EFFICIENCY OF NUTRITIONAL THERAPY IN SECONDARY SCHOOL-AGE STUDENTS OF PRINCESS CHULAPORN'S COLLEGE CHIANGRAI, THAILAND IN LOWERING RISK FACTORS OF CARDIOVASCULAR DISEASE

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ABSTRACT

In 2008, the study of nutritional status in boarding students of Princess Chulaporn's College Chiangrai shown the prevalence of obesity and CVD risk factors in these students were similar to in adults. So nutrition therapy for reducing obesity and CVD risk factors in students is very important. Therefore, this study conducted to evaluate an efficiency of nutritional therapy in these students to reduce the severity of obesity and various risk factors of CVD. This study was conducted in 49 obese students, 59 dyslipidemic students, 13 hypertriglyceridemic students, and 41 hyperglycemic students. They participated in nutrition therapy for 16 months follow-up and individual counseling to improve nutritional status every four months assessed by anthropometric parameters, biochemical parameters, and dietary record. The results showed that body fat in 88.9% of obese male students decreased from 1.5-15.0 %bw, 90.3% of obese female students decreased from 0.3-12.4 %bw, LDL levels in 81.0% of hypercholesterolemic students decreased from 0.2-87.2 mg/dL, TG levels in 84.6% of hypertriglyceridemic students decreased from 5.0-159.0 mg/dL, and FBG levels in all hyperglycemic students decreased from 16.0-78.0 mg/dL. In conclusion, this nutrition therapy can reduce obesity and risk factors of CVD efficiently by simplifying the nutrition education knowledge and some suggestions which easily to understand and practice. Regulary follow-up, individual and class consultation, nutrition boards both in dormitory and school areas, and modification of school meal contributed to successful results. Moreover, this nutrition therapy had beneficial and promote a good health to teacher, parents and staff of the school to learn and apply nutrition to their health properly. It is noticeable from this study that the assessment of dietary record by students was not suitable for student population. Owing to the compliance of students were low, but did not affect the nutrition therapy at all in our study.

KEY WORDS: NUTRITIONAL THERAPY / CVD RISK FACTORS / OBESITY / PCCCR / STUDENTS

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ประสิทธิภาพการให้โภชนบำบัดในนักเรียนระดับมัธยมศึกษา โรงเรียนจุฬาภรณราชวิทยาลัย เชียงราย ต่อการลดปัจจัยเสี่ยงของโรคหัวใจและหลอดเลือด

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บทคัดย่อ

การศึกษาภาวะโภชนาการในนร.ประจำโรงเรียนจุฬาภรณราชวิทยาลัย เชียงราย ในปีการศึกษา 2551 พบความชุกของ นร.อ้วนและ นร.ที่มีปัจจัยเสี่ยงต่อโรคหัวใจและหลอดเลือดใกล้เคียงกับในกลุ่มประชากรผู้ใหญ่ การให้โภชนบำบัดในนร.กลุ่มเสี่ยงนี้จึงมีความสำคัญอย่างมาก ดังนั้นจึงดำเนินการศึกษานี้เพื่อประเมินประสิทธิ -ภาพการให้โภชนบำบัดในนร.ดังกล่าวต่อการลดภาวะอ้วนและความรุนแรงของปัจจัยเสี่ยงต่างๆของโรคหัวใจและหลอดเลือด ทำการศึกษาในนร.อ้วนจำนวน 49 คน นร.ที่มีระดับไขมันในเลือดสูงจำนวน 58 คน นร.ที่มีระดับไตรกลีเซอร์ไรด์ในเลือดสูงจำนวน 13 คน และนร.ที่มีระดับน้ำตาลในเลือดสูงจำนวน 41 คน โดยให้เข้าร่วมโครงการโภชนบำบัดนาน 16 เดือน ติดตามผลและให้คำปรึกษารายบุคคลเพื่อปรับปรุงภาวะโภชนาการทุก 4 เดือน โดยประเมินจากค่าสัดส่วนร่างกาย ผลชีวเคมีในเลือด และบันทึกรายการอาหารที่รับประทาน ผลการศึกษาพบว่าร้อยละ 88.9 ของนร.ชายอ้วนมีระดับไขมันในร่างกายลดลง 1.5-15.0 %ของน้ำหนัก ร้อยละ 90.3 ของนร.หญิงอ้วนมีระดับไขมันในร่างกายลดลง 0.3-12.4 %ของน้ำหนัก ร้อยละ 81 ของนร.ที่มีระดับแอล-ดี-แอลโคเลสเตอรอลในเลือดสูงลดลง 0.2-87.2 มก./ดล. ร้อยละ 84.6 ของนร.ที่มีระดับไตรกลีเซอร์ไรด์ในเลือดสูงลดลง 5-159 มก./ดล. และ นร.ทั้งหมดที่มีระดับน้ำตาลในเลือดสูงลดลง 16-78 มก./ดล. สรุปจากการศึกษาครั้งนี้ การให้โภชนบำบัดเพื่อลดภาวะอ้วนและปัจจัยเสี่ยงการเกิดโรคหัวใจและหลอดเลือดโดยการให้ความรู้ด้านโภชนาการที่ถูกต้อง เข้าใจง่าย และสามารถนำไปปฏิบัติได้จริง ติดตามผลสม่ำเสมอ และให้โอกาสเข้าปรึกษานักโภชนาการได้ทั้งแบบส่วนตัวและรายกลุ่ม ร่วมด้วยการติดสื่อเกี่ยวกับโภชนบำบัดในบริเวณโรงเรียน หอพัก ปรับปรุงวัตถุดิบและเมนูในการจัดเตรียมอาหารของโรงเรียน ทำให้ได้ผลดีมาก รวมทั้งยังส่งผลดีไปยังสังคมครู ผู้ปกครอง และบุคลากรอื่นๆของโรงเรียนได้เรียนรู้และนำโภชนบำบัดไปดูแลสุขภาพตนเองได้อย่างถูกต้อง เป็นการสร้างเสริมสุขภาพที่ดีด้วย เป็นที่น่าสังเกตจากการศึกษานี้ว่าการให้นร.จดบันทึกอาหารเพื่อนำมาประเมินตลอดโครงการนั้นเป็นสิ่งที่ไม่เหมาะสมสำหรับประชากรกลุ่มนร. ปฏิบัติตามได้ไม่ดีแต่ก็ไม่ส่งผลต่อการให้โภชนบำบัดแต่อย่างใด

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LIST OF ABBREVIATIONS

AHA	American Heart Association
BMI	Body mass index
BW	Body weight
CDC	The Centers for disease Control and Prevention
cm	Centimeter
cont.	Continued
CVD	Cardiovascular disease
DBP	Diastolic blood pressure
DM	Diabetes mellitus
dL	Decilitre
FBG	Fasting blood glucose
g.	Gram
GH	Growth hormone
HDL	High density lipoprotein cholesterol
Hb	Hemoglobin
INMU	Institute of nutrition, mahidol University
Kcal	Kilocalorie
Kg	Kilogram
LH	Leutienizing hormone
LDL	Low density lipoprotein-cholesterol
M	Mathayom
m	Meter
mg	Milligram
mL	Milliliter
mm	Muscle mass

LIST OF ABBREVIATIONS (cont.)

mo	Month
MOPH	Ministry of Public Health
n	Number
NCEP	The National Cholesterol Education Program
NS	Not significant
RDA	Recommended dietary allowance
SBP	Systolic blood pressure
SEM	Standard error mean
SPSS	Statistical package for the social science
TC	Total cholesterol
TG	Triglyceride
USPSTF	The United States Preventive Service Task Force
VLDL	Very low density lipoprotein-cholesterol
WHO	World Health Organization
WHR	Waist over hip ratio

CHAPTER I
INTRODUCTION

1.1 Background

Cardiovascular disease (CVD) is expected to become one of the major of morbidity and premature mortality not only in developed country but also in developing country such as Thailand. According to World Health Organization (WHO) estimates, in 2005, 17.5 million people died from CVD. This is 30 percent of all deaths globally (1). In Thailand, the current mortality rate of CVD among Thai population, it is assumed that there would be 167 deaths from CVD each day, or seven persons would die every hour, from CVD (2). Definition of CVD is a malfunction of heart and blood vessel system (arteries, vein, and capillaries) such as congestive heart failure, coronary heart disease, stroke, hypertensive disease, and atherosclerosis (3). CVD is a life threatening condition. At beginning, the oxidized low density lipoproteins cholesterol (LDL) and migration of monocyte were built up in the internal layer of vessel in this stage show no sign of abnormal symptoms and normal blood flow. In the next stage, fatty streaks are formed beneath the endothelium and protrude toward the internal layer of vessel. Therefore, the diminution of blood vessel decreases blood supply of oxygen and nutrients to the affected organ. In case of exercise or more activity, the heart or brain tissue doesn't get enough of oxygen perfusion. In the later progression, the raised lesion or plaque interrupt the blood supply to the brain or heart (4). CVD is an imperative cause of socio-economic hardships due to lost income, decreased productivity and increased health care costs. Over 80 percent of chronic disease deaths occur in low and middle income countries and occur almost equally in men and women. At least 20 million people survive heart attacks and strokes every year; many require continuing costly clinical care (5). Thai staples and side dishes are being replaced by diets containing a higher proportion of fats and animal meat. The prevalence of overweight and obesity among children and adolescents has increased

dramatically during the past 20 years. The overall causes of death among the Thai population, the leading causes are diet-related chronic degenerative diseases (6). CVD risk factors have 2 types including changeable and unchangeable. Age, sex, and genetic are an unchangeable of CVD risk factors. Most of CVD risk factors can be change such as cigarette smoking, hypertension, dyslipidemia, diabetes mellitus, overweight, obesity, a sedentary lifestyle and poor nutrition (7, 8).

The extensive evidence of CVD risk factors can begin in early childhood. Specifically, data from the Bogalusa Heart Study shows that autopsy studies on 204 young persons 2 to 39 years of age, who had died from various causes, principally trauma have a fatty streaks and atherosclerotic lesions in the aorta and coronary arteries of children and adolescents (9, 10).

This study focused on adolescents because many of the risk factors for chronic diseases during adulthood, such as CVD, have their origins in childhood. In addition, adolescents are in the critical transition period of early adulthood and need guidance for the information of healthy behaviors or lifestyles (11, 12). Lifetime patterns of diet and physical activity are often established and reinforced in childhood. For example, the initiation of smoking is often during adolescence (13).

