches, participation in organized and non-organized active leisure pursuits (Groffik et al., 2012) have shown to increase the level of physical activity. Fostering a classroom and school culture that encourages physical activity at school, can bring healthy behaivoural modifications (Mc Cormack, 2011).