IMPACT OF PHYSICAL ACTIVITY AND NUTRITION EDUCATION ON METABOLIC SYNDROME AMONG OVERWEIGHT AND OBESE ADOLESCENT GIRLS

By

A.C. REVATHI

(13PFN015)

A THESIS SUBMITTED TO THE

AVINASHILINGAM INSTITUTE FOR HOME SCIENCE AND HIGHER EDUCATION FOR WOMEN.

COIMBATORE-641 043

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE IN

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CERTIFIED AS BONAFIDE RESEARCH WORK

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Dr. Malpana 31/3/15
SIGNATURE OF THE GUIDE

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THE HEAD OF DEPARTMENT

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I INTRODUCTION

World Health Organization (2013) defines adolescence as the period of life between 10-19 years. It is a period of rapid physical and biological changes, which may lead to confusion, tension, frustration and feeling of insecurity. Adolescence is a prime time for health promotion and for establishment of healthy behavior that influence health in later years and are at high risk for nutritional morbidity (Gouri et al., 2013).

The prevalence of obesity has increased steadily over the past five decades not only in adults, but also among children and adolescents and had a significant impact on the quality adjusted life years (Hong et al.,2012).

The presence of obesity increases the risk of non-communicable diseases such as metabolic syndrome, Type 2 diabetes mellitus, hypertension, hyperlipidemia, cardiovascular disease, and certain cancers(Battaloglu et al., 2012).

Obesity plays a central role in the development of the metabolic syndrome, an important clustering of metabolic syndrome abnormalities and anthropometric characteristics entailing an increased risk for mortality from cardiovascular and all causes in adults, as well as an increase in Type 2 diabetes and early cardiovascular disease (Lafortuna et al., 2010).

Metabolic syndrome also called as syndrome X, metabolic syndrome X, cardio metabolic syndrome, insulin resistance syndrome. Metabolic syndrome increased the risk of cardiovascular disease (CVD) and Type 2 diabetes and death due to CVD. The primary risk factors for metabolic syndrome included insulin resistance and abdominal obesity, which are highly prevalent in Indians (Kassi et al., 2011).

Metabolic syndrome has become one of the most severe health problems of the 21st century *(Alvarez, 2010).* Metabolic syndrome is a major public health problem in the United States. (Myers, 2009).

Metabolic syndrome is associated with an increased risk of type 2 diabetes early onset and cardio vascular disease, which may lead to an increased cardio vascular mortality (Atabek et al., 2009.

Metabolic syndrome is caused by an unhealthy lifestyle that includes eating too much calories, being inactive and gaining weight particularly around your waist which can lead to insulin resistance, a condition in which the body is unable to respond normally to insulin and lead to diabetes and mellitus. (Ganie,2010).

Factors such as high blood pressure, elevated triglycerides, and or overweight or obesity may be signs of metabolic syndrome. People with insulin resistance may have acanthosis nigricans, which is darkened skin areas on the back of the neck, in the armpits, and under the breasts. In general, however, people do not directly experience symptoms of metabolic syndrome(Jacob and Issac, 2012).

Insulin resistance is associated with an increased prevalence of the metabolic syndrome among both obese and Hispanic adolescents. Because adolescents with PCOS are as insulin resistant as their adult counterparts, they would be predicted to be at increased risk for the metabolic syndrome (Lergo,2011).

World Health Organization relied more heavily on insulin resistance as a necessary component of the metabolic syndrome. Regular consumption of sugar sweetened beverages is another risk factor for diabetes and metabolic syndrome (Malik et al.,2010).

High Blood Pressure is the major risk factor for cardiovascular disease. Detecting adolescents with pre hypertension would help in identifying those to be targeted for early management. Hypertension is the leading metabolic syndrome risk factor, the association of elevated blood pressure to metabolic syndrome being strongly linked through the causative pathway of obesity.(Ejike et al., 2010).

The concerns are caused by the fact that obesity is a potential trigger factor for many different diseases, including the metabolic conditions that affect an ever growing number of children and adolescents. The metabolic syndrome (MS) is one of these conditions. The metabolic syndrome is characterized by the presence of cardiovascular risk factors such as arterial hypertension, insulin resistance, hyper insulinemia, glucose intolerance, central obesity and dyslipidemia .(Battaloglu et al., 2012).

Obesity severely reduces health-related quality of life, particularly in terms of pain, functional capacity and vitality, as well as effects on social functioning and

mental health. Weight gain adversely affects quality of life, while weight loss improves it. In the short term, a modest weight loss of initial weight in overweight and obese people is associated with substantial health benefits, including improvements in blood pressure, lipids and glucose tolerance. In the longer term, a large prospective study found that intentional weight loss is associated with a reduction in mortality, independently of the amount of weight lost. (Punyadeera et al., 2008).

Triglycerides are also present in blood plasma and, in association with cholesterol, from the plasma lipids. Triglyceride levels correspond to how well your body utilizes sugars (triglyceride is an intermediary step in the conversion to fats). Elevated triglycerides,>150, is a sign of metabolic disorder. High density lipoprotein (HDL) is known as “good” cholesterol. Elevated levels of HDL also reduce LDL, low-density lipoprotein, and decrease blood pressure. However, a low HDL indicates greater risk for cardiovascular disease and it is indicative of metabolic syndrome (Mary, 2009)

Mild elevations of blood pressure can be controlled with lifestyle modifications, especially weight control, increased physical activity, alcohol moderation, sodium reduction, and increased consumption of fresh fruits and vegetables in accordance with the Dietary Approaches to Stop Hypertension (DASH) diet (Wong, 2009).

Polycystic ovarian syndrome (PCOS) is the most common cause of androgen excess in women and girls and is characterized by hirsutism, menstrual irregularities, obesity and polycystic ovaries. PCOS increases one’s risk of diabetes, metabolic syndrome, dyslipidemia, and hypertension. Approximately one-third to one- half of all adolescent girls with polycystic ovary syndrome (PCOS) has the metabolic syndrome, associated with increased risk for cardiovascular disease and type 2 diabetes (Essah et al., 2010). Polycystic ovarian syndrome (PCOS) is a leading cause of glucose intolerance and insulin resistance in adolescent girls, particularly those with obesity (Andrea et al., 2013)

Metabolic syndrome is highly reversible. Adopting new eating and exercise habits, along with managing stress in healthy ways, can change the underlying body

functions that contribute to these risk factors – and give you more energy and a better outlook (Tsuneki et al., 2013).

Treatment of obesity and, as a result, of the components of MS is more effective when there is a link between acquisition of healthy lifestyle habits and participation in physical exercise, promoting improved glucose metabolism, a better lipid profile and lower blood pressure. Physical Education professionals, Endocrinologists, Pediatricians, Nutritionists, Physiotherapists and Psychologists. If few studies have been conducted into Brazil investigate the effects on the components of MS in this population of interventions that include physical exercises and dietary guidance. (Charlotte et al., 2009).

Adolescents are no longer as physically active as a few decades ago (Dwyer et al., 2009). Low levels of physical activity (PA) are widely assumed to be involved in the etiology of obesity and underlie public health messages *globally* (Must & Tybor, 2005).

This significantly higher rate of obesity in the black population is of serious concern, because the metabolic syndrome (MS) is high among obese children and adolescents (Weiss et al., 2004). The MS is defined by the clustering of metabolic abnormalities, primarily overweight and more specifically central obesity, insulin resistance, dyslipidemia and hypertension*(Jennings et al., 2009).* The MS affects a great number of adolescents (Day et al., 2009) and is related to cardiovascular risk (Day et al., 2009; Leite et al., 2009)

Adolescents require monitoring, as risk-related behavior patterns for coronary heart disease have their origin in childhood and adolescence. The benefits of regular PA are substantial as it plays a crucial role in the regulation and maintenance of an adolescent's body weight by decreasing the percentage body fat(Day et al., 2009).

Therapeutic lifestyle changes, such as increased physical exercise, improved diet, and weight reduction, are the cornerstones of the treatment of obesity, hypertension, insulin resistance, and most dyslipidemia. Reducing dietary calories and fats (especially saturated fats) and increasing exercise can significantly reduce the risk

of developing diabetes and atherosclerotic cardiovascular disease (Boudreauet al., 2009).

Food intake of adolescents is influenced by psychosocial factors; peers and popular culture , including mass media and advertising, significantly affect dietary patterns (Edelstein and Sharlin, 2009). Diets of today's preadolescent and adolescents are low in fruits, vegetables, dairy products, whole grains, and high in total fats, saturated fats and added sugars(Krebs et al., 2009).

Changes in dietary habits are important in the treatment of metabolic syndrome. According to the American Heart Association, treatment of insulin resistance is necessary to achieve the greatest benefit for modifying metabolic risk factors. In general, the best way to treat insulin resistance is through weight loss and increased physical activity (Spitaels et al.,2010).

A reduced –calorie diet is usually necessary, and dieting is the second critical part of the initial treatment of metabolic syndrome. Overweight people with metabolic syndrome must reduce the number of calories that they eat each day. Simply reducing the overall calories in the diet will improve the lipid profile. Reducing the amount of fat improves the lipid profile even further. It is especially important to remove foods that are high in saturated fats (Michael,2011).

Nutrition health education is an effective method to improve the dietary behavior of university students. It provides great opportunity to learn about the essentials of nutrition for health and to take steps to improve the quality of their diets, thus their well-being (Qiaoling et al., 2009).

Various modes of nutrition education interventions, their effectiveness on eating habits remain unclear, nutrition education is widely used for a range of population groups as a medium to deliver healthy diet and nutrition information using internet this type of intervention is still rarely implemented for college students (White et al., 2009).

With this in view, the following objectives are set for the present study.

- Screen adolescent girls (18-21 years) for obesity.
- Study the socio-economic and health status of obese adolescent girls.

- Identify the metabolic syndrome
- Develop of physical activity packages and nutrition education aids.
- Implement physical activity and nutrition education to selected obese adolescent girls.
- Evaluate the impact of physical activity and nutrition education on selected obese adolescent girls.

II REVIEW OF LITERATURE

The review of literature of the study entitled "**Impact of Physical Activity and Nutrition Education on Metabolic Syndrome among Overweight and Obese Adolescent Girls**" is discussed under the following headings:

E. Metabolic syndrome among obese adolescent girls
F. Relationship between obesity and metabolic syndrome
G. Physical activity – An intervention strategy for obesity and metabolic syndrome
H. Role of Nutrition Education in Metabolic syndrome

A. Metabolic syndrome among obese adolescent girls.

Metabolic syndrome is a group of health problems that include too much fat around the waist, elevated blood pressure, high triglycerides, elevated blood sugar, and low HDL cholesterol. Together, this group of health problems increases the risk of heart attack, stroke, and diabetes (Hong et al., 2012).

Goswami et al. (2012) stated that "metabolic syndrome", "insulin resistance syndrome" and "syndrome X" are now used specifically to define a constellation of abnormalities that is associated with increased risk for the development of type II diabetes and atherosclerotic vascular disease.

Metabolic syndrome, which is a constellation of metabolic abnormalities including insulin resistance, hyperinsulinemia, glucose intolerance, dyslipidemia, and hypertension, is common among overweight youths, affecting around 30 percent of overweight children and adolescents in the United States (Lee, 2008).

One- third of adolescent girls in the United States are overweight or obese (Ogden et al., 2010). Approximately 32 percent of the population in the U.S. have metabolic syndrome. Around 25 percent of adults in Europe and Latin America are estimated to have the condition and rates are rising in developing East Asian countries. Within the US, Mexican Americans have the highest prevalence of metabolic syndrome.

Metabolic syndrome is characterized by the presence of obesity and insulin resistance, a reduced responsiveness of the body tissues to insulin. Associated disorders of metabolic syndrome are high blood pressure and two lipid problems: high blood levels of triglycerides and low blood levels of high- density lipoprotein cholesterol (HDL). Metabolic syndrome quintuples the individual's change of developing type II diabetes and doubles the change of developing coronary heart disease. Metabolic syndrome is caused by an unhealthy lifestyle that includes eating too many calories, being inactive, and weight, particularly around your waist (Weijia et al., 2010).

Obesity

Obesity in adolescence has acquired epidemic proportions worldwide, with a high prevalence in both developed and developing countries. It is considered a risk factor for a number of serious disorders, such as metabolic syndrome, which can manifest at early ages (Ogden et al., 2010).