To maintain good health and avoid preventable disease throughout their lifes, adolescents must acquire knowledge about health risks and acquire the skills that are needed to avoid or reduce those risks. Moreover, because a growing number of children attend preschool, and the vast majorities attend elementary through high school, the schools are an especially effective and efficient system for providing health education for children (14).

The researcher was interested in studying effective model of nutritional therapy program in school-aged students for reduced CVD risk factors. In this study, the researcher modified the nutrition counseling theory, behavior modification techniques. The hypothesis for this study is that adolescents will have positive change toward healthy status nutrition, eating behavior, and physical activity behaviors. We expect that this study can be a management program of reduce cardiovascular risk factors for nutritionists and adolescents in school and maintain healthy lifestyles throughout life.

1.2 Objectives

1.2.1 General Objective

To evaluate efficiency of nutritional therapy in secondary school-age students of Princess Chulaporn's College Chiangrai on lowering risk factors of cardiovascular disease .

1.2.2 Specific Objectives

1.2.2.1 To reduce the prevalence of those CVD risk factors by nutritional therapy

1.2.2.2 To improve their nutitional behavior by nutritional education

1.2.3 Expect benefits and application

1.2.3.1 To improve the nutritional status in adolescents who have risk factors of cardiovascular disease.

1.2.3.2 To reduce the consequences and the severity of CVD risk factors in adolescent students in order to prevent the development of CVD of their adulthood.

1.2.3.3 To improve lifestyle including eating behavior and physical activity for better healthy lifestyles throughout life.

1.2.3.4 To be an effective model of nutrition therapy program for teaching and providing information on how to modify risk factors of CVD for adolescent school children, promoting healthy lifestyles and reducing the incidence of CVD in Thai adults in the future.

CHAPTER II
LITERATURE REVIEW

2.1 Etiology of Cardiovascular Disease

In the early stage of atherogenesis, blood monocytes adhere to the injured arterial endothelium. Migration of these monocytes into the internal layer of the vessel is facilitated by the oxidation of lipids which are carried by low density lipoproteins cholesterol (LDL). In the next stage of atherogenesis, fatty streaks are formed beneath the endothelium by the accumulation of fat laden monocytes. Smooth muscle cells from the media move into the internal layer of the arterial wall proliferate resulting in a marked multiplication of these cells. In the later progression, the raised lesion or plaque is produced which may protrude from the wall of the vessel. Additionally, it has been suggested that endothelial cell dysfunction or damage from viral infection, high blood lipid concentrations, or other possible cause may initiate this process. Local thrombosis then occurs from the adherence of platelets to the damaged endothelial cell and leads to the occlusion of the artery and obstruction of blood flow to the tissues beyond (4). Atherosclerotic lesions are composed of three greater components. The first is the cellular component consisted of macrophages and smooth muscle cells. The second component is the connective tissue extracellular lipid and matrix. The third component is intracellular lipid that accumulates within macrophages, thereby converting them into foam cells. Atherosclerotic lesions develop as a result of inflammatory stimuli, subsequent release of various cytokines, proliferation of smooth muscle cells, synthesis of connective tissue matrix, and accumulation of macrophages and lipid (15).

2.2 Risk Factors for Cardiovascular Disease

Risk factors for cardiovascular disease means risk factors for CVD, such as blood cholesterol, blood glucose, fat intake, cigarette smoking, physical activity, blood pressure and obesity. These risk factors are modifiable by changing behaviors, lifestyles, or health habits of individuals which result in decline or delay of CVD incident.

2.2.1 Obesity

Obesity is often defined as a condition of abnormal or excessive fat accumulation in adipose tissue, to the extent that health may be impaired (16). The relationships between intra-abdominal adiposity (IAA) and increased cardiometabolic risk. Intra-abdominal adiposity drives the progression of multiple risk factors directly, through the secretion of excess free fatty acids and inflammatory adipokines, and decreased secretion of adiponectin. The important contributions of IAA to dyslipidemia and insulin resistance provide an indirect, though clinically important, link to the genesis and progression of atherosclerosis and cardiovascular disease. The location of excess IAA is an important determinant of cardiometabolic risk. IAA is associated with insulin resistance, hyperglycemia, dyslipidemia, hypertension, and prothrombotic/proinflammatory states. Excess IAA typically is accompanied by elevated levels of C-reactive protein (CRP) and free fatty acids (FFAs), as well as decreased levels of adiponectin. Elevated CRP is an indicator of inflammation. Abdominal obesity has been shown to be associated with the inflammation cascade, with adipose tissue expressing a number of inflammatory cytokines. Inflammation is now believed to play a role in the development of atherosclerosis and type 2 diabetes. Elevated levels of CRP are considered to be predictive of cardiovascular disease and insulin resistance. Elevated FFA levels appear to play a significant role in the cause of insulin resistance. It has been suggested that elevated FFAs and intracellular lipids inhibit the insulin signaling mechanism, leading to decreased glucose transport to muscle. FFAs also play a mediating role between insulin resistance and β-cell dysfunction, indicating that a reduction in FFA level could be a desirable therapeutic target. Adiponectin is an adipose tissue-specific circulating protein which is involved in the regulation of lipid and glucose metabolism. Adiponectin has been shown to be

reduced in adults with obesity and type 2 diabetes. In non-diabetics, hypertriglyceridaemia and low HDL-cholesterol have been shown to be associated with low plasma adiponectin concentrations (17). Obesity is an independent risk factor for CVD, and CVD risks have also been documented in obese children. Besides an altered metabolic profile, a variety of adaptations/alterations in cardiac structure and function occur in the individual as adipose tissue accumulates in excess amounts, even in the absence of co morbidities. Hence, obesity may affect the heart through its influence on known risk factors such as dyslipidemia, hypertension, glucose intolerance, inflammatory markers, obstructive sleep apnea/hypoventilation, and the prothrombotic state, in addition to as-yet-unrecognized mechanisms. On the whole, overweight and obesity predispose to or are associated with numerous cardiac complications such as coronary heart disease, heart failure, and sudden death because of their impact on the cardiovascular system (18). Reducing caloric intakes and increasing physical activity to achieve even a modest weight loss can improve insulin resistance and the concomitant metabolic abnormalities. The AHA guidelines on obesity address interventions to reduce and maintain weight in a slow but steady weight reduction, for example, 1 to 2 lb per week for up to 6 months, are at least as efficacious as diets with more rapid initial weight loss over the long term (19).

2.2.2 Dyslipidemia

On the basis of continuing evidence that high total and LDL cholesterol levels are strongly related to coronary artery disease risk and that reductions in LDL levels are associated with reduced coronary disease risks, the AHA continues to recommend dietary measures aimed at maintaining desirable LDL cholesterol levels, as defined by the current guidelines of the National Cholesterol Education Program (NCEP) (20). The major food components that raise LDL cholesterol are saturated fatty acids, trans-unsaturated fatty acids, and, to a lesser extent, cholesterol. Dietary factors that lower LDL cholesterol include polyunsaturated fatty acids, monounsaturated fatty acids (when substituted for saturated fatty acids), and, to a lesser extent, soluble fiber and soy protein. In addition, sustained weight reduction can lower LDL levels in some individuals (21).

2.2.3 Hypertriglyceridemia

Hypertriglyceridemia is a theoretical risk factor for CHD because of the increased production of atherogenic chylomicron and VLDL remnants, the inverse relationship present between serum triglyceride and HDL, the possible resultant increase in LDL attributable to remnant-reduced hepatic LDL-receptors as well as the formation of more dense and, therefore, more atherogenic LDL, and to the interaction between serum triglyceride and the fibrinolytic/coagulation system. However, most clinical trials that have found hypertriglyceridemia to be a risk factor for CHD do not include other CHD risk factors in their analyses (22). Of particular importance in this regard are excess body weight, reduced physical activity, and increased intake of sugar and refined carbohydrates, particularly in the setting of insulin resistance and glucose intolerance. In addition, increased alcohol intake can aggravate hypertriglyceridemia. Maintenance of plasma triglyceride below a specific target has not been established as a means of reducing coronary heart disease risk. However, individuals with the combination of low HDL cholesterol and elevated triglycerides as defined by the NCEP are appropriate candidates for efforts at weight reduction, increased physical activity, and reduced carbohydrate intake (23).

2.2.4 Hyperglycemia

Diabetes is a chronic disease that occurs either when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin it produces. Insulin is a hormone that regulates blood sugar. Hyperglycaemia, or raised blood sugar, is a common effect of uncontrolled diabetes and over time leads to serious damage to many of the body's systems, especially the nerves and blood vessels. Diabetes mellitus can lead to numerous cardiovascular complications, including coronary artery disease, stroke, peripheral vascular disease, cardiomyopathy, and congestive heart failure (24). The most common form of diabetes, Type 2, is associated with a metabolic syndrome characterized by central obesity and insulin resistance. Insulin-mediated glucose disposal varies widely in apparently healthy human beings, and the more insulin resistant an individual, the more insulin they must secrete in order to prevent the development of type 2 diabetes. However, the combination of insulin resistance and compensatory hyperinsulinemia increases the

likelihood that an individual will be hypertensive, and have a dyslipidemia characterized by a high plasma triglyceride (TG) and low high-density lipoprotein cholesterol (HDL) concentration. These changes increase risk of cardiovascular disease (CVD), and in 1988, this cluster of related abnormalities was designated as comprising a syndrome (X). Several other clinical syndromes are now known to be associated with insulin resistance and compensatory hyperinsulinemia. For example, polycystic ovary syndrome appears to be secondary to insulin resistance and compensatory hyperinsulinemia (25). WHO suggest that people should achieve and maintain healthy body weight, physically active – at least 30 minutes of regular, moderate-intensity activity on most days, eat a healthy diet of between three and five servings of fruit and vegetables a day and reduce sugar and saturated fats intake, avoid tobacco use (26).

2.3 Schools-Base of Intervention for CVD Risk Reduction

The AHA's Guide for Improving Cardiovascular Health at the Community Level outlines a comprehensive list of goals, strategies, and recommendations that exemplify the population-based approach. As such, they are intended for and are applicable on a community-wide basis, and they identify relevant community-based structures (including schools) as central and essential components of population-based strategies. The rationale for school-based heart health education and related preventive interventions is compelling (27).

Numerous school-based health promotion interventions improved cardiovascular health behaviors and reduced risk factors for CVD (28-35). Since the late 1970s, the first-generation of school-based research were primarily didactic and focused on positively influencing health knowledge, attitudes, and self-reported behavior. By the mid-1980s, school-based research focused on theoretically derived behavioral interventions and incorporated the assessment and measurement of physiological risk factors for CVD as primary end points/outcomes. The results of these second generation trials (36) demonstrated the potential of school-based

interventions for improving the CVD risk status of children and youth and informed the third generation of research that extended beyond the classroom, with interventions focused on the broader school environment, including food service, physical activity programs and facilities, and school policies that affect health-related behaviors. Extension into after-school and community programs and linkages with community agencies also were emphasized (37).

2.4 Dietary Management

National surveys indicate that patterns of dietary intake for youth are not meeting current recommendations. Dietary fat intake has decreased over the past 2 decades from 36.3% to 34% of total food energy intake, however, saturated fat intake (12% to 13% of energy intake) exceeds current recommendations (38). In addition, 2001 data from the national Youth Risk Behavior Surveillance indicated that almost 80% of school children do not consume the recommended 5 or more servings of fruits and vegetables per day (39). The AHA has a long-standing commitment to the promotion of lifestyle practices aimed at preventing the development or recurrence of heart and blood vessel diseases and promoting overall well-being. The guidelines are designed to assist individuals in achieve and maintain a healthy eating pattern including foods from all major food groups. Eating adequate amounts of essential nutrients, coupled with energy intake in balance with energy expenditure, is essential to maintain health and to prevent or delay the development of cardiovascular disease, stroke, hypertension, and obesity. The potential benefits to some patients with insulin resistance of diets in which reduced saturated fat consumption is achieved by increasing the intake of unsaturated fatty acids (40). The National Cholesterol Education Program (NCEP) guidelines on high blood cholesterol level address that the major food components that raise LDL cholesterol are saturated fatty acids, *trans*-unsaturated fatty acids, and, to a lesser extent, cholesterol. Dietary factors that lower LDL cholesterol include polyunsaturated fatty acids, monounsaturated fatty acids (when substituted for saturated fatty acids), and, to a lesser extent, soluble fiber and

soy protein. In addition, sustained weight reduction can lower LDL levels in some individuals (41).

2.5 Nutrition education

Nutrition education is an important factor in improving poor nutrition behavior of obese children. It emphasizes transferring and instilling knowledge that will lead to behavior change. The effectiveness of nutrition education required factors and the other processes including eating pattern, food preference, social culture and environmental contexts that surround his eating behavior, which guide the development of health behavior (42, 43).

2.6 Nutrition counseling

Nutrition counseling is the process of guiding a client toward a healthy nutrition lifestyle by meeting normal nutritional needs and solving problems that are barriers to change (44). In addition, nutrition counseling is an approach to disease prevention and general good health. There are three special goals in nutrition counseling have been identified. The first is to facilitate lifestyle awareness; the second is to make decision for healthy lifestyle. The last goal is to obtain a healthier lifestyle (45). The counseling process has been described as an internal process for the clients, a sequence of events and the elements of the interpersonal relationship between the counselor and client. The proceeding of nutrition counseling described by the Five A's Organizational Construct.

2.6.1 The Five A's Organizational Construct for Clinical Counseling

The Five A's Organizational Construct for Clinical Counseling was adapted by the United States Preventive Service Task Force (USPSTF). The main

objective is to assist patients in adopting, changing, or maintaining behaviors that lead to a healthy lifestyle (46, 47). The Five A's construct consist of

2.6.1.1 Assess: Ask about/assess behavioral health risks and factors affecting choice of behavior change goals/methods.

2.6.1.2 Advise: Give clear, specific, and personalized behavior change advice, including information about personal health harms/benefits.

2.6.1.3 Agree: Collaboratively select appropriate treatment goals and methods based on the patient's interest in and willingness to change the behavior.

2.6.1.4 Assist: Using behavior change techniques (self-help and/or counseling), aid the patient in achieving agreed-upon goals by acquiring the skills, confidence, and social/environmental supports for behavior change, supplemented with adjunctive medical treatments when appropriate (e.g., pharmacotherapy for tobacco dependence, contraceptive drugs/devices).

2.6.1.5 Arrange: Schedule follow-up contacts (in person or by telephone) to provide ongoing assistance/support and to adjust the treatment plan as needed, including referral to more intensive or specialized treatment.

2.7 Behavior Modification

The behavior weight management treatment strategies focus primarily on maladaptive eating and activity patterns that lead to positive energy balance and, eventually, weight gain. They are designed to increase awareness of eating and activity patterns, to reduce exposure to cues for maladaptive eating or activity patterns, to normalize eating patterns and to alter the response to problem solution (48). Behavior Modification has been shown to be efficacious in the treatment of overweight and obesity (48-53). Behavior Modifications for treatment of adolescents' obesity typically involve the use of:

2.7.1 Self-monitoring

Self-monitoring is a key component in the process of behavior change. It is used to increases the awareness of behavior pattern by identifying antecedents or reinforcing consequences that lead to or strengthen faulty eating and activity pattern (54). Monitoring involves observation, record keeping of eating and exercise behaviors and weight scales or body composition (55-57).

2.7.2 Social reinforcement

Form of social reinforcement, positive or negative, is communicated. Positive reinforcement is the presentation of a satisfying stimulus that is used when the youth demonstrates appropriate behavior such as praise, a smile, a nod of approval, money, food. Behavior frequency is increased. Negative reinforcement is the presentation of a dissatisfying stimulus that is used when the youth demonstrates inappropriate behavior such as punishment. Behavior frequency is decreased (58).

CHAPTER III
MATERIALS AND METHODS

3.1 Subjects

3.1.1 Characteristics

Subjects of this study were adolescent students who have risk factors of CVD from Princess Chulaporn's College Chiangrai (PCCCR), which is the boarding school located in Chiangrai Province.

PCCCR is a boarding school where some or all students study and live during the school year with their fellow students and possibly teachers or administrators. The word "boarding" is used in the sense of "bed and board" that is, food and lodging. Most boarding schools also have day students who are students that live off-campus with their families, but PCCCR does not have day students.

PCCCR students reside in 8 provinces of the northern part of Thailand. PCCCR is secondary science school.

3.1.2 Inclusion criteria

3.2.1.1. Obesity students classified by percent age of body fat (59).

3.2.1.2. Hypercholesterolemic students classified by serum LDL ≥ 130 mg/dL (60).

3.2.1.3. Hypertriglyceridemic students classified by serum TG ≥150 mg/dL (60).

3.2.1.4. Hyperglycemic students classified by FBG ≥ 110 mg/dL (61).

3.2.1.5. Willing to participate throughout the study period, with permission of their parent or legal guardians

3.1.3 Exclusion criteria

Students who had a history illness such as liver disease, kidney disease, heart disease, thyroid disease, and thalassemia.

3.1.4 Subject recruitment and informed consent

The researcher invited students who had risk factors of CVD through their classroom teachers. The researcher described the study protocol to school authorities, teachers, parents, legal guardians and the students. Written informed consents will be signed by both parents or legal guardians and students who willing to participate throughout the study. The students were allowed to withdraw from the study at any time and reasons for withdrawal were documented. The protocol of this study design was reviewed and approved by Committee on Human Right Related to Research Involving Human Subjects, Faculty of medicine, Ramathibodi hospital, Mahidol University.

3.2 Study design

This study was a prospective study with 16 month program of nutrition therapy and follow up every 4 month, evaluated by anthropometric parameters, biochemical parameters, and dietary records. Our subjects consisted of 49 obese students, 58 hypercholesterolemic students, 13 hypertriglyceridemic students, and 42 hyperglycemic students. Nutrition therapy included nutrition education, individual and group nutrition counseling, behavior modification, and modification of school meals.

3.3 Nutrition therapy

The subjects received nutrition therapy for reducing the severity of obesity and CVD risk factors by the following means:

3.3.1. Nutrition education

At the beginning of this study, the subjects were invited to the nutrition class. The nutrition education class was taught by the researcher for 30-45 minutes. The contents include the definition, cause, consequence of cardiovascular risk factors and prevention obesity, hypercholesterolemia, hypertriglyceridemia, and hyperglycemia. Students were taught how to select the heart-healthy foods, read the food labeling, benefit of exercise, and weight reduction for obese subjects.

3.3.2. Individual nutrition and group counseling and behavior modification

The subjects were invited to individual and group nutrition counseling every 4 month during the 16 month study. During each nutrition counseling, the subjects were meet the researcher for 15-30 minutes to discuss about the five A's construct (assess, advise, agree, assist and arrange) and behavior modification. The details are as follows:

3.3.2.1 Assess

This is the first step of nutrition counseling. The researcher asked and assessed factor that related to CVD risk factors including dietary and physical activity assessment.

3.3.2.2 Advice

The researcher as a nutrition counselor gave clear advice to subjects on reducing risk factors associate with CVD and benefit if they obey the advice.

3.3.2.3 Agree

The subjects collaborated and selected appropriate method based on individual's interest and willingness to change the behavior.

3.3.2.4 Assist

The researcher used behavior change techniques to aid the subjects in achieving agree-upon goals by acquiring the skills, confidence, and social/environment support for behavior change. In this study, the behavior modification techniques comprise of:

3.3.2.4.1 Self-monitoring

Every subject was received log sheets for keeping record of food consumption in term of quality and quantity, type and duration of physical activity and monitoring body weight everyday.

3.3.2.4.2 Social reinforcement

The researcher used positive reinforcement techniques such as praise for the progress of nutrition status, behaviors and avoids condemning their subjects.

3.3.2.5 Arrange

The follow-up schedule was set at every 4 month during the 16 month study to provide assistance or support and to adjust the treatment planning.

3.3.2. Modification of School Meals

School meals were modified by control cooking oils, salt, and sugar, restrict organ meat, egg yolk, serve various fruits after lunch three times a week, prepare food depend on student's prefer such as serve instant noodle with meat and vegetables. Moreover, students were recommended to avoid junk foods and snacks, motivated to drink skim milk.