Overweight is caused by taking in more calories than we should Calories are taken in through food. All activity in our bodies is fuelled by calories. This includes physical activity and basic body functions. Excess weight gain occurs when this relationship is not kept in balance. If this imbalance happens regularly it will lead to obesity (Lafortuna, 2010).

Overweight in adolescence is associated with increased risk of obesity and metabolic dysfunction as dyslipidemia, hypertension and insulin resistance. These conditions are involved in the atherosclerotic process and contribute to the development of cardio vascular diseases (Huebner, 2010).

Central obesity is a key feature of the syndrome, reflecting the fact that the syndrome's prevalence is driven by the strong relationship between waist circumference and increasing adiposity. However, despite the importance of obesity, patients who are of normal weight may also be insulin – resistant and have the syndrome (Singhal et al., 2010).

Diabetes Mellitus

Obesity and metabolic syndrome the role of insulin resistance. Most persons with multiple metabolic risk factors are insulin resistant. This observation led to the concept that insulin resistance is the cause of the metabolic syndrome (Grundy, 2013). Intra-abdominal (Subcutaneous) fat. Intra-abdominal fat is largely visceral fat, and an overabundance of visceral fats cells will cause insulin resistance (Zimmet et al., 2009)

Magnussen et al. (2010) stated that insulin resistance probably results from a variety of genetic and environment factors. Some people may be genetically are prone to insulin resistance, inheriting the tendency from their parents. But being overweight and of insulin resistance, and metabolic syndrome.

Increased insulin resistance raises your triglyceride level and other blood fat levels. It also interferes with higher blood pressure. These combined effects of insulin resistance put you at heart disease, stroke, diabetes and other conditions (Centre for Disease Control and Prevention,2011).

Regular consumption of sugar-sweetened beverages is another risk factor for diabetes and metabolic syndrome. Eleven studies involving more than 310,000 individuals evaluated for diabetes and more than 19,000 for metabolic syndrome, those who drank one to two 12-ounce servings per day of sugar- sweetened beverages increased their risk of developing type 2 diabetes by 26 per cent and of developing metabolic syndrome by 20 per cent, compared to those who drank less than one serving per month (Stern et al., 2010).

Metabolic syndrome and insulin resistance are closely associated, many health care professionals believe that insulin resistance may be a cause of metabolic syndrome. Others believe that hormone changes, caused by chronic stress, lead to the development of abdominal obesity, insulin resistance, and elevated blood lipids (Buchwald et al., 2009).

High blood pressure

High blood pressure is defined as systolic pressure greater than 130mmHg and/or diastolic pressure greater than 85 mmHg. Hypertension is one of the chronic metabolic diseases associated with obesity can also cause sleep apnea (Anapaula et

al., 2013) Pre hypertension is the borderline region of blood pressures of 120 to 139 mm Hg systolic and 80-89mm Hg diastolic and pre hypertension warns of future health risks.

Epidemiologic studies have shown that pre hypertension (specifically,>130/85 mm Hg, or being on medication to lower blood pressure) is a sufficient criterion for making a diagnosis of metabolic syndrome.

- Normal blood pressure is when your blood pressure is lower than 120/80 mmHg most of the time .
- High blood pressure (hypertension) is when your blood pressure is 140/90 mmHg or above most of the time.
- If your blood pressure numbers are 120/80 or higher, but below 140/90, it is called pre-hypertension.

Hypertension is one of the components of the metabolic syndrome, and the presence of the syndrome increases the risk of hypertension-included organ damage. Hypertension is a common disease associated with high morbidity and mortality (Joseph and Renata, 2009).

National High Blood Pressure Education Programme (NHBPEP) of United States has recognized the presence of primary hypertension in children and adolescents are exposed to multiple risk factors including obesity and also family history of hypertension. Early diagnosis of Hypertension is an important strategy in its control, which will be useful in tracking and effective treatment, to prevent further complications (Obarzanek et al., 2010).

Coronary Heart Disease

Metabolic syndrome is associated with CVD or type 2 diabetes mellitus; it doubles the risk for CVD and further raises the risk for type 2 diabetes by about 5-fold. According to WHO, non–communicable diseases, including CVD and type 2 diabetes, were responsible for 52percent of the Eastern Mediterranean region's disease burden in 2006, and expected to rise to 60 percent by 2020 (Halfon et al., 2012).

Waist circumference is a simple measure by which abdominal obesity can be easily assessed, and a strong predictor of CVD risk factors in children, and its use

together with BMI has significant clinical importance for the prediction of risk factors among children and adolescents (Wan et al., 2007).

An increased prevalence of overweight and obesity, together with cardio vascular metabolic risk factors such as dyslipidemia and abnormal blood pressure, were observed in adolescents, contributing to the onset of metabolic syndrome at younger ages. Risk factors for metabolic syndrome were more prevalent in females a total of 321 adolescents (Rizzo et al.,2013).

Cardiovascular diseases, particularly hypertension, account for high mortality in the form of cardiovascular strokes in countries like India, Taiwan and Japan. In Indian adolescent children, there is a high prevalence of obesity, hypertension, and hypercholesterolemia. Children and adolescence with hypertension are likely to be hypertensive as adults and will be at risk for early Coronary heart disease (Reinehr and Toschke, 2009).

B. Relationship between obesity and metabolic syndrome

The clustering of cardiovascular risk factors associated with abdominal obesity is well established. Although currently lacking a universal definition, the metabolic syndrome describes a constellation of metabolic abnormalities, including abdominal obesity, and was originally introduced to characterize a population at high cardiovascular risk. Adipose tissue is a dynamic endocrine organ that secretes several inflammatory and immune mediators known as adipokines. Deregulation of adipokine secretion, free fatty acid toxicity, and the site-specific differences in abdominal (visceral) versus subcutaneous fat support abdominal obesity as a causal factor mediating the insulin resistance, increased risk of diabetes, and cardiovascular disease in the metabolic syndrome *(*Phillips and, Prins et al.,2008).

Metabolic syndrome is associated with a pro-inflammatory state and the role of visceral obesity is thought to be central to this. Visceral obesity leads to alteration of the normal physiological balance of adipokines, insulin resistance, endothelial dysfunction and a pro-atherogenic state. In association with this, the presence of conventional cardiovascular risk factors such as hypertension, dyslipidaemia and smoking results in a significantly elevated cardiovascular and metabolic (cardiometabolic) risk. Better understanding of the molecular mechanisms central to

this association has led to the development of potential therapeutic agents. (Ritchie' and Connell et al.,2007).

A chronic low-grade inflammation and an activation of the immune system are involved in the pathogenesis of obesity-related insulin resistance and type 2 diabetes. Systemic inflammatory markers are risk factors for the development of type 2 diabetes and its macro vascular complications. Adipose tissue, liver, muscle and pancreas are themselves sites of inflammation in presence of obesity. An infiltration of macrophages and other immune cells is observed in these tissues associated with a cell population shift from an anti-inflammatory to a pro-inflammatory profile. These cells are crucial for the production of pro-inflammatory cytokines, which act in an autocrine and paracrine manner to interfere with insulin signaling in peripheral tissues or induce β-cell dysfunction and subsequent insulin deficiency. Particularly, the pro-inflammatory interleukin-1β is implicated in the pathogenesis of type II diabetes through the activation of the NLRP3 inflammasome. This supports the role of the immune system in the pathogenesis of insulin resistance and type 2 diabetes and to examine various mechanisms underlying this relationship. If type 2 diabetes is an inflammatory disease, anti-inflammatory therapies could have a place in prevention and treatment of type 2 diabetes. (Epub et al.,2014).

C. Physical activity – An intervention strategy for obesity and metabolic syndrome

Obesity has a complex development, involving environmental, physiological and genetic factors, the basic case of this condition is an imbalance between energy intake and energy expenditure. Physical activity is the only modified component of the energy expenditure and energy balance equation. Increasing physical activity has the potential to improve weight loss and maintenance. (Stettler et al., 2004).

Increasing the sedentary activity, particularly watching television, and using mobile , and an overall decrease in physical activity will increase the incident of overweight and obesity in adolescents. Regular physical activity is must because it will reduce the weight reduction and improving sensitivity in youth with type 2 diabetes. (American Diabetes Association,2000).

All aspects of metabolic syndrome benefit from increased physical activity. Physical exercise helps in losing weight and in maintaining weight loss, and it has additional independent metabolic effects that directly reduce insulin resistance. Physical activity is usually a safe and beneficial treatment for people with metabolic syndrome and its consequences, atherosclerotic cardiovascular disease and type 2 diabetes (Sipileat al ., 2009).

D. Role of Nutrition Education in Metabolic syndrome.

Nutrition plays a critical role in promoting and maintaining optimal health throughout the life style (Kuriyan et al., 2014).

To improve the health of adolescent girls, nutrition education is an important measure to improve dietary habits and ignorance are the main reason for poor nutritional status of the adolescent girls (Spence et al., 2009).

Nutrition education can be used as an effective measure to bring about favorable and significant changes in the dietary pattern of adolescent girls who are future mothers and who would be responsible for bringing nutritious balanced diet to their family members (Sharma et al., 2009).

Nutrition education is the process which assists the public in applying knowledge from nutrition science and the relationship between diet and health to their practices (Barasi,2009). Educating adolescent's plays an important role in generating social understanding and acceptance of broader interventions to improve nutrition (Franko et al., 2012).

Yudkin (2012) opined that need for nutrition education of the public implied that people are eating less than could be eating and they can be persuaded to eat better through nutrition education. It is said that persuasion in to changed behavior requires, three stages, knowledge, an attitude and behavior.

To take steps to improve the quality of their diets and thus their well being, nutrition education offers a great opportunity to individuals to learn about the essential of nutrition for health (Marshall et al., 2009).

Traditional nutrition education interventions have mainly targeted motivational determinants, such as attitude and self- efficacy. Although motivation alone will lead to sustained behavior change (Deursen and Dijk,2012).

Health education is a process that bridges the gap between health information and health practices. In recent years, the crucial role of nutrition education in improving nutritional status has been greatly recognized (Reghawanshi,2009). Nutrition education is usually community oriented (i.e.) designed with consideration of social and cultural context (Maria et al., 2013).

Good nutrition education provides good health. Better health enables people to improve their productive efficiency and it enhances the capacity and the consumption pattern of the population food and nutrition is thus intimately linked with production and economic development of the country (Chinko and story, 2009). A beneficial change in dietary habits is more significant in college students after the implementation of nutrition interventions (Silva et al., 2009).

Nutritional guidelines have been used as therapeutic package to reduce obesity, modulate insulin sensibility and improve cardiovascular protection (Gutin et al., 2009).

Treatment of the components of metabolic syndrome begins with lifestyle changes. Because lifestyle changes are easy to prescribe but difficult to carry out, often medications must be added to ensure that the treatment regimens succeed (Misra,2009). Reducing dietary calories and fats (especially saturated fats) and increasing exercise can significantly reduce the risk of developing diabetes and atherosclerotic cardiovascular disease (Wassink et al., 2009).

III METHODOLOGY

The methodology adopted for the study entitled "Impact of physical activity and nutrition education on metabolic syndrome among obese adolescent girls" is presented under the following:

1. Selection of Area and Participants
2. Screening for obesity
3. Ethical clearance of the study
4. Socio-economic background, dietary pattern, food consumption and life style pattern of selected obese adolescent girls.
5. Identification of metabolic syndrome
6. Development of physical activity packages and nutrition education aids.
7. Implementation of physical activity and nutrition education
8. Evaluation of the impact of selected obese adolescent girls
9. Analysis of data

1. Selection of Area

The present study was carried out in Coimbatore city. Since, the study participants were adolescents, it was decided by the investigator to select onecollege and one fitness centre for the study. As per permission to do the study, SNR & SONS COLLEGE, Coimbatore FITNESS ONE, a fitness centre, were selected for the prevalence study, using convenient sampling method. The convenient type of non-probability sampling which involves the sample being drawn from that part of population which is handy, a sample population selected because it is readily available and convenient (Gupta,2006).

Necessary permission was obtained from the authorities of the selected college and fitness center to conduct the study and convenient dates were fixed for obesity screening, data collection, biochemical evaluation and intervention.

2. Selection of participants

Participant between the age group of 18-21 years were selected for the study. Necessary permission was obtained from the college Principal and the hostel warden of SNR college ladies hostel and themanager of the fitness respectively to select the participants for the study.