3.4 Nutrition Assessment

3.4.1. Nutrition status

3.4.1.1 Anthropometric assessment (BL, 4 mo, 8 mo, 12 mo, 16 mo)

3.4.1.1.1 Height (Ht) measurement

The students were asked to stand straight barefoot on a horizontal platform with his heel together, stretching upward to the fullest extension. The back was as straight as possible against the vertical bar and the horizontal arm of the height meter was in contact with student's head. The reading was read to the nearest 0.1 millimeter

3.4.1.1.2 Body weight and body composition analyzer were measured by using bio-electrical impedance analysis (Tanita BC-418 Segmental Body Composition Analyser) according the following parameter:

3.4.1.1.2.1 Body weight (bw)

3.4.1.1.2.2 Body mass index (BMI)

3.4.1.1.2.3 Body fat (% bw)

3.4.1.1.2.4 Trunk fat (%bw)

3.4.1.1.2.5 Trunk muscle mass (Trunk mm)

3.4.1.1.2.6 Right leg fat (%)

3.4.1.1.2.7 Right leg muscle (Right leg mm)

3.4.1.1.2.8 Left leg fat (%)

3.4.1.1.2.9 Left leg muscle (Left leg mm)

3.4.1.1.2.10 Right arm fat (%)

3.4.1.1.2.11 Right arm muscle (Right arm mm)

3.4.1.1.2.12 Left arm fat (%)

3.4.1.1.2.13 Left arm muscle (Left arm mm)

3.4.1.1.3 Waist circumference (WC)

Measure the abdominal circumference at the level of the umbilicus (or the level of greatest anterior extension of the abdomen) whiles the patient standing.

3.4.1.1.4 Hip circumference (HC) measurement

Measure the greatest circumference at the level of the buttocks.

3.4.1.2 Biochemical assessment (BL, 8 mo, 12 mo, 16 mo)

Twenty ml of blood was collected in the morning after 10 hours overnight fast at PCCCR by private service of laboratory test)

3.4.1.2.1 Serum total cholesterol (TC)

3.4.1.2.2 Serum triglyceride (TG)

3.4.1.2.3 High density lipoprotein cholesterol (HDL)

3.4.1.2.4 Low density lipoprotein cholesterol (LDL)

3.4.1.2.5 Fasting plasma glucose (FPG)

3.4.2. Dietary assessment

Subjects were instructed about the 24 hours dietary record during the study. The samples of dietary record were given to students. Food portion sizes were estimated by using standard household measuring laden and spoon. The food records were analyzed for energy intake and its distribution derived from protein, fat, and carbohydrate. Data was analyzed by using the computerized food composition analysis package modified for Thai food by the Institute of Nutrition, Mahidol University.

3.4.3. Physical activity assessments

Students were asked to record type, duration, frequency of daily physical activity in book of daily dietary record.

3.5 Duration of study period

May 2008- September 2009

3.6 Statistical Analysis

Results were presented as mean ± SEM. Mean of anthropometric and biochemical parameters during the study period were compared by using paired *t*-test in same subjects. The results showed the 4 levels of significant including p value < 0.001, 0.005, 0.01, and 0.05 which were considered a highest to less significant levels respectively. These statistical analyses were done using the Statistical Package for Social Science (SPSS for windows version 16).

CHAPTER IV
RESULTS

One hundred and thirty-eight students were enrolled in this study. Fourteen students were excluded due to leave school and three student loss to follow-up. Therefore, data from a total of 121 subjects were completed for analysis. Of these subjects, 49 subjects were obese, 42 were hyperglycemia, 58 were hypercholesterolemia and 13 were hypertriglyceridemia. Some subjects had more than one risk factor.

4.1 Characteristics of subjects

4.1.1 Characteristics of obese students

Means (±SEM) of age and anthropometric parameters in 18 obese male students at baseline are shown in Table 4.1. Obese male students were divided into two age groups: 9-12 years old and 13-15 years old. Eight obese male students in 9-12 years, age group had age ranged 12-12.1 years, body fat (%bw) above or equal to over fat levels ranged from 29.3 %bw to 56.6 %bw. Ten obese male students aged 13-15 years with aged minimum 13.0 years and maximum 15.1 years had body fat above or equal to over fat levels with body fat from 26.6 %bw to 47.1 %bw.

Table 4.1. Means (±SEM) of age and anthropometric in 18 obese male students at baseline

	9-12 y (*n* = 8)			13-15 y (*n* = 10)		
Parameters	Mean ± SEM	Min	Max	Mean ± SEM	Min	Max
Age (y)	12.1 ± 0.0	12.0	12.1	14.2 ± 0.3	13.0	15.1
Height (cm)	159.3 ± 3.8	143.0	171.0	169.3 ± 2.1	154.0	177.0
Weight (kg)	73.8 ± 5.9	50.5	95.1	83.1 ± 3.5	69.0	106.2
BMI (kg/m^2)	28.8 ± 1.3	24.7	34.8	29.0 ± 1.0	25.1	33.9
Body fat (%bw)	41.2 ± 3.2	29.3	56.6	35.4 ± 2.3	26.6	47.1
Trunk fat (%)	40.1 ± 3.3	27.7	55.7	35.6 ± 2.7	24.0	50.7
Trunk mm (kg)	17.6 ± 1.5	11.6	22.1	24.6 ± 2.0	15.0	34.9
Right leg fat (%)	43.1 ± 3.0	31.6	58.1	36.4 ± 2.1	26.0	46.0
Right leg mm (kg)	9.3 ± 0.8	6.0	12.3	10.7 ± 0.5	8.4	14.2
Left leg fat (%)	44.4 ± 3.2	32.5	59.0	37.1 ± 2.3	26.3	46.2
Left leg mm (kg)	9.1 ± 0.8	5.9	11.8	10.4 ± 0.5	8.3	13.8
Right arm fat (%)	35.4 ± 3.0	24.7	51.9	29.2 ± 2.0	22.0	40.0
Right arm mm (kg)	2.3 ± 0.2	1.6	2.9	2.7 ± 0.1	2.2	3.6
Left arm fat (%)	34.3 ± 2.5	24.6	47.0	29.2 ± 2.1	21.9	40.1
Left arm mm (kg)	2.3 ± 0.2	1.6	2.9	2.7 ± 0.1	2.2	3.3
WC (cm)	97.1 ± 3.5	85.0	111.0	97.3 ± 2.4	89.0	110.0
HC (cm)	104.1 ± 2.6	93.0	112.0	106.5 ± 1.6	101.0	119.0
WHR	0.93 ± 0.01	0.87	1.00	0.91 ± 0.02	0.83	1.01

Means (±SEM) of age and anthropometric in 31 obese female students at baseline are shown in Table 4.2. Obese female students were divided into two age groups: 9-12 years old and 13-15 years old. Fifteen obese female students in 9-12 years, age group had age ranged 11.1-12.1 years, body fat above or equal to over fat levels ranged from 36.8 %bw to 52.7 %bw. Sixteen obese female students aged 13-15 years with aged minimum 13.0 years and maximum 15.1 years had body fat above or equal to over fat levels with body fat from 36.2 %bw to 48.6 %bw.

Table 4.2. Means (±SEM) of age and anthropometric in obese 31 female students at baseline

	9-12 y (*n* = 15)			13-15 y (*n* = 16)		
Parameters	Mean ± SEM	Min	Max	Mean ± SEM	Min	Max
Age (y)	12.0 ± 0.1	11.1	12.1	13.9 ± 0.2	13.0	15.1
Height (cm)	155.3 ± 1.1	149.0	162.0	158.8 ± 1.1	149.0	167.0
Weight (kg)	66.5 ± 2.7	53.2	83.3	66.8 ± 2.4	51.7	84.9
BMI (kg/m^2)	27.6 ± 1.1	21.5	35.1	26.4 ± 0.8	21.0	32.0
Body fat (%bw)	42.4 ± 1.3	36.8	52.7	39.9 ± 0.9	36.2	48.6
Trunk fat (%)	42.7 ± 1.6	35.8	57.8	40.0 ± 1.1	35.2	50.7
Trunk mm (kg)	18.8 ± 0.4	15.8	21.9	20.2 ± 0.4	17.6	22.8
Right leg fat (%)	42.9 ± 1.0	36.9	51.2	40.5 ± 0.8	35.2	46.2
Right leg mm (kg)	6.6 ± 0.2	5.4	8.0	6.8 ± 0.2	5.3	8.2
Left leg fat (%)	42.5 ± 0.9	37.2	48.2	40.5 ± 0.8	35.5	46.1
Left leg mm (kg)	6.7 ± 0.2	5.6	8.2	6.8 ± 0.2	5.4	8.2
Right arm fat (%)	38.8 ± 1.7	31.3	56.2	36.2 ± 1.1	29.9	46.6
Right arm mm (kg)	1.9 ± 0.1	1.5	2.4	1.9 ± 0.1	1.3	2.3
Left arm fat (%)	40.8 ± 1.6	34.1	55.8	38.2 ± 1.1	33.3	48.4
Left arm mm (kg)	1.8 ± 0.1	1.5	2.3	1.8 ± 0.1	1.2	2.2
WC (cm)	86.9 ± 1.9	72.0	98.0	86.5 ± 1.5	77.0	99.0
HC (cm)	102.5 ± 1.6	93.5	113.5	102.5 ± 1.4	90.0	111.5
WHR	0.85 ± 0.01	0.74	0.91	0.84 ± 0.01	0.75	0.91

Means (±SEM) of biochemical parameters in 18 obese male students at baseline are shown in Table 4.3. According to the National Cholesterol Education Program's recommendations : NCEP, 2001 (60), in both groups of obese male students, means of serum total cholesterol (TC) and low density lipoprotein cholesterol (LDL) were at high levels, however 9 of them had normal serum TC and LDL whereas 9 of them had hypercholesterolemia. Mean serum triglyceride levels in both groups were within normal limit, whereas 1 of 13-15 year age group had hypertriglyceridemia. One from 9-12 year age group and 2 from 13-15 year age group had low serum high density lipoprotein cholesterol (HDL) level. Three from 9-12 year age group had fasting blood glucose (FBG) within 110-125 mg/dL, i.e., impaired fasting blood glucose, whereas 1 from 9-12 year age group and 1 from 13-15 year age group had FBG ≥ 126 mg/dL, i.e., diabetes mellitus.

Table 4.3. Means (±SEM) of biochemical parameters in 18 obese male students at baseline

	9-12 y (*n* = 8)			13-15 y (*n* = 10)		
Parameters	Mean ± SEM	Min	Max	Mean ± SEM	Min	Max
TC (mg/dL)	221 ± 12	179	280	206 ± 17	139	322
TG (mg/dL)	74 ± 5	60	101	90 ± 12	51	169
HDL (mg/dL)	56 ± 4	37	68	53 ± 4	37	71
LDL (mg/dL)	150 ± 12	109	198	135 ± 19	68	259
FBG (mg/dL)	113 ± 5	87	130	103 ± 3	86	126

Means (±SEM) of biochemical parameters in 31 obese female students at baseline are shown in Table 4.4. According to the National Cholesterol Education Program's recommendations : NCEP, 2001 (60), in both groups of obese female students, means of serum TC and LDL were at high levels, however 12 of them had normal serum TC and LDL whereas 3 of them had hypercholesterolemia. Mean serum triglyceride levels in both groups were within normal limit, where as 1 of 9-12 year age group and 1 of 13-15 year age group had hypertriglyceridemia. All of them had normal serum HDL level. Two from 9-12 year age group and 2 from 13-15 year age group had FBG within 110-125 mg/dL, i.e., impaired fasting blood glucose, whereas one from 13-15 year age group had FBG ≥ 126 mg/dL, i.e., diabetes mellitus.

Table 4.4. Means (±SEM) of biochemical parameters in 31 obese female students at baseline

	9-12 y (*n* = 15)			13-15 y (*n* = 16)		
Parameters	Mean ± SEM	Min	Max	Mean ± SEM	Min	Max
TC (mg/dL)	181 ± 10	130	281	194 ± 8	132	237
TG (mg/dL)	79 ± 8	57	164	89 ± 10	51	224
HDL (mg/dL)	61 ± 2	44	80	58 ± 2	44	64
LDL (mg/dL)	104 ± 11	53	219	118 ± 8	57	164
FBG (mg/dL)	100 ± 3	85	123	105 ± 3	91	131

4.1.2 Characteristics of hypercholesterolemic students

Means (±SEM) of age and anthropometric parameters in 20 hypercholesterolemic male students at baseline are shown in Table 4.5. Hypercholesterolemic male students were divided into 3 age groups. Seven hypercholesterolemic male students aged 9-12 years who had body fat from 13.5-56.6 %bw, which were within normal to obesity levels, respectively. Twelve hypercholesterolemic male students aged 13-15 years who had body fat from 8.9-35.7 %bw which were within normal to obesity levels, respectively. One hypercholesterolemic male student aged 16.1 years had normal levels of body fat.

Table 4.5. Means (±SEM) of age and anthropometric in 20 hypercholesterolemic male students at baseline

	9-12 y (n = 7)			13-15 y (n = 12)			16-18 y (n = 1)
Parameters	Mean ± SEM	Min	Max	Mean ± SEM	Min	Max	Value
Age (y)	12.0 ± 0.0	12.0	12.1	14.4 ± 0.3	13.0	15.1	16.1
Height (cm)	154.4 ± 4.4	143.0	171.0	167.3 ± 1.6	159.0	177.0	180.0
Weight (kg)	63.1 ± 8.6	34.4	89.2	66.9 ± 5.8	46.9	106.2	56.8
BMI (kg/m^2)	25.8 ± 2.5	16.4	34.8	23.6 ± 1.6	17.7	33.9	17.5
Body fat (%bw)	35.6 ± 5.8	13.5	56.6	21.2 ± 2.6	8.9	35.7	8.2
Trunk fat (%)	34.2 ± 6.0	11.6	55.7	20.2 ± 2.8	8.0	34.3	6.5
Trunk mm (kg)	16.8 ± 1.6	11.6	22.1	25.1 ± 1.2	20.6	34.9	27.3
Right leg fat (%)	37.9 ± 5.4	16.9	58.1	23.1 ± 2.4	10.7	38.4	10.2
Right leg mm (kg)	8.0 ± 1.1	4.7	12.3	9.5 ± 0.6	6.8	14.2	8.9
Left leg fat (%)	39.6 ± 5.5	17.3	59.0	23.7 ± 2.5	10.2	39.4	10.7
Left leg mm (kg)	7.7 ± 1.1	4.7	11.8	9.2 ± 0.6	6.8	13.8	8.7
Right arm fat (%)	30.2 ± 5.6	9.9	51.9	17.4 ± 2.1	7.2	28.6	10.3
Right arm mm (kg)	2.0 ± 0.2	1.2	2.7	2.4 ± 0.2	1.8	3.6	2.3
Left arm fat (%)	29.2 ± 4.9	10.4	47.0	17.5 ± 2.0	8.2	28.6	9.8
Left arm mm (kg)	2.0 ± 0.2	1.2	2.8	2.3 ± 0.1	1.8	3.3	2.3
WC (cm)	88.8 ± 7.1	61.0	111.0	82.3 ± 4.1	69.0	110.0	68.5
HC (cm)	97.6 ± 4.9	79.0	111.0	96.0 ± 3.2	84.5	119.0	87.0
WHR	0.90 ± 0.03	0.77	1.00	0.85 ± 0.02	0.78	1.00	0.79

Means (±SEM) of age and anthropometric in 38 hypercholesterolemic female students at baseline are shown in Table 4.6. Hypercholesterolemic female students were divided into 3 age groups. Eight hypercholesterolemic female students aged 9-12 years who had body fat from 13.8-42.7 %bw, which were within normal to obesity levels, respectively. Twenty-four hypercholesterolemic female students aged 13-15 years who had body fat from 17.7-48.6 %bw which were within normal to obesity levels, respectively. Six hypercholesterolemic female students aged 16-18 years who had body fat from 23.2-30.3 %bw, which were within normal to obesity levels, respectively.

Table 4.6. Means (±SEM) of age and anthropometric in 38 hypercholesterolemic female students at baseline

	9-12 y (n = 8)			13-15 y (n = 24)			16-18 y (n = 6)		
Parameters	Mean ± SEM	Min	Max	Mean ± SEM	Min	Max	Mean ± SEM	Min	Max
Age (y)	11.8 ± 0.2	11.1	12.1	13.9 ± 0.2	13.0	15.1	16.0 ± 0.0	16.0	16.1
Height (cm)	154.6 ± 1.9	147.0	162.0	156.3 ± 1.0	149.0	167.0	155.2 ± 1.3	149.0	157.0
Weight (kg)	48.9 ± 3.2	38.2	62.1	54.1 ± 2.8	36.2	84.9	49.7 ± 1.8	43.4	56.5
BMI (kg/m^2)	20.5 ± 1.2	16.1	26.9	21.9 ± 0.9	15.7	32.0	20.7 ± 0.8	17.8	22.9
Body fat (%bw)	28.0 ± 3.7	13.8	42.7	30.6 ± 1.8	17.7	48.6	28.4 ± 1.1	23.2	30.3
Trunk fat (%)	25.6 ± 4.3	9.0	43.1	28.8 ± 2.2	13.0	50.7	26.7 ± 1.3	20.6	29.7
Trunk mm (kg)	18.0 ± 0.4	16.3	19.4	18.9 ± 0.3	15.4	22.2	19.2 ± 0.4	18.2	21.0
Right leg fat (%)	32.1 ± 3.0	19.6	43.6	33.8 ± 1.3	25.1	46.2	31.3 ± 0.7	27.8	32.6
Right leg mm (kg)	5.8 ± 0.2	4.8	6.3	6.1 ± 0.2	4.8	8.2	5.9 ± 0.2	5.2	6.8
Left leg fat (%)	32.0 ± 2.8	20.7	42.2	34.0 ± 1.3	25.1	46.1	31.6 ± 0.7	28.4	33.0
Left leg mm (kg)	5.8 ± 0.2	4.9	6.4	6.1 ± 0.2	4.7	8.2	5.7 ± 0.2	5.2	6.7
Right arm fat (%)	24.4 ± 3.4	11.2	37.3	26.8 ± 1.9	12.5	46.6	25.3 ± 1.3	19.2	28.0
Right arm mm (kg)	1.5 ± 0.1	1.2	1.8	1.6 ± 0.1	1.1	2.3	1.5 ± 0.1	1.3	1.8
Left arm fat (%)	25.7 ± 3.8	11.6	41.5	28.2 ± 2.0	13.4	48.4	27.0 ± 1.3	20.9	29.4
Left arm mm (kg)	1.5 ± 0.0	1.2	1.6	1.5 ± 0.1	1.1	2.2	1.4 ± 0.1	1.2	1.7
WC (cm)	72.9 ± 3.7	62.0	86.0	75.0 ± 2.2	61.0	99.0	73.3 ± 1.7	67.0	78.0
HC (cm)	90.8 ± 2.8	81.5	102.0	94.3 ± 1.8	82.0	111.5	92.2 ± 1.4	87.0	97.0
WHR	0.80 ± 0.02	0.75	0.87	0.79 ± 0.01	0.73	0.91	0.79 ± 0.01	0.77	0.85

Means (±SEM) of biochemical parameters in 20 hypercholesterolemic male students at baseline are shown in Table 4.7. All of them had normal serum TG levels, where as 1 in 9-12 year age groups and 2 in 13-15 year age groups had low serum HDL level. One from 9-12 year age group had FBG within 110-125 mg/dL, i.e., impaired fasting blood glucose, whereas 4 from 13-15 year age group had FBG ≥ 126 mg/dL, i.e., diabetes mellitus.

Table 4.7. Means (±SEM) of biochemical parameters in 20 hypercholesterolemic male students at baseline

	9-12 y (*n* = 7)			13-15 y (*n* = 12)			16-18 y (*n* = 1)
Parameters	Mean ± SEM	Min	Max	Mean ± SEM	Min	Max	Value
TC (mg/dL)	249 ± 9	224	280	240 ± 9	210	322	247
TG (mg/dL)	81 ± 9	63	123	75 ± 3	57	92	86
HDL (mg/dL)	60 ± 6	37	88	56 ± 4	37	83	57
LDL (mg/dL)	173 ± 5	161	198	169 ± 10	135	259	173
FBG (mg/dL)	106 ± 4	87	125	114 ± 7	88	184	101

Means (±SEM) of biochemical parameters in 38 hypercholesterolemic female students at baseline are shown in Table 4.8. Mean serum triglyceride levels in every group were within normal limit, whereas 2 of 13-15 year age group had hypertriglyceridemia. One in 9-12 year age groups had low serum HDL level. Two from 13-15 year age group and 1 from 16-18 year age group had FBG within 110-125 mg/dL, i.e., impaired fasting blood glucose, whereas 1 from 9-12 year age group and 1 from 13-15 year age group had FBG ≥ 126 mg/dL, i.e., diabetes mellitus.