3. Ethical clearance of the study

The research design and the protocols used in the study were submitted for scrutinisation and approval of the Institutional Human Ethical Committee and Ethical Clearance approval **No AUW/IHEC-14-15/XPD-02** was obtained. The Ethical clearance certificate given by the Institutional Ethical Committee Avinashilingam Institute for Home Science and Higher Education for Women is given in Appendix I.

4. Screening for obesity

From the selected study area, 100 participants were screened for obesity by measuring their height, body weight, and calculating their BMI as follows.

i. Measurement of Height

The subject should stand erect on a leveled surface, without shoes, looking straight with heels together and toes apart, shoulders and back of the head touching the wall. The investigator standing on the left side of the subjects should firmly hold the chin of the subject with her left hand and the occiput of the subject with her right little finger to maintain the Frankfurt horizontal plane. A flat object like scale was placed horizontally on top of the head and the height was measured in centimeters. (Bamji et al., 2009).

A vertical measuring tape was fixed on the wall and used to record the height. The investigator measured the height of each participant and an average of three measurements were recorded.

ii. Measurement of weight

Body weight is the most widely used and the simplest reproducible anthropometric measurement for the overall evaluation of nutritional status of adolescents. Weight is the most popular and reliable indicative of recent nutritional status. Body weight was

measured with the participants minimally clothed, without shoes standing in upright position using

PLATE I

MEASUREMENT OF WEIGHT

PLATE II

MEASUREMENT OF HEIGHT

PLATE III

COLLECTION OF BLOOD FOR BIOCHEMICAL ESTIMATION

PLATE IV

MEASUREMENT OF BLOOD PRESSURE

digital weighing scales. The balance was checked before taking the weight. The balance was adjusted to zero and the readings were noted. The weight was noted to the nearest 0.1kg.

iii. Body Mass Index

Weight and height measures can be used to calculate BMI, which is a better assessment tool. The body mass index (BMI) is one of the most commonly used measures. It can be simply calculated by dividing the body weight in kilograms by the height in meters square (kg/m²) BMI offers a reliable and valid measure of obesity in adolescent. BMI was calculated and the subjects were graded as per the WHO classification (2007) as

$$BMI = \frac{\text{Weight in kg}}{\text{Height in m}^2}$$

From the classification of BMI, out of the total 100 participants, 60 obese adolescent girls were selected and included for further study on their willingness.

5. Socio-economic background, dietary pattern, Food consumption and Life style pattern of selected obese adolescent girls

An interview schedule is a written list of questions, open ended, prepared for use by an interviewer in a person to person interaction (Kumar, 2009). The investigator formulated an interview schedule to elicit information on the socio-economic, personal information, health status, dietary pattern, food consumption pattern, lifestyle and physical activity pattern of obese adolescent girls.

Information on socio economic status, family history, menstrual history and a detailed medical history was collected using the formulated interview schedule.

A set of questions that each research participant fills out as part of the research study, the questionnaire is a self- report data collection (Johnson, 2012). A questionnaire which comprised of 20 multiple choice questions on metabolic syndrome, obesity, and essential nutrients during adolescence period, physical activity pattern was also formulated.

6.Identification of metabolic syndrome

International Diabetic Federation proposed a consensus definition of metabolic syndrome for children and adolescents so as to obtain a universally accepted tool which is easy to use for the early diagnosis, preventive measures before they develop diabetes or cardiovascular disease (Quah et al., 2010).

According to Parikh and Mohan (2012) obese adolescents with metabolic syndrome are at increasing risk of progressing to type 2 diabetes and cardiovascular disease in later life.

TABLE I

THE FOLLOWING CRITERIA WERE CONSIDERED FOR IDENTIFICATION OF METABOLIC SYNDROME

waist circumference	≥90cm for men, ≥80cm for women
Blood pressure	Systolic BP ≥130mmHg or Diastolic BP ≥85mmHg
Triglycerides	≥150mg/dL
HDL	<40 mg/dL in males and <50 mg/dL in females
Glucose	Fasting plasma glucose ≥100mg/dL

*** International Diabetic Federation, (2007)**

As per the criteria, the following measurements were taken

i. Waist and Hip Circumference

Waist and hip circumference as an index of obesity and obesity related health risk among adolescence, as the waist circumference has shown strong associations with risk for coronary heart disease (Kuriyan et al., 2010).

Waist and hip circumference were measured by making the participant stand straight and taken at a level midway between the lowest lateral border of the ribs and the uppermost lateral iliac crest using a measuring tape. A fiber glass tape was used to measure the waist and hip circumference and the readings were taken.

ii. Blood pressure

Elevated blood pressure is an early risk factor for cardiovascular disease and is positively associated with BMI (Brion et al., 2007). Blood pressure was measured with digital blood pressure monitor, where the participants was made to sit straight and the cuff was placed on left hand and measured.

iii. Blood lipid profile

Estimation of serum Triglycerides was done by (GPO/PAP method) and HDL was estimated by PPT.SET method.

Two ml of blood was collected from all the selected participants by alaboratory technician after 12 hours overnight fasting. The drawn blood was transferred into tubes and used for analysis.

iv. Blood glucose

Insulin resistance has been implicated in the pathogenesis of metabolic syndrome, moreover obesity in adolescents in the most common feature associated with Insulin resistance (Friend et al.,2013).

Blood glucose was measured by a one touch glucometer. One drop of blood was collected from the selected sample, after 12 hours over night fasting. The drawn blood was placed on the glucometer strip and the indicated blood glucose level was recorded.

6. Development of physical activity packages and nutrition education aids

Physical Activity Package

The physical activity package for intervention was developed with the help of fitness centre. The activities covered under the physical activity package are as follows.

- Cycling
- Stretch
- Exercise
- Salsa

- ❖ Stomach weight loss exercise which includes crunches, bicycle exercises, walking, running, jogging and cycling.

Nutrition Education aids

A power presentation consisting of 26 slides were prepared for imparting nutrition education among the obese adolescent girls. The topics covered under the nutrition knowledge on metabolic syndrome are as follows.

- ❖ Causes and symptoms of metabolic syndrome
- ❖ Risk factors of metabolic syndrome
- ❖ Overweight/obese
- ❖ Type 2 diabetes mellitus
- ❖ Hypertension
- ❖ Coronary Heart Disease
- ❖ Healthy tips to prevent obesity, CVD
- ❖ Metabolic syndrome diet plans
- ❖ Healthy food guide
- ❖ Obesity intervention
- ❖ Dietary change
- ❖ Glycemic index of foods
- ❖ Fat burning foods

Each topic to be presented was chosen carefully and the contents were made brief, along with the text contents, download images were included to make the power point.

7. Implementation of physical activity and nutrition education

The selected 60 participants were divided into three groups namely, Group A, B and C and each group consisted of twenty participants. Participants under Group A were given nutrition education, participants under Group B were given physical activity and participants under Group C were given both nutrition education and physical activity. The implementation study was carried out for a period of 90 days. A demo session was given for physical activity package for the girls belonging to Group B and C. The girls were able to carry out the physical activities and there was good cooperation among them.

8. Evaluation of selected obese adolescent girls

The impact of nutritional education and physical activity on the participants were evaluated by assessing the changes in their nutritional knowledge and by measuring the changes in their waist circumference and body weight.

9. Analysis of data

The data obtained was consolidated, tabulated, analyzed, and interpreted using appropriate statistical methods.

RESEARCH DESIGN

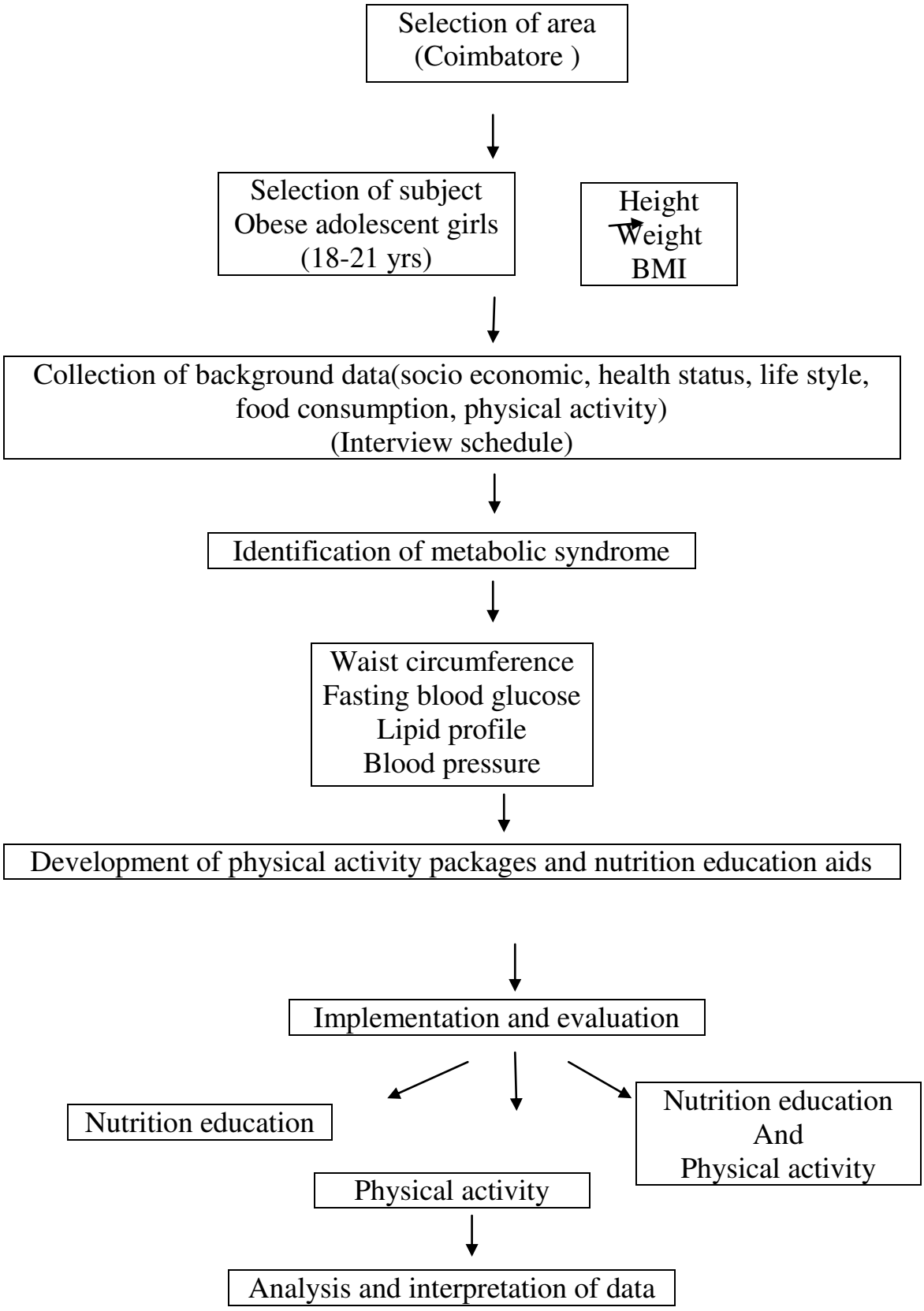

FIGURE 1

IV RESULTS AND DISCUSSION

The results of the study titled, **"Impact of Physical activity and Nutrition Education on Metabolic syndrome among Overweight and Obese Adolescent Girls"** is presented under the following headings:

E. Metabolic syndrome among obese adolescent girls.
F. Factors associated with overweight, obese and Metabolic Syndrome
G. Dietary and Lifestyle Pattern of Obese Adolescent girls.
H. Impact of Physical Activity and Nutrition Education of obese Adolescent girls

A. Metabolic syndrome among obese adolescent girls.

A total of two places, one in College and one in Fitness one were selected through convenient sampling method for the prevalence study. From this college and fitness centre, a total of 100 adolescent girls (in the age group 18-21 years) were screened for obese. The findings of the prevalence study are presented as follows:

1. Distribution of selected adolescent girls according to age

Table depicts the distribution of selected adolescent girls according to age.

TABLE II

DISTRIBUTION OF SELECTED ADOLESCENT GIRLS ACCORDING TO AGE

Age (in years)	No. of. Adolescent girls	Percentage
18	25	25.0
19	43	43.0
20	18	18.0
21	14	14.0
Total	100	100

Among the selected group, 25 students (25%) belonged to the age group of 18 years, followed by 43 students (43%) in the age group of 19 years, 18 students (18%) in the age group of 20 years and 14 students (14%) in the age group of 21 years.