Table 4.8. Means (±SEM) of biochemical parameters in 38 hypercholesterolemic female students at baseline

	9-12 y (*n* = 8)			13-15 y (*n* = 24)			16-18 y (*n* = 6)		
Parameters	Mean ± SEM	Min	Max	Mean ± SEM	Min	Max	Mean ± SEM	Min	Max
TC (mg/dL)	244 ± 8	216	281	244 ± 5	198	307	267 ± 20	233	363
TG (mg/dL)	84 ± 10	59	144	89 ± 8	45	224	73 ± 5	62	95
HDL (mg/dL)	56 ± 4	38	72	61 ± 2	44	92	60 ± 3	49	69
LDL (mg/dL)	171 ± 9	143	219	166 ± 4	132	208	193 ± 19	164	283
FBG (mg/dL)	103 ± 5	90	132	100 ± 3	72	126	97 ± 7	73	121

4.1.3 Characteristics of hypertriglyceridemic students

Means (±SEM) of age and anthropometric in 2 hypertriglyceridemic male students at baseline are shown in Table 4.9. Hypertriglyceridemic male students were divided into 2 age groups. One student aged 14.1 years had body fat 26.6 %bw which was within over fat levels. Another one student aged aged 16.0 years had body fat 10.7 %bw which was within normal levels.

Means (±SEM) of age and anthropometric in 11 hypertriglyceridemic female students at baseline are shown in Table 4.10. Hypertriglyceridemic female students were divided into 3 age groups. Two hypertriglyceridemic female students aged 9-12 years who had body fat from 22.0 and 47.1 %bw, which were within normal and obesity levels, respectively. Seven hypertriglyceridemic female students aged 13-15 years who had body fat from 20.5-47.9 %bw which were within normal to obesity levels, respectively. Two hypertriglyceridemic female students aged 16-18 years who had body fat from 28.9 and 29.2 %bw, which were within normal levels.

Table 4.9. Age and anthropometric in 2 hypertriglyceridemic male students at baseline

Parameters	13-15 y (*n* = 1)	16-18 y (*n* = 1)
Age (y)	14.1	16.0
Height (cm)	175.0	162.0
Weight (kg)	77.0	49.0
BMI (kg/m^2)	25.1	18.7
Body fat (%bw)	26.6	10.7
Trunk fat (%)	24.0	7.8
Trunk mm (kg)	26.7	24.2
Right leg fat (%)	30.5	15.4
Right leg mm (kg)	10.8	6.6
Left leg fat (%)	30.5	15.8
Left leg mm (kg)	10.7	6.6
Right arm fat (%)	22.9	9.2
Right arm mm (kg)	2.6	2.1
Left arm fat (%)	21.9	9.9
Left arm mm (kg)	2.7	2.0
WC (cm)	92.0	66.0
HC (cm)	104.0	85.0
WHR	0.88	0.78

Table 4.10. Means (±SEM) of age and anthropometric in 11 hypertriglyceridemic female students at baseline

	9-12 y (n = 2)	13-15 y (n = 7)			16-18 y (n = 2)
Parameters	Value	Mean ± SEM	Min	Max	Value
Age (y)	12.1, 12.1	14.0 ± 0.3	13.0	15.1	16.0, 17.0
Height (cm)	152.0, 155.0	158.0 ± 3.0	147.0	169.0	158.0, 167.0
Weight (kg)	44.8, 79.5	55.5 ± 5.7	42.0	81.8	54.4, 56.9
BMI (kg/m^2)	19.4, 33.1	21.9 ± 1.5	17.5	29.3	20.4. 21.8
Body fat (%bw)	22.0, 47.1	29.9 ± 3.5	20.5	47.9	28.9, 29.2
Trunk fat (%)	18.5, 45.7	27.7 ± 4.2	16.5	49.7	27.3, 28.1
Trunk mm (kg)	17.9, 20.7	19.7 ± 1.0	16.6	25.1	20.3, 22.6
Right leg fat (%)	27.1, 51.2	33.6 ± 2.4	26.6	46.1	31.5, 32.0
Right leg mm (kg)	6.0, 7.0	6.3 ± 0.3	5.4	7.7	6.1, 6.5
Left leg fat (%)	28.2, 48.2	33.8 ± 2.4	27.0	46.1	31.5, 32.1
Left leg mm (kg)	5.9, 7.4	6.3 ± 0.4	5.4	7.8	6.0, 6.5
Right arm fat (%)	17.7, 44.2	26.3 ± 3.6	16.4	44.3	24.5, 26.6
Right arm mm (kg)	1.6, 2.2	1.7 ± 0.1	1.4	2.2	1.7, 1.7
Left arm fat (%)	19.2, 44.6	27.5 ± 3.7	17.7	46.3	26.8, 28.5
Left arm mm (kg)	1.5, 2.2	1.6 ± 0.1	1.3	2.1	1.5, 1.5
WC (cm)	70.0, 94.0	75.8 ± 4.4	65.5	99.0	74.0, 74.0
HC (cm)	87.5, 108.5	95.6 ± 3.3	87.0	111.5	93.0, 96.0
WHR	0.80, 0.79	0.79 ± 0.03	0.68	0.89	0.77, 0.80

Biochemical parameters in 2 hypertriglyceridemic male students at baseline are shown in Table 4.11. Both of them had normal serum FBG and HDL levels. One student aged 16.0 years had high level of TC and borderline of LDL.

Table 4.11. Biochemical parameters in 2 hypertriglyceridemic male students at baseline

Parameters	13-15 y (*n* = 1)	16-18 y (*n* = 1)
TC (mg/dL)	194	225
TG (mg/dL)	169	158
HDL (mg/dL)	71	67
LDL (mg/dL)	89	126
FBG (mg/dL)	86	83

Means (±SEM) of biochemical parameters in 11 hypertriglyceridemic female students at baseline are shown in Table 4.12. All of them had normal serum HDL levels. Two from 13-15 year age group had hypercholesterolemia. One from 9-12 year age group and 1 from 13-15 year age group had FBG within 110-125 mg/dL, i.e., impaired fasting blood glucose.

Table 4.12. Means (±SEM) of biochemical parameters in 11 hypertriglyceridemic female students at baseline

	9-12 y (*n* = 2)	13-15 y (*n* = 7)			16-18 y (*n* = 2)
Parameters	Value	Mean ± SEM	Min	Max	Value
TC (mg/dL)	185, 217	212 ± 10	184	260	157, 228
TG (mg/dL)	151, 164	183 ± 12	154	224	153, 174
HDL (mg/dL)	65, 73	61 ± 6	46	93	50, 71
LDL (mg/dL)	79, 122	115 ± 12	83	168	76, 122
FBG (mg/dL)	101, 122	104 ± 3	96	123	86, 108

4.1.4 Characteristics of hyperglycemic students

Means (±SEM) of age and anthropometric in 18 hyperglycemic male students at baseline are shown in Table 4.13. Hyperglycemic male students were divided into 2 age groups. Five hyperglycemic male students aged 9-12 years who had body fat from 12.1-56.6 %bw, which were within normal and obesity levels, respectively. Thirteen hyperglycemic male students aged 13-15 years who had body fat from 8.9-36.2 %bw which were within normal to obesity levels, respectively.

Table 4.13. Means (±SEM) of age and anthropometric in 18 hyperglycemic male students at baseline

	9-12 y (*n* = 5)			13-15 y (*n* = 13)		
Parameters	Mean ± SEM	Min	Max	Mean ± SEM	Min	Max
Age (y)	12.1 ± 0.0	12.0	12.1	14.2 ± 0.2	13.0	15.1
Height (cm)	160.2 ± 2.9	154.0	170.0	164.8 ± 1.7	150.0	173.0
Weight (kg)	70.9 ± 9.8	42.1	95.1	55.7 ± 1.9	46.9	69.0
BMI (kg/m^2)	27.3 ± 3.1	17.5	34.8	20.5 ± 0.7	17.3	26.0
Body fat (%bw)	36.1 ± 7.7	12.1	56.6	15.5 ± 2.1	8.9	36.2
Trunk fat (%)	34.6 ± 8.1	9.1	55.7	13.5 ± 2.0	7.2	33.3
Trunk mm (kg)	17.7 ± 1.6	11.6	20.6	23.2 ± 0.7	19.3	26.3
Right leg fat (%)	38.8 ± 7.1	16.6	58.1	18.6 ± 2.2	10.4	40.6
Right leg mm (kg)	9.1 ± 0.9	6.6	11.8	8.5 ± 0.2	6.8	10.1
Left leg fat (%)	39.2 ± 7.4	16.4	59.0	19.0 ± 2.2	10.2	41.4
Left leg mm (kg)	8.9 ± 0.8	6.6	11.2	8.3 ± 0.2	6.8	9.8
Right arm fat (%)	31.1 ± 7.1	9.7	51.9	13.0 ± 1.7	6.5	29.3
Right arm mm (kg)	2.2 ± 0.2	1.6	2.9	2.2 ± 0.1	1.8	2.7
Left arm fat (%)	30.3 ± 6.3	10.5	47.0	13.6 ± 1.6	7.9	29.1
Left arm mm (kg)	2.3 ± 0.2	1.6	2.9	2.1 ± 0.1	1.8	2.6
WC (cm)	91.6 ± 8.4	64.0	111.0	74.4 ± 2.3	66.0	89.0
HC (cm)	100.7 ± 5.8	81.0	112.0	89.2 ± 1.6	82.0	104.5
WHR	0.90 ± 0.04	0.79	1.00	0.83 ± 0.02	0.76	0.98

Means (±SEM) of age and anthropometric in 24 hyperglycemic female students at baseline are shown in Table 4.14. Hyperglycemic female students were divided into 3 age groups. Nine hyperglycemic female students aged 9-12 years who had body fat from 15.7-52.7 %bw, which were within normal and obesity levels, respectively. Thirteen hyperglycemic female students aged 13-15 years who had body fat from 15.7-47.9 %bw which were within normal to obesity levels, respectively. Two hyperglycemic female students aged 16-18 years who had body fat from 28.9 and 35.7 %bw, which were within normal levels.