2. Overall prevalence of Normal, Overweight, Obese and Underweight among selected adolescent girls

Table presents the Overall prevalence of Normal, Overweight, Obese and Underweight among selected adolescent girls.

TABLE III

OVERALL PREVALENCE OF NORMAL, OVERWEIGHT, OBESE AND UNDERWEIGHT AMONG SELECTED ADOLESCENT GIRLS

Normal*		**Overweight***		**Obese***		**Underweight***	
No	%	No	%	No	%	No	%
20	20	38	38	22	22	20	20

***Based on WHO (2007)**

The body weights and heights of all the 100 adolescents girls were measured, Their body mass index calculated using WHO cut-off 2007 BMI. Based on the classification, it was found that 20 (20%) had normal BMI below normal where considered as underweight. These findings seek attention in the importance of imparting awareness leading to a healthy lifestyle.

As per the classification, the overall prevalence of overweight and obese among adolescent girls belonging to college and fitness in Coimbatore was found to be 22 per cent and 38 per cent respectively. The percentage of normal adolescent girls was 20 per cent and underweight adolescent girls were 20 per cent respectively.

Obese is the result of a caloric imbalance and is mediated by genetic, behavioral and environmental factors. It is associated with several risk factors for later heart disease and other chronic diseases including hyperlipidaemia, hyperinsulinemia, hypertension, and early atherosclerosis.

3. Anthropometric Measurements of overweight and obese adolescent girls

Table revealed the mean anthropometric measurements of overweight and obese adolescent girls.

TABLE IV

ANTHROPOMETRIC MEASUREMENTS OF OVERWEIGHT AND OBESE ADOLESCENT GIRLS

Variables	Values	Mean ± SD	
		Overweight (38)	Obese (22)
Height (cm)	152	157.6±6.1	159.7±6.3
Weight (kg)	52.1	63.9±5.2	80.0±12.2
Body Mass Index (cm)	22.9	25.7± 0.9	31.2±3.1
Waist circumference (cm)	>80	34.1±4.1	35.2±4.3
Hip circumference (cm)	>80	32.0±3.0	32.9±3.4

The above table, clearly revealed that the over weight, obese adolescent girls at the age group of 18, 19, 20 and 21 years the mean height of was 157 cm and the standard height was 152cm, the mean height of obese girls height was 159 cm. The mean weight of the overweight adolescent girls was 63 kg and the obese girls was 80 kg and the standard weight was 52 kg. The BMI of the overweight girls 25.7cm and obese girls 31.2 cm and the standard value was 22.9cm.

The mean waist circumference of the overweight adolescent was 34.1cm and the obese was 35.2cm and the standard value was >80, hip circumference is overweight girls was 32cm and obese 32.9cm and the standard value was >80.

4. Body weight, Waist circumference and Blood pressure of overweight and obese adolescent girls

The body weight, waist circumference, and blood pressure of overweight, obese adolescent girls in the age group 18-21 years was presented in Table.

TABLE V

CRITERIA FOR IDENTIFYING METABOLIC SYNDROME AMONG OVERWEIGHT AND OBESE ADOLESCENT GIRLS

Criteria	Value *	Total number of adolescent girls			
		Overweight (38)		Obese (22)	
		No	%	No	%
Waist circumference(cm)	≥80cm	32	84.2	17	77.2
Systolic BP (mmHg)	>130	18	47.3	15	68.1
Diastolic BP(mmHg)	>85	21	55.2	19	86.3
Fasting blood glucose (mg/dl)	>100	29	76.3	22	9.0
Triglycerides (mg/dl)	>150	20	52.6	18	81.8
HDL	<50	28	73.6	11	50

*** International Diabetic Federation, (2007)**

It was observed from the table for Metabolic syndrome among overweight and obese adolescents, nearly 84.2 and 77.2 per cent of the subjects had higher degree of waist circumference, and 73.6 and 50 per cent of them had low HDL concentration. 52.6 and 81.8 per cent had higher level of triglycerides. About 47.3 and 68.1 per cent of the subjects had elevated systolic blood pressure, 55.2 and 86.3 per cent of the subjects had elevated diastolic blood pressure. 76.3 and nine per cent of the subjects had slightly higher than the normal range.

5. Biochemical profile of selected overweight obese adolescent girls

The biochemical profile of selected overweight and obese adolescent girls is given in Table.

TABLE VI

BIOCHEMICAL PROFILE OF OVERWEIGHT AND OBESE ADOLESCENT GIRLS

Blood Indices	Standard value	Mean value ± S.D
Fasting Blood glucose (mg/dl)	>100	83.8±5.9
Triglycerides (mg/dl)*	>150	102.7±39.0
HDL	<50	48.8±3.7

It was observed from the table that the mean fasting blood glucose level of overweight and obese adolescent girls was 83.8mg/dl which was below the normal range (>100 mg/dl). The mean values of triglycerides were lesser than the normal values (102.7mg/dl). HDL cholesterol level was found to be lower than the standard value for all the overweight obese adolescents girls (48.8mg/dl).

6. Menstrual history of overweight and obese adolescent girls

The menstrual history of overweight, obese adolescent girls is presented in Table.

TABLE VII

MENSTRUAL HISTORY OF OVERWEIGHT AND OBESE ADOLESCENT GIRLS

Health status		No. of respondents			
		Overweight(38)		Obese(22)	
		No	%	No	%
Age of Menarche (years)	10-12	12	31.5	5	22.7
	12-14	18	47.3	14	63.6
	14-16	8	21.0	3	13.6
	Total	38	100	22	100
Pattern of Menstrual Cycle	Regular	26	68.4	17	77.2
	Irregular	12	31.5	5	22.7
Duration of Menstrual Cycle (in days)	<25	4	10.5	3	13.6
	25-34	25	65.7	13	59.0
	35-60	5	13.1	4	18.1
	>60	-	-	-	-
	Totally irregular	4	10.5	2	9.0
Treatment for menstrual problem	On treatment	4	10.5	2	9.0
	Nil	34	89.4	20	90.9

Among the selected 60 overweight, obese adolescent girls, 12 , overweight students and 5 obese students attained their puberty in the age group of 10-12 years,

18 overweight and 14 obese students and remaining 8 overweight students and 3 obese students attained their puberty in the age group of 12-14 years and 14-16 years. It is revealed from the present study that 25 overweight students, and 13 of adolescent girls have their menstrual cycle of 25-34 days while 4 overweight adolescent girls and 3 obese girls of the subjects have their menstrual cycle of less than 25 days, it was noted that 5 overweight girls and 4 obese of the subjects have their menstrual cycle of 35-60 days and whereas 4 overweight girls, and 2 obese girls of the subjects have an irregular cycle. 10.5 per cent of the selected subjects are on treatment for irregular cycle

B. Factors associated with overweight, obese and Metabolic Syndrome

1. Socio economic profile of overweight, obese adolescent girls

Table shows the socio-economic background of obese adolescent girls.

TABLE VIII

SOCIO-ECONOMIC BACKGROUND OF OVERWEIGHT AND OBESE ADOLESCENT GIRLS

Socio-economic factors		No. of. Respondents			
		Overweight(38)		Obese(22)	
		No	%	No	%
Type of family	Nuclear Joint	27 11	71 28.9	18 4	81.8 18.1
Family Size	1-3 3-4 5 and above	7 28 3	18.4 73.6 7.8	7 9 8	31.8 40.9 36.3
Occupation of the head of the family	Agriculturists Business Laborers	11 12 15	28.9 31.5 39.4	4 13 5	18.1 59.0 22.7
Total monthly income	<3000 3300-8000 8000-15000 >15000	- 2 12 24	- 5.2 31.5 63.1	- 3 16 19	- 7.8 42.1 50

Details on socio economic background of the selected adolescent girls was elicited it terms of their type in family, monthly income of the family, occupation of

the head of the family using a structured interview schedule and the results obtained are tabulated.

Majority of overweight, obese adolescent girls (71) (81.8%) belonged to nuclear families and the remaining (28.9%) (18.1%) belonged to the joint families. It is general observation that obese adolescent girls of nuclear families receive more attention and nutrition which may lead to obese.

Family size is one of the factors, which affect the nutritional status of individuals, there by the entire family and the society. The above the above table showed 18.4 and 31.8 per cent of families had 1-3 members and belonged to small family, 73.6 and 40.9 per cent of families had 3-4 members and 7.8, and 36.3 per cent families had five and above members in their families.

It was found that 28.9 and 18.1 per cent of head of the families of subjects were agriculturists, 31.9 and 50 per cent were engaged in business, and head of families of 29.4 and 22.7 per cent were laborers.

A total of sixty three per cent and fifty pre cent families had a monthly income of more than Rs.15,000 and were classified as high income group, whereas thirty one per cent and forty one per cent of families had a monthly income ranging from Rs. 8000-15000 falling into the category of middle income group, it was found that none of the subjects belonged to very low income group.

2. Birth order and birth weight of overweight and obese adolescent girls

Details of birth order and birth weight of obese adolescent girls are present in Table.

TABLE IX

BIRTH ORDER AND BIRTHWEIGHT OF OVERWEIGHT AND OBESE ADOLESCENT GIRLS

Birth order	Over weight (38)		Obese (22)		Birth weight	Over weight (38)		Obese (22)	
	No	%	No	%		No	%	No	%
1	9	23.6	5	22.7	<2.5	-	-	3	13.6
2	21	55.2	11	50	2.5-3.0	7	18.4	4	18.1
3	8	21.0	6	15.7	3.0-3.5	23	60.5	8	36.3
					3.5-4.0	6	15.7	5	22.7
					4.0-4.5	2	5.2	2	9.0

The findings revealed that 23.6 per cent and 22.7 per cent of overweight and obese adolescent girls were the first child in the family whereas 55 per cent and 50 per cent of overweight and obese adolescent girls were the second child in the family whereas 21 per cent and sixteen per cent of overweight and obese girls were the third child in the family. It is found from the study that 23 per cent and 8 per cent of overweight and obese adolescent girls were born with a weight between 3-3.5 kg whereas 5.2 per cent and 9.0 per cent of overweight and obese adolescent girls were born with a weight more than 4-4.5kg. whereas 15.7 per cent and 22.7 per cent of overweight and obese adolescent girls were born with a weight of 3.5-4.0. The remaining 3 per cent of overweight and obese adolescent girls were born with a weight of less than 2.5kg.

C. Dietary and Lifestyle Pattern of Obese Adolescent girls.

1. Type of diet, meal pattern and skipping of meals

Table the dietary and lifestyle pattern of obese adolescent girls are presented as follow

TABLE X

TYPE OF DIET, MEAL PATTERN AND SKIPPING OF MEALS OF OVERWEIGHT AND OBESE ADOLESCENT GIRLS

Dietary pattern		No. of adolescent girls			
		Over weight (38)		Obese (22)	
		No	%	No	%
Type of diet consumed	Vegetarian	13	34.2	4	18.1
	Non-Vegetarian	25	65.7	18	81.8
	Lacto-ova Vegetarian	-	-	-	-
	Ova- Vegetarian	-	-	-	-
Meal Pattern	2 meal	9	23.6	3	13.6
	3 meal	17	44.7	8	36.3
	4 meal	12	31.5	11	50
Type of meal skipped	Breakfast	28	73.6	19	86.3
	Lunch	4	10.5	3	13.6
	Dinner	6	15.7	-	-

65.7 and 81.8 per cent of the overweight and obese adolescent girls were non-vegetarian and 34.2 and 18.1 per cent were vegetarians.

A total of 23.6 and 13.6 per cent of overweight and obese adolescent girls followed a two meal pattern, 44.7 and 36.3 per cent of overweight and obese adolescent girls followed a three meal pattern, and 31.5 and 50 per cent of overweight and obese adolescent girls were followed a four meal patterns per day respectively.

The findings indicate, that a higher percentage of obese adolescent girls had skipped their meals. It was observed in the present study that 73.6 and 86.3 per cent of overweight and obese adolescent girls skipped their breakfast. Among the selected group, 10.5 and 13.6 per cent skipped their lunch and 15.7 per cent skipped their dinner.

2. Frequency of skipping meals and compensation for meals skipped by obese adolescent girls

Details regarding the frequency of skipping meal are given in table.

TABLE XI

FREQUENCY AND COMPENSATION OF MEALS SKIPPED

Frequency and Compensation of Meals Skipped		Overweight(38)		Obese(22)	
		No	%	No	%
Frequency of skipped meals	Daily Once/Twice a week Occasionally	12 18 8	31.5 47.3 21.0	3 4 15	13.6 18.1 68.1
Food After Skipped meals	Type of meals			5	
	Mid morning Lunch	5 33	13.1 86.8	8 14	36.3 63.6
Eat during mid morning/ lunch	Types of food items				
	Snacks Fruit juices Whole fruits Meals	8 6 2 22	21.0 15.7 5.2 57.8	6 3 2 11	27.2 13.6 9.0 50.0

It was revealed from the above the table that 31.5 and 13.6 per cent of the overweight and obese adolescent girls skipped their meals daily. 47.3 and 18.1 per cent of the overweight and obese adolescent girls skipped their meals once/twice a week, whereas 21 and 68.1 per cent of overweight and obese adolescent girls skipped their meals occasionally.

Study that 13.1 and 36.8 per cent of overweight and obese adolescent girls ate food during lunch after skipping their breakfast and remaining 86.8 and 63.6 per cent of the overweight and obese adolescent girls ate during midmorning snacks to compensate the breakfast.

21 and 27.2 per cent of overweight and obese adolescent girls ate snacks to compensate the skipped meals, 15.7 and 13.6 per cent of overweight and obese adolescent girls consumed fruit juices to compensate their skipped meals and 5.2 and 9 per cent of overweight and obese adolescent girls consumed whole fruit to compensate their skipped meals respectively. The remaining 57.8 and 50 per cent of overweight and obese adolescent girls never compensated for their skipped meals and they directly preferred lunch.

3. Frequency of consumption of non-vegetarian foods

Frequency of consumption of non-vegetarian foods in given in Table

TABLE XII

FREQUENCY OF CONSUMPTION OF NON-VEGETARIAN FOODS

Frequency of consumption of non-vegetarian	No. of adolescent girls			
	Overweight(38)		Obese(22)	
	No	%	No	%
Daily	7	18.4	9	40.9
Once a week	28	73.6	13	59.0
Once a month	3	7.8	-	-
Rarely	-	-	-	-

It was revealed from the above table, 73.6 and 59 per cent of the overweight and obese adolescent girls consumed non- vegetarian foods once a week, 7.8 per cent of overweight girls consumed non- vegetarian foods once a month, 18.4 and per cent consumed non-vegetarian foods daily of the overweight and obese adolescent girls.

4**. Food consumption pattern of adolescent girls**

Table presented data about the Food consumption pattern of the obese adolescent girls.

sThe consumption pattern of cereals and millets varied among girls and within cereals and millets too. Food frequency pattern of the obese adolescent girls revealed that 100 per cent of adolescent girls consumed rice everyday and other cereals and millets like ragi and wheat were consumed once a week, twice or thrice in a week, sometimes once in a month or occasionally. Among the pulses, red gram dhal was consumed regularly on all the days while other pulses black gram, green gram, horse gram were consumed either once in a week. Vegetables and green leafy vegetables were not taken daily, it was eaten once, twice or thrice in a week. With a regard to fruits, banana was consumed regularly, 97 per cent consumed milk and milk products every day, 100 per cent of the adolescents consumed oil and sugar everyday.

5. Mean food intake of overweight and obese adolescent girls

The mean food intake of obese adolescent girls in comparison with the recommended dietary allowances.

TABLE XIV
MEAN FOOD INTAKE OF OVERWEIGHT AND OBESE ADOLESCENT GIRLS

Food Groups (g)/ (ml)	RDA*	Actual intake	% Excess or deficit
Cereals (g)	330	420	+27.2
Pulses (g)	75	56	-20.6
Green leafy vegetables (g)	100	78	-22
Roots and Tubers (g)	200	250	+25
Other vegetables (g)	200	124	-33.6
Fruits (g)	100	78	-26
Milk and milk products (ml)	500	380	-24
Fish and fleshy foods (g)	125	160	+27.6
Fats and oils (ml)	35	42	+21
Sugar and jaggery (g)	25	40	+40

***ICMR (2011)**

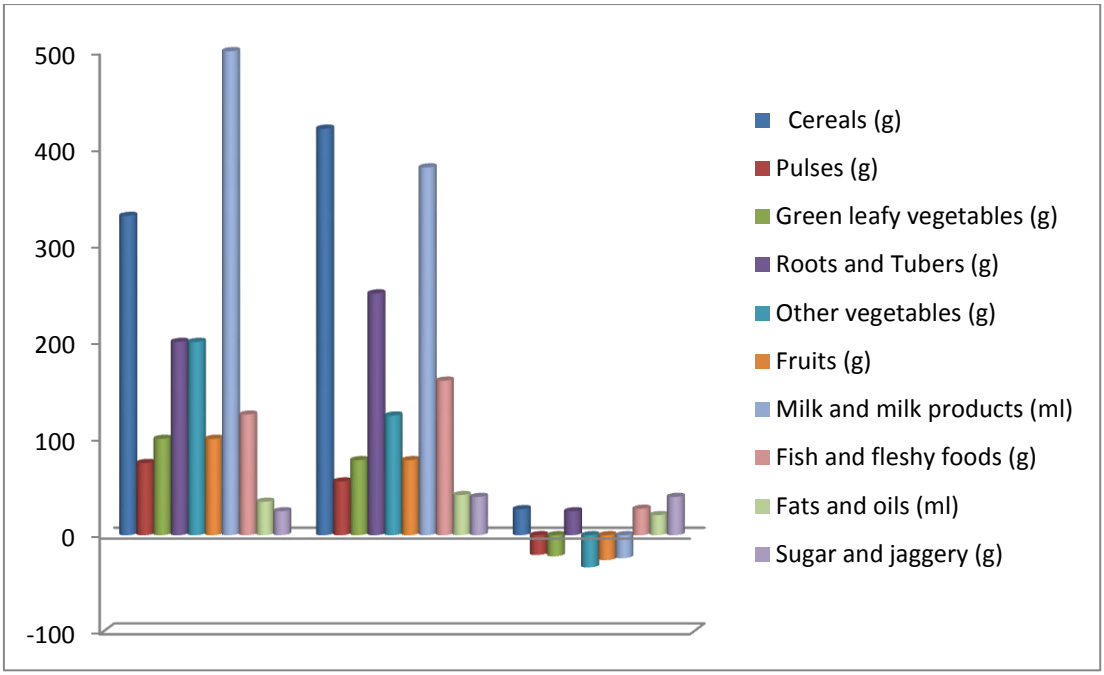

FIGURE 2

MEAN FOOD INTAKE OF OVERWEIGHT AND OBESE ADOLESCENT GIRLS

It was observed that mean food intake of all the food groups by obese adolescent girls excluding cereals, roots and tubers, fish and fleshy foods, fats and oils, sugar and jiggery was deficit than the suggested allowances of ICMR. The intake of pulses was deficit by 20.6 per cent. The findings revealed that consumption of green leafy vegetables was less by 22 per cent and fruits were deficit 26 per cent by when compared with RDA. The food choices was not uniformly distributed and was concentrated from cereals and other energy dense foods a direct source for excess energy intake and there by increasing the risk for metabolic syndrome.

The intake of milk and milk products was deficit by 24 per cent among obese adolescent girls. With regard to intake of other vegetables there was also found to be higher per cent of deficit by 33.6., the consumption of cereals, roots and tubers, fats and oils and fleshy food was in excess by 27.2, 25, 21,and 27.6 per cent respectively. Sugar and jaggery was found to be 40 per cent excess than RDA.

5. Fitness pattern of obese adolescent girls

Details on fitness pattern of obese adolescent girls are presented in Table

TABLE XV

FITNESS PATTERN OF OVERWEIGHT AND OBESE ADOLESCENT GIRLS

Type of fitness	Details	Overweight(38)		Obese(22)	
		No	%	No	%
Follow dieting	Yes	17	44.7	16	72.7
	No	21	55.2	6	27.2
Attending physical fitness class	Yes	27	71.0	12	54.5
	No	11	28.9	10	45.4
Duration of fitness class	½-1 hour	18	66.6	6	50.0
	1-1/2 hour	9	33.3	4	33.3
	11/2- 2 hour	-	-	2	16.6
	>2 hour	-	-	-	-
Measures to stay healthy	Yoga	3	7.8	2	9.0
	Meditation	6	15.7	4	18.1
	Physical activity	17	44.7	12	54.5
	Diet modification	12	31.5	4	18.1

From the table, 44.7 and 72.7 per cent practiced dieting. To stay healthy 15.7 and 18.1per cent of subjects optioned meditation their diet to lead a healthy life. Majority 44.7 and 54.5 per cent of the adolescent girls had participated in physical fitness class and out of those had participated, it was noted that 66.6 and 50.0 per cent of them practiced for ½ to 1 hour and 16.6 per cent of them had worked out for 11/2 to 2 hours.

6. Physical activity pattern of obese adolescent girls

Details on physical activity pattern of obese adolescent girls are presented in table

TABLE XVI

PHYSICAL ACTIVITY PARTTERN OF OVERWEIGHT AND OBESE ADOLESCENT GIRLS

	Exercise pattern	No. of. adolescents			
		Overweight(38)		Obese(22)	
		No	%	No	%
Exercise daily	Yes	27	71.0	19	86.3
	No	11	28.9	3	13.6
Type of exercise	Walking	18	47.3	7	31.8
	Jogging	12	31.5	9	40.9
	Others	8	21.0	6	27.2
Duration of exercise	½ hour	19	50	16	72.7
	1-2 hour	13	34.2	4	18.1
	>2 hour	6	15.7	2	9.0
Reason for not doing exercise	Joint pain	5	13.1	6	27.2
	Shortness of breath	6	15.7	7	31.8
	No routine	27	71.0	9	40.9

It was found that majority 71 and 86.3 per cent had carried out any physical activity or exercise and the kind of exercise varied. If was found that 28.9 and 13.5 per cent of study group had not exercised. Majority of 47.3 per cent of walking, followed by 21 and 27.2 per cent who carried out other forms of exercise like salsa, aerobics, and 31.5 and 40.9 per cent of the group had jogging. 50 and 72.7 per cent of exercised for ½ hour, followed by 34.2 and 18.1 per cent who exercised 1-2 hours.

The reason for not carrying out exercise was 15.7 and 31.8 per cent had problems of shortness of breath while exercising, 71 and 40.9 per cent were not able to maintain a routine in performing exercise. Such figures and reasons for not performing exercise emphasis on importance of education on healthy lifestyle for healthy living.

D. Impact of Physical Activity and Nutrition Education on Among obese Adolescent girls

A questionnaire consisting of multiple choice questions was administered to the obese adolescent girls and the changes in nutritional knowledge, attitude and practices of the obese adolescent girls imparting nutrition education was evaluated.

They consisting the some of physical activity to the selected obese adolescent girls and the changes in physical activity, attitude and practices of the obese adolescent girls imparting physical activity was evaluated.

i. Changes in mean scores for nutritional knowledge of obese adolescent girls

Table showed the mean scores for nutritional knowledge of obese adolescent girls before and after education.

TABLE XVII

CHANGES IN MEAN SCORES FOR NUTRITIONAL KNOWLEDGE OF OVERWEIGHT AND OBESE ADOLESCENT GIRLS BEFORE AND AFTER EDUCATION

Score=20

Category	No. of. adolescent girls					
	Over weight (38)			Obese (22)		
	Before education	After education	Mean difference ±SD	Before education	After education	Mean difference ±SD
Group I	4.11±1.21	14.36±1.67	10.25±0.46	4.03 ± 1.23	14. 32± 1.54	10.29± 0.31
Group III	4.7±1.22	15.11±1.49	10.64±0.27	4.46± 1.21	15.39± 1.35	10.93± 0.14

Group I - Nutrition education only

Group II - Nutrition education and physical activity.