Table 4.14. Means (±SEM) of age and anthropometric in 24 hyperglycemic female students at baseline

	9-12 y (n = 9)			13-15 y (n = 13)			16-18 y (n = 2)		
Parameters	Mean ± SEM	Min	Max	Mean ± SEM	Min	Max	Mean ± SEM	Min	Max
Age (y)	11.8 ± 0.1	11.1	12.1	13.7 ± 0.2	13.0	15.1	16.0 ± 0.0	16.0	16.0
Height (cm)	152.6 ± 1.9	144.0	163.0	156.4 ± 1.2	150.0	167.0	154.0 ± 3.0	151.0	157.0
Weight (kg)	51.9 ± 5.5	39.1	81.2	54.1 ± 3.9	38.1	81.8	51.6 ± 4.2	47.4	55.7
BMI (kg/m^2)	22.3 ± 2.3	16.3	35.1	22.0 ± 1.4	15.9	30.3	21.8 ± 2.6	19.2	24.4
Body fat (%bw)	29.0 ± 4.2	15.7	52.7	29.3 ± 2.9	15.7	47.9	32.3 ± 3.4	28.9	35.7
Trunk fat (%)	27.1 ± 5.0	11.3	57.8	27.1 ± 3.5	10.9	49.7	31.7 ± 3.7	28.0	35.3
Trunk mm (kg)	17.7 ± 0.6	15.7	20.7	19.1 ± 0.5	16.9	22.2	19.4 ± 0.4	19.0	19.8
Right leg fat (%)	32.2 ± 3.3	21.4	51.2	32.6 ± 2.1	22.2	46.1	34.2 ± 2.7	31.5	36.9
Right leg mm (kg)	6.1 ± 0.3	4.8	8.0	6.3 ± 0.2	5.2	7.9	5.5 ± 0.3	5.2	5.7
Left leg fat (%)	32.1 ± 2.9	22.5	48.2	33.1 ± 2.2	23.2	46.1	34.0 ± 3.0	31.0	37.0
Left leg mm (kg)	6.1 ± 0.4	4.8	8.2	6.2 ± 0.2	5.2	7.8	5.3 ± 0.1	5.2	5.4
Right arm fat (%)	26.4 ± 4.8	12.2	56.2	25.9 ± 2.9	11.9	44.3	28.9 ± 3.9	25.0	32.7
Right arm mm (kg)	1.6 ± 0.1	1.2	2.2	1.7 ± 0.1	1.3	2.3	1.4 ± 0.1	1.3	1.5
Left arm fat (%)	27.2 ± 4.6	13.2	55.8	26.9 ± 3.0	12.6	46.3	30.2 ± 3.6	26.6	33.8
Left arm mm (kg)	1.5 ± 0.1	1.2	2.2	1.6 ± 0.1	1.2	2.2	1.3 ± 0.1	1.2	1.4
WC (cm)	73.0 ± 4.5	59.5	97.5	76.5 ± 3.1	60.5	99.0	76.0 ± 1.0	75.0	77.0
HC (cm)	92.4 ± 3.8	80.0	113.5	94.4 ± 2.5	84.5	111.5	93.8 ± 2.8	91.0	96.5
WHR	0.79 ± 0.02	0.69	0.87	0.81 ± 0.01	0.70	0.89	0.81 ± 0.01	0.80	0.82

Means (±SEM) of biochemical parameters in 18 hyperglycemic male students at baseline are shown in Table 4.15. All of them had normal serum triglyceride levels. One of them in 9-12 year age groups, and 4 of them in 13-15 year age groups were hypercholesterolemia.

Table 4.15. Means (±SEM) of biochemical parameters in 18 hyperglycemic male students at baseline

	9-12 y (*n* = 5)			13-15 y (*n* = 13)		
Parameters	Mean ± SEM	Min	Max	Mean ± SEM	Min	Max
TC (mg/dL)	187 ± 11	156	224	185 ± 11	116	242
TG (mg/dL)	67 ± 6	56	92	63 ± 4	40	87
HDL (mg/dL)	59 ± 4	48	71	60 ± 3	37	83
LDL (mg/dL)	115 ± 14	74	163	113 ± 9	68	166
FBG (mg/dL)	125 ± 2	119	131	131 ± 5	121	184

Means (±SEM) of biochemical parameters in 24 hyperglycemic female students at baseline are shown in Table 4.16. Mean serum triglyceride levels in every group were within normal limit, whereas 1 of 9-12 year age group and1 of 13-15 year age group had hypertriglyceridemia. One of them in 9-12 year age group, 3 of them in 13-15 year age group, and 1 of them in 16-18 year age group were hypercholesterolemia.

Table 4.16. Means (±SEM) of biochemical parameters in 24 hyperglycemic female students at baseline

Parameters	9-12 y (*n* = 9)			13-15 y (*n* = 13)			16-18 y (*n* = 2)		
	Mean ± SEM	Min	Max	Mean ± SEM	Min	Max	Mean ± SEM	Min	Max
TC (mg/dL)	192 ± 9	166	256	185 ± 6	143	224	225 ± 52	173	277
TG (mg/dL)	83 ± 12	50	164	88 ± 12	52	224	100 ± 33	67	133
HDL (mg/dL)	67 ± 3	50	80	59 ± 2	46	71	62 ± 8	54	69
LDL (mg/dL)	109 ± 9	79	163	109 ± 6	59	145	144 ± 51	92	195
FBG (mg/dL)	126 ± 3	117	147	126 ± 1	120	136	123 ± 2	121	125

4.2 Efficiency of dietary counseling

4.2.1 Effect of dietary counseling on obese students

Means (±SEM) of daily nutrient intake in 6 obese students during the study are shown in Table 4.17. The mean values for total energy intake, carbohydrate intake, protein intake, and fat intake were not significantly difference during the study period. The mean value for total energy intake during baseline and 4th month was 1,103.5 (±97.7) kcal/day. The mean value for total energy intake during time between 12th month and 16th month was 1,173.5 (±35.3) kcal/day. These total energy intakes by dietary record less than energy requirement calculated from basal metabolic rate. Dietary Reference Intake for Thais 2003, an energy requirement for adolescence ranged from 1,700 to 2,300 kcal /day for males and 1,600 to 1,850 kcal /day for female and protein requirement for adolescence range from 42 to 63 g/d for male and 42 to 57 g/d for female. According to the American Heart Association recommendations regarding macronutrients intake for healthy children and adolescents over the age of two years, an average of total fat intake should not be more than 30% and no less than 20% of total calories.

Table 4.17. Mean (±SEM) of daily nutrient intake in 6 obese students during the study

	BL-4 mo	12 mo-16 mo
Energy (kcal)	1103.5 ± 97.7 (813.1, 1,399.1)	1173.6 ± 35.3 (1,038.1, 1,281.1)
Carbohydrate		
(g/d)	126.1 ± 14.3 (89.4, 183.3)	142.1 ± 7.4 (116.0, 171.3)
(%kcal)	45.5 ± 2.1 (39.9, 55.0)	48.5 ± 2.1 (41.6, 54.3)
Protein		
(g/d)	55.7 ± 7.1 (39.0, 88.3)	53.2 ± 2.5 (42.7, 60.1)
(%kcal)	20.0 ± 1.1 (17.7, 25.2)	18.1 ± 0.6 (16.0, 19.5)
Fat		
(g/d)	42.0 ± 3.2 (33.2, 54.4)	43.8 ± 2.5 (34.2, 51.6)
(%kcal)	34.7 ± 1.5 (27.8, 38.2)	33.5 ± 1.6 (29.7, 39.1)

4.2.2 Effect of dietary counseling on hypercholesterolemic students

Mean (±SEM) of daily nutrient intake in 7 hypercholesterolemic students during the study are shown in Table 4.18. The mean values for total energy intake, carbohydrate intake, protein intake, and fat intake were not significantly difference during the study period.

Table 4.18. Mean (±SEM) of daily nutrient intake in 7 hypercholesterolemic students during the study

	BL-4 mo	12 mo-16 mo
Energy (kcal)	1329.8 ± 134.6 (788.1, 1,930.9)	1268.6 ± 100.0 (961.9, 1,794.6)
Carbohydrate		
(g/d)	170.4 ± 22.5 (77.6, 257.0)	148.0 ± 17.7 (116.1, 250.0)
(%kcal)	50.2 ± 2.7 (39.4, 59.6)	46.1 ± 2.0 (40.1, 55.7)
Protein		
(g/d)	60.3 ± 4.3 (44.8, 78.8)	55.1 ± 2.8 (44.0, 65.7)
(%kcal)	18.7 ± 1.2 (14.3, 22.7)	17.7 ± 1.0 (12.9, 21.1)
Fat		
(g/d)	45.5 ± 4.8 (32.6, 69.6)	51.0 ± 3.7 (35.5, 63.7)
(%kcal)	31.3 ± 2.1 (22.1, 38.2)	36.4 ± 1.4 (31.9, 40.6)

4.2.3 Effect of dietary counseling on hypertriglyceridemic students

Daily nutrient intake in 2 hypertriglyceridemic students during the study are shown in Table 4.19. The values for total energy intake, carbohydrate intake, protein intake, and fat intake during 12th mo and 16th mo were less than before without significantly difference during the study period.

Table 4.19. Daily nutrient intake in 2 hypertriglyceridemic students during the study

	BL-4 mo	12 mo-16 mo
Energy (kcal)	1,287.7, 4,292.8	1,140.7, 1,637.1
Carbohydrate		
(g/d)	148.6, 524.3	152.6, 246.1
(%kcal)	46.2, 48.9	53.5, 60.1
Protein		
(g/d)	63.0, 167.3	45.9, 56.9
(%kcal)	19.6, 15.6	16.1, 13.9
Fat		
(g/d)	49.1, 171.2	38.5, 47.8
(%kcal)	34.3, 35.9	30.4, 26.3

4.2.4 Effect of dietary counseling on hyperglycemic students

Means (±SEM) of daily nutrient intake in 5 hyperglycemic students during the study are shown in Table 4.20. The mean values for total energy intake, carbohydrate intake, protein intake, and fat intake were not significantly difference during the study period.

Table 4.20. Mean (±SEM) of daily nutrient intake in 5 hyperglycemic students during the study

	BL-4 mo	12 mo-16 mo
Energy (kcal)	948.2 ± 78.4 (788.1, 1,157.9)	1,161.1 ± 49.5 (1,038.1, 1,281.1)
Carbohydrate		
(g/d)	107.1 ± 12.5 (77.6, 137.2)	139.9 ± 9.6 (115.9, 171.3)
(%kcal)	44.7 ± 1.7 (39.4, 49.0)	48.2 ± 2.7 (40.1, 54.3)
Protein		
(g/d)	45.1 ± 2.4 (39.0, 53.6)	53.3 ± 3.9 (42.7, 65.7)
(%kcal)	19.3 ± 1.1 (15.8, 22.7)	18.3 ± 1.0 (16.0, 21.1)
Fat		
(g/d)	37.7 ± 2.5 (32.9, 44.2)	43.4 ± 3.1 (34.2, 53.5)
(%kcal)	36.0 ± 0.6 (34.4, 37.6)	33.6 ± 1.9 (29.7, 38.8)

4.3 Effect of Intervention

4.3.1 Effect on anthropometric parameter in 18 obese male students

Means (±SEM) of anthropometric parameters in 18 obese male students during the study are shown in Tables 4.21-4.24 and changes of anthropometric parameters in 18 obese male students during the study are shown in Tables 4.25-4.28.