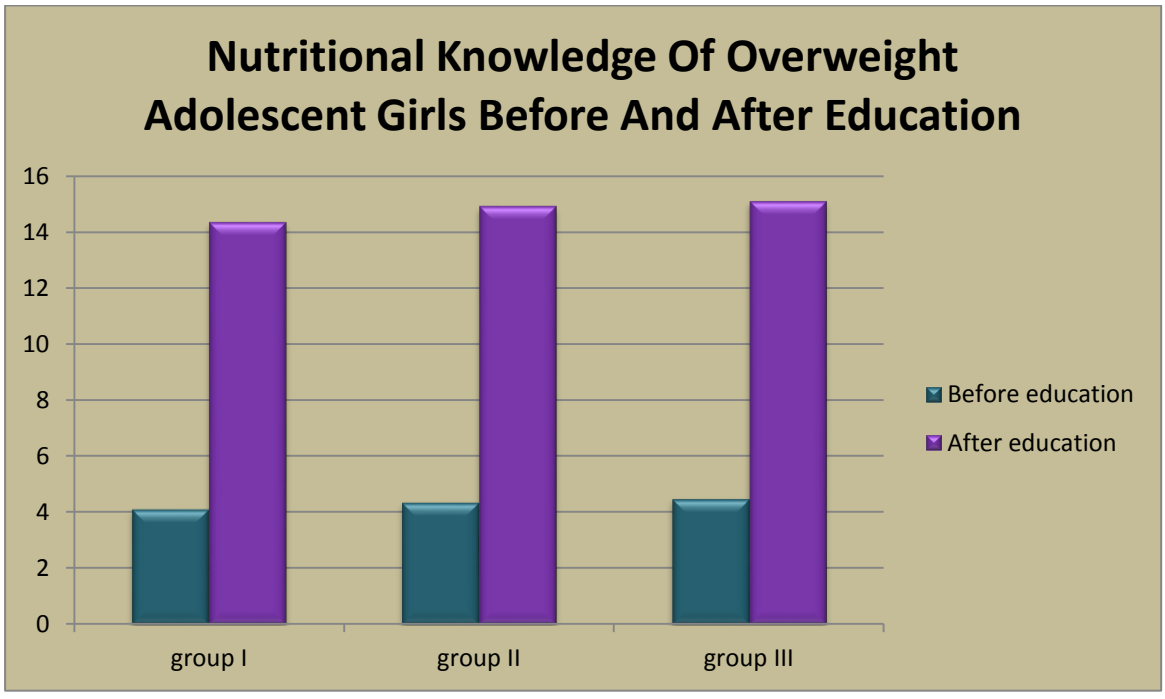

FIGURE 3

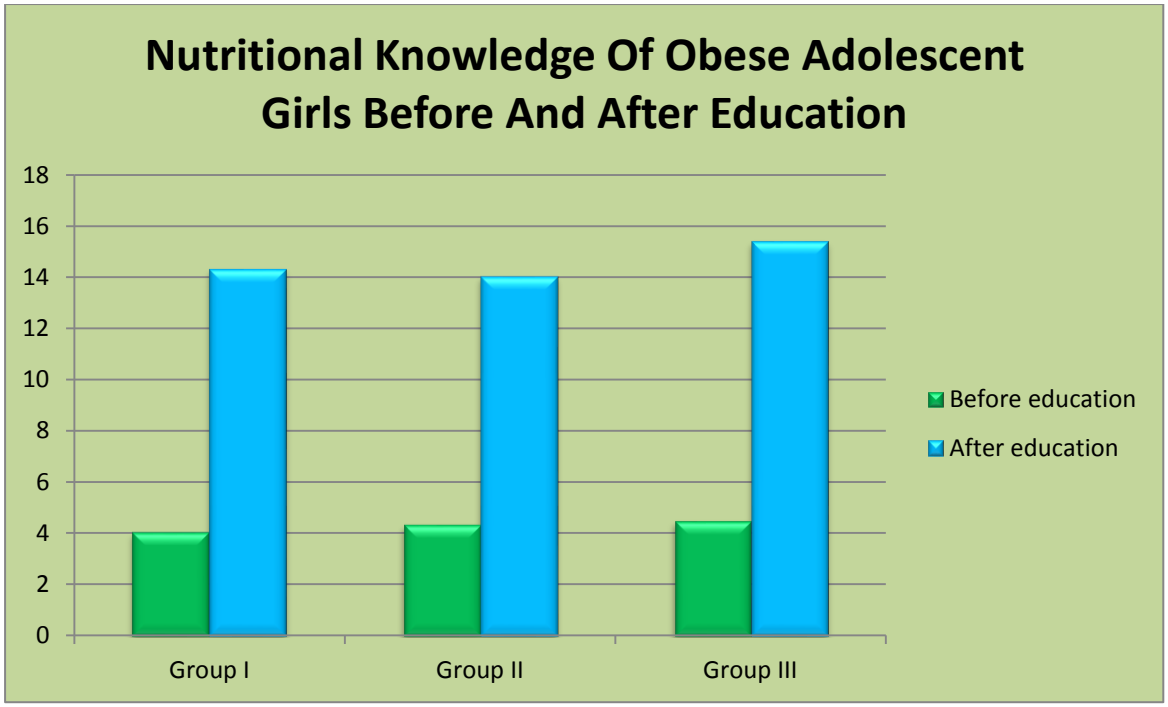

FIGURE 4

It was observed from the present study that there was an increase in nutritional knowledge after imparting nutrition education among overweight and obese adolescent girls. The scores for nutritional knowledge before education were 4.1 and it had increased to 14.4 after education and before education were 4.0 and it had increased 14.3 among the overweight and obese adolescent girls, while among the overweight obese adolescent girls in the physical activity scores before education was 4.3 and it had increased to 14.9, 14. after education and the overweight and obese adolescent girls nutrition education and physical activity scores before education were 4.5 and it had increased to 15 after education.

TABLE XVIII

MEAN ANTHROPOMETRIC MEASUREMENTS OF ADOLESCENT GIRLS BEFORE AND AFTER INTERVENTION

Parameters	Mean ± SD		Mean difference ± SD
	Before intervention	After intervention	
Weight (kg)			
Group A	59.9±6.40	58.9±7.01	-1.0±0.37
Group B	58.4±4.71	57.1±4.65	-1.2±0.11
Group C	53.4±6.47	52.2±6.46	-1.4±0.10
Body Mass Index (BMI)			
Group A	27.1±2.22	26.1±2.20	-1.0±0.02
Group B	28.2±2.20	27.2±2.18	-1.0±0.02
Group C	26.3±3.21	25.3±3.20	-1.0±0.01
Waist circumference (cm)			
Group A	32.2±1.23	31.2±1.19	-1.0±0.04
Group B	33.4±2.32	32.2±2.30	-1.2±0.02
Group C	34.2±1.23	33.2±1.20	-1.0±0.03

Group A- Nutrition education only

Group B- Physical activity only

Group C- Physical activity and Nutrition education.

In the present study, the mean weight of overweight and obese girls in experimental Groups A, B, and C was found to be 59.9, 58.4, 53.4 kg at the start of the intervention strategies which got reduced 58.9, 57.1, and 52.2 respectively after

the intervention strategies. The mean difference in weight reduction ranged from 1kg to 1.4kg among all the groups.

The findings of the present study revealed that the mean body mass index of the overweight and obese girls given different intervention strategies had a reduction. It was observed that the mean BMI value among the overweight and obese girls in Groups A, B, and C were 27.1, 28.2, 26.3initially, which reduced to 26.1, 27.2, 25.3 after intervention with a mean difference of 1.0- 1.6 respectively.

Before intervention, the mean waist circumference of experimental groups A, B, and C ranged from 32.2, 33.4, 34.2 cm but intervention reduced to 31.2, 32.2, 33.2 cm.

V SUMMARY AND CONCLUSION

Adolescence is a state or process of growing up from puberty to maturity and is the period of the second growth spurt. It is a prime time for health promotion and for establishment of healthy behavior that influence health in later years. It is important for adolescents to consume enough calories to support normal growth and development without promoting excessive weight gain.

Adolescent around the world are eating more calories, they are not necessarily eating healthier food. High fats and empty calories, combined with a decrease in physical activity, have created an obesity problem among them.

Obesity is one of the most significant contributes or morbid conditions like metabolic syndrome. Adolescent obesity is a major public health problem associated with cardiovascular risk factors including abdominal obesity, insulin resistance, dyslipidemia and hypertension.

Metabolic syndrome is caused by an unhealthy lifestyle that includes eating too many calories, being inactive and gaining weight particularly around your waist which can lead to insulin resistance, a condition in which the body is unable to respond normally to insulin and lead to type 2 diabetes.

The obese adolescents were educated and instructed to visit the nutritional website and changes in their nutritional knowledge.

With this in view the present study entitled, “Impact of Physical activity and Nutrition education on metabolic syndrome among overweight and obese adolescent girls”.

A total of one college, one fitness center in Coimbatore, one college in SNR college and fitness centre were selected through convenient sampling method for the prevalence study. From these college and fitness centers, a total of 103 adolescent girls in the age group 18-21 years were selected and screened for obesity.

- Among the selected group, 25 students (25%) belonged to the age group of 18 years, followed by 43 students (43%) in the age group of 19years and 18 students (18%) in the age group of 19 years and 14 students (14%) in the age group of 21 years.

- The study revealed that 20 students (20%) had normal BMI, 38 students (38%) had BMI above normal were classified as overweight, 22 students (22%) were categorized as obese, while 20 students (20%) had BMI below normal where considered as underweight.

- 22 adolescent girls who had BMI >24.5,>24.6>,24.8 and >25.0 were of 18,19,20 and 21 years respectively were classified as overweight while 36 adolescent girls having their BMI >28.8 for 18years,>29.0 for 19 years,>29.2 for 20 years, and >29.5 for 21 years were categorized as obese and 18 adolescent girls having their BMI below 18.1 were considered as underweight.

- Over weight, obese adolescent girls at the age group of 18, 19, 20 and 21 years the mean height of was 157 cm and the standard height was 152cm, the mean height of obese girls height was 159 cm. The mean weight of the overweight adolescent girls was 63 kg and the obese girls was 80 kg and the standard weight was 52 kg. The BMI of the overweight girls 25.7cm and obese girls 31.2 cm and the standard value was 22.9cm.

- The mean waist circumference of the overweight adolescent was 34.1cm and the obese was 35.2cm and the standard value was >80, hip circumference is overweight girls was 32cm and obese 32.9cm and the standard value was >80.

- Metabolic syndrome among overweight and obese adolescents was nearly 84.2 and 77.2 per cent of the subjects had higher degree of waist circumference, and 73.6 and 50 per cent of them low HDL -C concentration. 52.6 and 81.8 per cent had higher level of triglycerides. About 47.3 and 68.1 per cent of the subjects had elevated systolic blood pressure, 55.2 and 86.3 per cent of the subjects had elevated diastolic blood pressure. 76.3 and nine per cent of the subjects had slightly higher than the normal range.

- The mean fasting blood glucose level of overweight and obese adolescent girls was 83.8mg/dl which was below the normal range (>100 mg/dl). The mean values of triglycerides were lesser than the normal values (102.7mg/dl). HDL

cholesterol level was found to be lower than the standard value for all the overweight obese adolescents girls (48.8mg/dl).

- The selected 60 overweight, obese adolescent girls, 12 , overweight students and 5 obese students attained their puberty in the age group of 10-12 years, 18 overweight and 14 obese students and remaining 8 overweight students and 3 obese students attained their puberty in the age group of 12-14 years and 14-16 years. It is revealed from the present study that 25 overweight students, and 13 of adolescent girls have their menstrual cycle of 25-34 days while 4 overweight adolescent girls and 3 obese girls of the subjects have their menstrual cycle of less than 25 days, it was noted that 5 overweight girls and 4 obese of the subjects have their menstrual cycle of 35-60 days and whereas 4 overweight girls, and 2 obese girls of the subjects have an irregular cycle. 10.5 per cent of the selected subjects are on treatment for irregular cycle.

- Majority of overweight, obese adolescent girls (71%) (81.8%) belonged to nuclear families and the remaining (28.9%) (18.1%) belonged to the joint families. It is general observation that obese adolescent girls of nuclear families receive more attention and nutrition which may lead to obese.

- Family size is one of the factors, which affect the nutritional status of individuals, there by the entire family and the society. The above the above table showed 18.4 and 31.8 per cent of families had 1-3 members and belonged to small family, 73.6 and 40.9 per cent of families had 3-4 members and 7.8, and 36.3 per cent families had five and above members in their families.

- It was found that 28.9 and 18.1 per cent of head of the families of subjects were agriculturists, 31.9 and 50 per cent were engaged in business, and head of families of 29.4 and 22.7 per cent were laborers.

- A total of sixty three per cent and fifty pre cent families had a monthly income of more than Rs.15,000 and were classified as high income group, whereas thirty one per cent and forty one per cent of families had a monthly

income ranging from Rs. 8000-15000 falling into the category of middle income group, it was found that none of the subjects belonged to very low income group.

- 23.6 per cent and 22.7 per cent of overweight and obese adolescent girls were the first child in the family whereas 55 per cent and 50 per cent of overweight and obese adolescent girls were the second child in the family whereas 21 per cent and sixteen per cent of overweight and obese girls were the third child in the family. It is found from the study that 23 per cent and 8 per cent of overweight and obese adolescent girls were born with a weight between 3-3.5 kg whereas 5.2 per cent and 9.0 per cent of overweight and obese adolescent girls were born with a weight more than 4-4.5kg. Whereas 15.7 per cent and 22.7 per cent of overweight and obese adolescent girls were born with a weight of 3.5-4.0. The remaining 3 per cent of overweight and obese adolescent girls were born with a weight of less than 2.5kg.

- 65.7 and 81.8 per cent of the overweight and obese adolescent girls were non-vegetarian and 34.2 and 18.1 per cent were vegetarians.

- A total of 23.6 and 13.6 per cent of overweight and obese adolescent girls followed a two meal pattern, 44.7 and 36.3 per cent of overweight and obese adolescent girls followed a three meal pattern, and 31.5 and 50 per cent of overweight and obese adolescent girls were followed a four meal patterns per day respectively.

- A higher percentage of obese adolescent girls had skipped their meals. It was observed in the present study that 73.6 and 86.3 per cent of overweight and obese adolescent girls skipped their breakfast. Among the selected group, 10.5 and 13.6 per cent skipped their lunch and 15.7 per cent skipped their dinner.

- It was revealed from the above the table that 31.5 and 13.6 per cent of the overweight and obese adolescent girls skipped their meals daily. 47.3 and 18.1 per cent of the overweight and obese adolescent girls skipped their meals

once/twice a week, whereas 21 and 68.1 per cent of overweight and obese adolescent girls skipped their meals occasionally.

- 13.1 and 36.8 per cent of overweight and obese adolescent girls ate food during lunch after skipping their breakfast and remaining 86.8 and 63.6 per cent of the overweight and obese adolescent girls ate during midmorning snacks to compensate the breakfast.

- 21 and 27.2 per cent of overweight and obese adolescent girls ate snacks to compensate the skipped meals, 15.7 and 13.6 per cent of overweight and obese adolescent girls consumed fruit juices to compensate their skipped meals and 5.2 and 9 per cent of overweight and obese adolescent girls consumed whole fruit to compensate their skipped meals respectively. The remaining 57.8 and 50 per cent of overweight and obese adolescent girls never compensated for their skipped meals and they directly preferred lunch.

- 73.6 and 59 per cent of the overweight and obese adolescent girls consumed non- vegetarian foods once a week, 7.8 per cent of overweight girls consumed non- vegetarian foods once a month, 18.4 and per cent consumed non-vegetarian foods daily of the overweight and obese adolescent girls.

- The consumption pattern of cereals and millets varied among girls and within cereals and millets too. Food frequency pattern of the obese adolescent girls revealed that 100 per cent of adolescent girls consumed rice everyday and other cereals and millets like ragi and wheat were consumed once a week, twice or thrice in a week, sometimes once in a month or occasionally. Among the pulses, red gram dhal was consumed regularly on all the days while other pulses black gram, green gram, horse gram were consumed either once in a week.

- Vegetables and green leafy vegetables were not taken daily, it was eaten once, twice or thrice in a week. With a regard to fruits, banana was consumed

regularly, 97 per cent consumed milk and milk products every day, 100 per cent of the adolescents consumed oil and sugar everyday.

- The mean food intake of all the food groups by obese adolescent girls excluding cereals, roots and tubers, fish and fleshy foods, fats and oils, sugar and jiggery was deficit than the suggested allowances of ICMR. The intake of pulses was deficit by 20.6 per cent. The findings revealed that consumption of green leafy vegetables was less by 22 per cent and fruits were deficit 26 per cent by when compared with RDA. The food choices was not uniformly distributed and was concentrated from cereals and other energy dense foods a direct source for excess energy intake and there by increasing the risk for metabolic syndrome.

- The intake of milk and milk products was deficit by 24 per cent among obese adolescent girls. With regard to intake of other vegetables there was also found to be higher per cent of deficit by 33.6., the consumption of cereals, roots and tubers, fats and oils and fleshy food was in excess by 27.2, 25, 21,and 27.6 per cent respectively. Sugar and jaggery was found to be 40 per cent excess than RDA.

- 44.7 and 72.7 per cent practiced dieting. To stay healthy 15.7 and 18.1per cent of subjects optioned meditation their diet to lead a healthy life. Majority 44.7 and 54.5 per cent of the adolescent girls had participated in physical fitness class and out of those had participated, it was noted that 66.6 and 50.0 per cent of them practiced for ½ to 1 hour and 16.6 per cent of them had worked out for 11/2 to 2 hours.

- Majority 71 and 86.3 per cent had carried out any physical activity or exercise and the kind of exercise varied. If was found that 28.9 and 13.5 per cent of study group had not exercised. Majority of 47.3 per cent of walking, followed by 21 and 27.2 per cent who carried out other forms of exercise like salsa, aerobics, and 31.5 and 40.9 per cent of the group had jogging. 50 and 72.7 per cent of exercised for ½ hour, followed by 34.2 and 18.1 per cent who exercised 1-2 hours.

- The reason for not carrying out exercise was 15.7 and 31.8 per cent had problems of shortness of breath while exercising, 71 and 40.9 per cent were not able to maintain a routine in performing exercise. Such figures and reasons for not performing exercise emphasis on importance of education on healthy lifestyle for healthy living.

- An increase in nutritional knowledge after imparting nutrition education among overweight and obese adolescent girls. The scores for nutritional knowledge before education were 4.1 and it had increased to 14.4 after education and before education were 4.0 and it had increased 14.3 among the overweight and obese adolescent girls, while among the overweight obese adolescent girls in the physical activity scores before education was 4.3 and it had increased to 14.9, 14. after education and the overweight and obese adolescent girls nutrition education and physical activity scores before education were 4.5 and it had increased to 15 after education.

- The mean weight of overweight and obese girls in experimental Groups A, B, and C was found to be 59.9, 58.4, 53.4 kg at the start of the intervention strategies which got reduced 58.9, 57.1, and 52.2 respectively after the intervention strategies. The mean difference in weight reduction ranged from 1kg to 1.4kg among all the groups.

- The findings of the present study revealed that the mean body mass index of the overweight and obese girls given different intervention strategies had reduced. It is observed that the mean BMI value among the overweight and obese girls in Groups A, B, and C were 27.1, 28.2, 26.3initially, which reduced to 26.1, 27.2, 25.3 after intervention with a mean difference of 1.0-1.6.

- ❖ Before intervention, the mean waist circumference of experimental groups A, B, and C ranged from 32.2, 33.4, 34.2 but intervention reduced to 31.2, 32.2, 33.2cm.

CONCLUSION

Metabolic syndrome among adolescent girls shows an alarming increase, world wide. Severe obesity, age, puberty status, presence of family history of cardio vascular disease, type 2 diabetes, obesity and hypertension to be important risk factors associated with metabolic syndrome in adolescencts.

Appropriate nutrition education would certainly improve their nutrition knowledge as observed from the present study. The findings from this study to increase awareness and promote healthy lifestyles in college and fitness centers thus preventing the problem. Immediate lifestyle modifications are needed to control the obesity epidemic and its metabolic consequences.

From the findings of the study the following recommendations are made:

- Meal replacement for the overweight and obese girls can be given.
- Intervention period can be increased to six month.
- Nutrition education can be given to college going students and school children on metabolic syndrome.

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ANNEXURE II

INTERVIEW SCHEDULE ON SOCIO ECONOMIC BACKGROUND, LIFESTYLE PATTERN, HEALTH AND NUTRITIONAL STATUS OF ADOLESCENT GIRLS

A. SOCIO ECONOMIC STATUS

1. Name :
2. Age :
3. Date of birth :
4. Occupation : student /working
5. Name of the institution /working centre :
6. Place of residence

   a) Home b) Hostel c) others specify

   _____
7. Address for communication

   Pin code :

   Mobile number :

   E-mail id:
8. Religion :
9. Family type

   a)Nuclear family b) Joint family
10. Birth order : 1 ☐ 2 ☐ 3☐ 4☐ 5 ☐

11. Composition of the family

s.no	Name of the family members	Relation ship	Age (years)	Education	Occupation	Income

12. No., of siblings :
13. Birth weight (kg) :
14. Family income per month (rupees) :
15. Food expenditure per month (rupees) :

B. HEALTH STATUS

16. What is your age of menarche?
17. Do you have regular menstrual cycle (monthly periods)? yes/no
18. About how long was your average menstrual cycle (time from first day of one period to the first day of the next period)? a)< 25 days b) 25-34 days c)35-60 days d)more than 60 days e) Irregular always
19. Do you consult your doctor for your menstrual problem? yes/no
    If yes, what treatment was suggested?

20. Are you allergic to any food items? yes/ no
    If yes, specify the food item that you are allergic to?

21. Do you have any of the following health disorders? (Tick " √whatever is applicable)

a) Obese / over weight
b) Diabetes
c) Hypertension
d) Cholesterol
e) Heart problem
f) Thyroid
g) Anemia

22. Are you affected from any disorder/diseases other than the above mentioned question?

23. Do you have any of the following complications

•Tiredness	☐	• Hip pain	☐	
•Back pain	☐	• Sleeplessness	☐	
•Knee pain	☐	• Swelling	☐	
•Frequent eating	☐	• Anorexia nervosa	☐	
•Asthma	☐	• High blood pressure	☐	•None ☐

24. Do you have a family history of the following?

Health problems	Family member (Relationship)
Diabetes Hypertension Cholesterol Heart problem None	

C. DIETARY AND FOOD CONSUMPTION PATTERN

25. Food consumption pattern (Tick the appropriate one)

- Vegetarian
- Non-vegetarian
- Lacto vegetarian
- Ova-vegetarian

26. Type of meal pattern followed (tick the appropriate column)?

Meal pattern	Breakfast	Lunch	Evening	Dinner
2 meal				
3 meal				
4 meal				

27. Frequency of consumption of non-vegetarian foods (mutton/chicken)?

a) Daily b) once a week c) once a month d) rarely

28. Do you skip meals? Yes/ no

If yes, breakfast/ lunch/ dinner

29. Mention the reason for skipping meals.

a) Time constraints b) fasting c) Others, specify

_____

30. Frequency with which you skip meal?

a) Daily b) once/twice in a week c)occasionally

31. When do you eat after the skipped breakfast? midmorning / lunch

32. What do you eat during midmorning/ lunch?

Snacks / Fruit juice/ Meals/ Others, specify_____

33. Do you have the habit of drinking fresh juice every day? Yes/no

34. If you drink the fresh juice, how much quantity you drink of what kind?

_____

35. Do you eat snacks? Yes / no

36. What is your favorite snack item? _____

37. Do you consume soft drinks? yes/no

If yes,

a) Daily b) weekly c) occasionally

38. Do you eat outside? Yes/no

If yes, where?

•Restaurant	☐	•Fast food stalls	☐
•Cafeteria	☐	• Ready to eat foods	☐
•Street vendors	☐	• Chat corner	☐

39. Among the food establishments that have mentioned above, where do you go more often? _____

40. What kind of foods you prefer the most?

- Vegetarian based recipes
- Non vegetarian based recipes

41. Do you share your food with your friends? Yes/ no

42. Which of the following influence your food habits?

a) Friends b) advertisements c) parents d) self

43. Do you have the habit of seeing nutritional information in any snacks pack? Yes/no

44. Do you eat while watching TV? Yes/ no

C.**FOOD CONSUMPTION PATTERN:**

45. 24-Hour recall

Time	Menu	Ingredients	Quantity
Early morning			
Breakfast			
Midmorning			
Lunch			
Tea time			
Dinner			
Bed time			

46. Food Frequency (Tick the appropriate column)

S. nos	Food groups	Daily	Weekly thirce	Weekly twice	Weekly once	Fortnight (50 days once)	Monthly	Occasionally
	MEAT & FISH GROUPS							
1.	Mutton gravy							
2.	Chicken gravy							
3.	Chilly chicken							
4.	Tandoori chicken							
5.	Chicken popcorn							
6.	Chicken cutlet							
7.	Fried fish							
8.	Chilly fish							
9.	Shell fish							
	BREAD &SAVORY ITEMS							
10.	White bread							
11.	Brown bread							
12.	Cream crackers							
13.	Cheese biscuits							
14.	Nut cookies							
15.	Millet cookies							
	CEREALS							
16.	Porridge							
17.	Breakfast cereals (cornflakes, muesli etc…)							
	POTATOES,							

	RICE, PASTA & FAST FOODS							
18.	Chips							
19.	Roast potatoes							
20.	White rice							
21.	Brown rice							
22.	Pasta							
23.	Macaroni							
24.	Noodles							
25.	Pizza							
26.	Burger							
27.	Bonda							
S. no	Food groups	Daily	Weekly thirce	Weekly twice	Weekly once	Fortnight	Monthly	Occasionally
28.	Bajji							
29.	Pav-bajji							
30.	Cutlet							
31.	Pani puri							
32.	Bhel puri							
33.	Dhahi puri							
34.	Mushroom manchurian							
35.	Masala puri							
36.	Samosa							
37.	Puffs							
38.	Gobi manchurian							
39.	Fried noodles							
	DAIRY PRODUCTS							
40.	Cheese							
41.	Milk shake							

42.	Butter							
43.	Yoghurt							
44.	Khoa							
45.	Egg							
46.	Salad cream, mayonaisse							
47.	French dressing							
	SWEETS AND SNACKS							
48.	Chocolate biscuit							
49.	Sweet biscuit, plain							
50.	Cakes							
52.	Buns, pastries							
53.	Puddings							
54.	Ice-creams							
55.	Chocolate bars							
56.	Sweets,toffee, mints							
57.	Peanuts or other nuts							
	SOUPS, SAUCES AND SPREADS							
58.	Meat/ chicken soups							
59.	Sauces							
S. no	Food groups	Daily	Weekly thirce	Weekly twice	Weekly once	Fortnight	Monthly	Occasionally
60.	Tomato ketchup							
61.	Pickles							
62.	Jam, marmalade							

63.	Peanut butter							
64.	Drinks							
65.	Tea							
66.	Coffee							
67.	Hot chocolates							
68.	Soft drinks							
69.	Fruit juices							
	FRUITS							
70.	Apple							
71.	Pears							
72.	Banana							
73.	Musambi							
74.	Oranges							
75.	Grapes							
76.	Plums							
77.	Guava							
78.	Pomegranate							
79.	Papaya							
	DRIED FRUIT AND NUTS							
80.	Raisins							
81.	Figs(athippalam)							
82.	Cashews							
83.	Badams							
84.	Pistas							
	VEGETABLES							
85.	Carrot							
86.	Spinach							
87.	Broccoli							
88.	Peas							
89.	Green beans							
90.	Cauliflower							

91.	Onions							
92.	Garlic							
93.	Mushroom							
94.	Cucumber							
95.	Celery							
96.	Sweet corn							
97.	Beetroot							
98.	Beans							
99.	Tofu							
100	Soy beans							

D. LIFE STYLE PATTERN

46. Which oil is used in your family for cooking?

•Refined oil ☐ •Coconut oil ☐ •Groundnut oil ☐

•Gingelly oil ☐ •Sunflower oil ☐

47. How much oil is purchased every month in your family?

•1-3 liters

•3-5 liters

•5 liters and above

48. What is your mode of transport to school/university/college/workplace?

49. Do you have the habit of snacking while watching TV? Yes / no

50. How long you watch TV?

•30 minutes

•1 hour

•2 hours

•More than 2 hours

51. Do you follow dieting? Yes/ no.

52. Do you go for any physical fitness centre? Yes/ no

If yes, how many hours

•½ - 1hour

•1 hour- 1½ hours

•1½hours – 2 hours

•More than 2 hours

53. What do you do to stay healthy?

•Yoga

•Meditation

•Physical activity

•Diet modification

PHYSICAL ACTIVITY:

54. Do you exercise daily? yes/ no

If yes, what sort of exercise?

•Walking

•Jogging

•Cycling

•Others _____

55. How many minutes you spent in doing exercise?

A) ½ hour

B) 1 hour

C) 1 hour and above

56. Is there any reason for not doing the exercise? yes/no

If yes, what is the reason from the following?

•Joint pain

•Breath shortness

•No routine

•Laziness

57. Do you spend your time in browsing centers? Yes/ no

If yes, how many hours

•Less than one hour

•1-2 hours

•More than 2 hours

58. Where do you get nutritional information?

•Schools/colleges

•Friends

•Parents

•Radio/TV/magazines

•Internet

59. Have you visited any diet counseling websites?

    If yes, list out few nutritional websites

60. What is the reason for visiting such nutritional websites?

61. ANTROPOMETRIC MEASUREMENTS

    a) Height(cm) _____

    b) Weight(cm) _____

    c) BMI _____

    d) Waist circumference _____

    e) Hip circumference _____

    f) Waist / hip ratio _ _____

    g) Body fat percentage _____

    h) Body composition _____

ANNEXURE III

QUESTIONNAIRE TO ASSESS NUTRITIONAL KNOWLEDGE AND PRACTICE OF OVERWEIGHT AND OBESE ADOLESCENT GIRLS

1. Have you heard about the term metabolic syndrome?

Yes/No

2. People with metabolic syndrome are usually
    a. Overweight or obese
    b. Lactose intolerance
    c. Smokers
    d. Depressed
3. What is considered as larger waist for women?
    a. > 28 inches
    b. > 30 inches
    c. > 32 inches
    d. > 35 inches
4. ---------- is the best way to treat metabolic syndrome
    a. Weight loss
    b. Fasting
    c. Lifestyle modification
    d. Exercise
5. Obesity is caused by
    a. Lack of physical activity
    b. Less eating
    c. Eating protein rich foods
    d. Eating low calorie foods
6. Loss of physical activity leads to
    a. Overweight
    b. Tiredness
    c. Dental caries
    d. Underweight
7. Which food is rich in protein?
    a. Sundal
    b. Potato chips
    c. Noodles
    d. Ice cream
8. Which among these foods is rich in fats?
    a. Fruits
    b. Vegetables
    c. Oils
    d. Cereals

9. Which is the junk food among the following?
    a. Fruits
    b. Bread
    c. Pizza
    d. Idly
10. Packaged snacks are rich in
    a. Salt
    b. Sugar
    c. Proteins
    d. Vitamins
11. What might be the result of metabolic syndrome risk factors?
    a. Diabetes
    b. Skin problem
    c. Leg pain
    d. Headache
12. How do you feel, when you skip the breakfast?
    a. Increased concentration
    b. Decreased activity
    c. Increased memory
    d. Increased activity

13. From the following, can you say the use of dietary fibre?
    a. Reduces cholesterol level
    b. Increase body mass
    c. Increase weight
    d. Decreases blood level

14. How often do you skip your breakfast?
    a. Daily
    b. Once a week
    c. Occasionally
    d. Never
15. How often do you drink milk?
    a. Once a day
    b. Twice a day
    c. Thrice a day
    d. Never
16. How often do you include fruits and vegetables in your diet?
    a. Daily

b. Weekly
c. Monthly
d. Rarely

17. What will you do immediately after dinner?
    a. To be in front of TV
    b. Simply sitting chatting
    c. Suddenly engaging into household works
    d. Go for mild walking
18. Are you maintaining a lifestyle pattern? Yes/No
    If yes,
        a. Exercise
        b. Dieting
        c. Yoga
        d. Aerobics

19. Which game makes you more physically active?
    a. Chess
    b. Video games
    c. Cricket
    d. Computer game
20. Do you have the habits of exercising? Yes/No
    If Yes,
        a. 15 minutes
        b. 30 minutes
        c. 45 minutes
        d. 1 hour

ANNEXURE IV

ESTIMATION OF HDL CHOLESTROL

AIM

To estimate the amount of HDL cholesterol in the given serum.

SUMMARY

Lipoprotein are the proteins which mainly transport fats in the blood stream, they can be grouped into chylomicrons, very low density lipo protein (VLDL). Low density lipoproteins (LDL) and high density lipoproteins (HDL). Chylomicrons and VLDL transport mainly triglycerides, though VLDLs also transport some amount of cholesterol. LDL arteriosclerotic heart and peripheral vascular disease. Hence high level of LDL is antherogenic. HDL transport cholesterol from the peripheral tissues to the liver for excretion hence HDL has a protective effect. The measurement of total and HDL cholesterol and triglycerides provide valuable information for the risk assessment of coronary heart disease.

PRiNCIPLE

When the serum is reacted with the polyethylene glycol contained in the precipitating reagent, all the VLDL & LDL are precipitated. The HDL remains in the supernatant & is then assayed as a sample for cholesterol using the cholesterol (CHOD/PAP).

REAGENT PREPARATION

Reagents are ready to use.

After the preparation step cholesterol reagent is required additionally for conducting the cholesterol assay.

SAMPLE MATERIAL

Serum, EDTA plasma, HDL cholesterol is reported to be stable in serum for 7 days when stored at 2-8ºc. The sample should preferably be of 12-14hours fasting.

PROCEDURE

Pipette into clean dry test tubes labeled as blank (B), standard (S), & test (T).

Addition sequence	**B (ml)**	**S(ml)**	**T(ml)**
Working standard	1.0	1.0	1.0
Distilled water		-	-
HDL standard (S)	-	0.05	-
Supernatant	-	-	0.05

Mix well and incubate at 37ºc for 5 minutes or at R.T (25ºc) for 15 minutes. Measure the absorbance of the standard (Abs.S) and the test sample (Abs.T) against the blank, within 60 min.

CALCULATIONS

$$\text{HDL cholesterol in mg/dl} = \frac{\text{Abs.T} \times 25 \times 2}{\text{Abs.S}}$$

(Where 2 is the dilution factor due to the deprotenization step).

RESULT

The amount of HDL cholesterol present in serum/plasma: (mg/dl).

ANNEXURE V

ESTIMATION OF TRIGLYCERIDES IN SERUM

PRINCIPLE

The triglycerides in the serum sample are hydrolyzed enzymatically by the action of lipase to glycerol and fatty acids. The glycerol formed is converted to glycerol phosphate by glycerol kinase (GK). Glycerol phosphate is then oxidized di hydroxy acetone phosphate by glycerol oxidase(GPO). The liberated hydrogen peroxide is detected chromogenic acceptor, chlorophenol-4 - aminoantipyrine, in the presence of pereoxide (POD) . The red quinine formed is proportional to the amount of triglycerides present in the sample.

lipase

Triglycerides ⟶ Glycerol + fatty acids

GK

Glycerol + ATP ⟶ Glycerol-3-P+ ADP

GPO

Glycerol-3-P ⟶ Dihydroxyacetone -P + H_2O_2

POD

$2H_2O_2$ + chlorophenol + 4-AP ⟶ Red quinine + 4 H_2O

PROCEDURE

1. Blood sample is drawn from the patient and centrifuged. Then serum is separated for estimation of triglycerides.
2. Determine the concentration of triglycerides in the provided serum sample using the available kit for triglycerides determination as follows:
3. In a clean dry test tube, add 10µl of distilled water (blank), or standard triglycerides (standard) or serum sample (test), and then add 1 ml of the working reagent (N.B volumes are withdrawn by automatic pipettes using the proper disposable tips as instructed in the lab). The working reagent contains: lipase, glycerol kinase, glycerol phosphate oxidase and peroxidase.

	BLANK	STANDARD	TEST
Distilled water	10	-	-
Standard	-	10	-
Serum	-	-	10
Working reagent	1ml	1ml	1ml

- Mix and incubate for 5 min at 37º
- Measure the absorbance of the test and standard against blank at 500 nm. The final color is stable for at least 2 hours.
- Calculate the concentration of triglycerides (mg/dl) in the provided serum sample using the absorbance reading of standard triglycerides and applying the following equation:

Ctest = Cstd × Atest / Astd

RESULT

The amount of triglycerides present in Serum/plasma : (mg/dl).