The mean height in both age groups were significant increased especially in 9-12 year obese male students had significant increased 5 cm/year, whereas in 13-15 year group increased 3.2 cm/year.

The mean weight in both age groups decreased in 4 mo with highest decrease 9.4, 15.1 kg in 9-12 year group and 13-15 year group, respectively (Table 4.25). Between 4 mo and 12 mo of study periods, body weight slightly increase but was not significant difference from baseline. At the end of study, 16 mo, the mean weight in both groups tended to be less than that at 12 mo, but was not significant. These changes were also observed in BMI.

No drastic changes of body weight and BMI at the end of study, it may be due to child growth. So body fat is another parameter which high sensitive for obesity assessment which we also carried out in our study.

Percentages of total body fat and trunk fat in 9-12 year old obese male students at 4 mo, 8mo, 16mo were significantly lower than that at BL, except at 12mo was not significant difference but tended to be lower than that at BL. The similar changes were also observed in 13-15 year old obese male students, total body fat at 8mo and 16mo were significantly lower than that at BL, whereas percantage of trunk fat at 4mo was significantly lower than that at BL, percantage of trunk fat at 16mo was significantly lower than that at 8mo (Tables 4.21-4.23).

Body trunk mm in both groups of obese male students had increased from BL throughout the study, at the end of study, 16 mo, trunk mm were significantly higher than those at BL, 4mo, and 8mo, whereas only in 9-12 year group at 16 mo was significantly higher than that at 12mo (Tables 4.21-4.23).

Percentages of fat in both legs in both groups of obese male students at 4 mo, 8mo, 12mo, 16mo were significantly lower than that at BL. Percentage of fat at

right arm in 9-12 year old obese male students at 4 mo, 8mo, 12mo, 16mo were significantly lower than that at BL, whereas only at 4 mo and 16mo were significantly lower than that at BL. Right arm fat in 13-15 year old obese male students only at 4mo and 16 mo were significantly lower than that at BL, whereas left arm fat at 16mo only was lower than that at BL (Tables 4.21-4.23).

Muscle mass at both legs and arms had increased throughout the study in both groups (Tables 4.21-4.23).

Waist/hip ratio in both groups were within normal limit throughout the study, in 9-12 year old obese male students at 4 mo, 8mo, 12mo, 16mo were significantly lower than that at BL, however these changes were not observed in 13-15 year group (Tables 4.24).

Tables 4.25-4.28 showed the numbers and mean net changes of anthropometric parameters in 18 obese male students during the study.

Table 4.21. Means (±SEM) of anthropometric parameters (I) in 18 obese male students during the study

Parameters[1]	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
Height (cm)	9-12	8	159.3 ± 3.8	159.3 ± 3.8	159.3 ± 3.8	164.5 ± 3.5 ^{a1}	164.5 ± 3.5 ^{a1}
	13-15	10	169.3 ± 2.1	169.3 ± 2.1	169.3 ± 2.1	172.5 ± 1.4 ^{a3}	172.5 ± 1.4 ^{a3}
Weight (kg)	9-12	8	73.8 ± 5.9	68.5 ± 5.3 ^{a1}	71.1 ± 5.1 ^{b2}	76.1 ± 5.7 $^{b1, c1}$	73.7 ± 5.4 ^{b4}
	13-15	10	83.1 ± 3.5	78.9 ± 2.7 ^{a4}	81.0 ± 3.2 ^{b4}	84.0 ± 3.8 $^{b4, c4}$	83.3 ± 4.2
BMI (kg/m^2)	9-12	8	28.8 ± 1.3	26.7 ± 1.2 ^{a1}	27.8 ± 1.2 ^{b2}	27.8 ± 1.2 ^{b4}	27.0 ± 1.3
	13-15	10	29.0 ± 1.0	27.4 ± 0.9 ^{a4}	28.2 ± 0.9 ^{b4}	28.2 ± 1.1	27.9 ± 1.2
Body fat (%bw)	9-12	8	41.2 ± 3.2	35.2 ± 2.5 ^{a2}	34.3 ± 2.6 ^{a3}	35.5 ± 2.4	32.4 ± 2.7 $^{a2, d4}$
	13-15	10	35.4 ± 2.3	30.8 ± 2.4	31.7 ± 2.1 ^{a4}	29.5 ± 1.8	28.0 ± 1.6 ^{a2}, ^{c4}
Trunk fat (%)	9-12	8	40.1 ± 3.3	35.4 ± 2.8 ^{a4}	33.4 ± 2.8 ^{a4}	35.8 ± 2.9	30.0 ± 2.2 $^{a3, d3}$
	13-15	10	35.6 ± 2.7	31.2 ± 2.9 ^{a4}	32.5 ± 2.4	30.3 ± 2.1	28.5 ± 1.8 ^{c4}
Trunk mm (kg)	9-12	8	17.6 ± 1.5	18.8 ± 1.2	20.0 ± 1.5 ^{b4}	20.8 ± 1.2 $^{a4, b3}$	22.0 ± 1.1 $^{a2, b1, c4, d4}$
	13-15	10	24.6 ± 2.0	24.6 ± 1.5	24.7 ± 1.5	27.9 ± 1.6 $^{b3, c4}$	28.7 ± 1.4 $^{a2, b1, c1}$

[1] Significantly different from BL: ^{a1}p<0.001, ^{a2}p<0.005, ^{a3}p<0.01, ^{a4}p<0.05
Significantly different from 4 mo: ^{b1}p<0.001, ^{b2}p<0.005, ^{b3}p<0.01, ^{b4}p<0.05
Significantly different from 8 mo: ^{c1}p<0.001, ^{c2}p<0.005, ^{c3}p<0.01, ^{c4}p<0.05
Significantly different from 12 mo: ^{d1}p<0.001, ^{d2}p<0.005, ^{d3}p<0.01, ^{d4}p<0.05

Table 4.22. Means (±SEM) of anthropometric parameters (II) in 18 obese male students during the study

Parameters[1]	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
Right leg fat (%)	9-12	8	43.1 ± 3.0	36.2 ± 2.5 ^{a1}	36.2 ± 2.4 ^{a2}	36.2 ± 2.1 ^{a3}	35.8 ± 3.2 ^{a2}
	13-15	10	36.4 ± 2.1	31.2 ± 2.1 ^{a4}	31.7 ± 2.0 ^{a3}	29.4 ± 1.7 ^{a3}	28.4 ± 1.6 $^{a2, c4}$
Right leg mm (kg)	9-12	8	9.3 ± 0.8	9.3 ± 0.8	9.7 ± 0.8	10.1 ± 0.7 $^{a3, b2}$	9.8 ± 0.6
	13-15	10	10.7 ± 0.5	11.0 ± 0.5	11.3 ± 0.5 ^{a3}	11.3 ± 0.6	11.3 ± 0.6 ^{a4}
Left leg fat (%)	9-12	8	44.4 ± 3.2	36.4 ± 2.3 ^{a1}	36.5 ± 2.5 ^{a2}	36.9 ± 2.0 ^{a4}	35.7 ± 3.0 ^{a2}
	13-15	10	37.1 ± 2.3	31.8 ± 2.1 ^{a4}	32.2 ± 2.0 ^{a3}	29.7 ± 1.8 ^{a3}	28.7 ± 1.7 $^{a2, c4}$
Left leg mm (kg)	9-12	8	9.1 ± 0.8	9.2 ± 0.8	9.5 ± 0.8	9.9 ± 0.7 $^{a4, b2}$	9.7 ± 0.6
	13-15	10	10.4 ± 0.5	10.7 ± 0.5	11.0 ± 0.5 ^{a4}	11.0 ± 0.5	11.1 ± 0.6 ^{a3}

[1] Significantly different from BL: $^{a1}p<0.001$, $^{a2}p<0.005$, $^{a3}p<0.01$, $^{a4}p<0.05$
Significantly different from 4 mo: $^{b1}p<0.001$, $^{b2}p<0.005$, $^{b3}p<0.01$, $^{b4}p<0.05$
Significantly different from 8 mo: $^{c1}p<0.001$, $^{c2}p<0.005$, $^{c3}p<0.01$, $^{c4}p<0.05$
Significantly different from 12 mo: $^{d1}p<0.001$, $^{d2}p<0.005$, $^{d3}p<0.01$, $^{d4}p<0.05$

Table 4.23. Means (±SEM) of anthropometric parameters (III) in 18 obese male students during the study

Parameters[1]	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
Right arm fat (%)	9-12	8	35.4 ± 3.0	30.2 ± 2.6 ^{a1}	30.1 ± 2.5 ^{a2}	30.5 ± 2.2 ^{a4}	26.9 ± 2.4 $^{a2, d4}$
	13-15	10	29.2 ± 2.0	26.3 ± 2.1 ^{a4}	26.8 ± 1.8	25.2 ± 1.8	22.8 ± 1.4 $^{a2, c4}$
Right arm mm (kg)	9-12	8	2.3 ± 0.2	2.2 ± 0.1 ^{a2}	2.3 ± 0.2 ^{b1}	2.5 ± 0.2 $^{a2, b1, c3}$	2.5 ± 0.2 $^{a4, b1}$
	13-15	10	2.7 ± 0.1	2.7 ± 0.1	2.7 ± 0.1	2.9 ± 0.1	2.9 ± 0.1 $^{a4, b2, c3}$
Left arm fat (%)	9-12	8	34.3 ± 2.5	30.1 ± 2.2 ^{a2}	29.9 ± 2.1	30.4 ± 1.9	26.8 ± 2.1 $^{a2, d3}$
	13-15	10	29.2 ± 2.1	26.4 ± 2.0	27.0 ± 1.8	25.6 ± 1.8	23.4 ± 1.2 $^{a3, c4}$
Left arm mm (kg)	9-12	8	2.3 ± 0.2	2.2 ± 0.2 ^{a2}	2.3 ± 0.2 ^{b4}	2.5 ± 0.2 $^{a1, b1, c2}$	2.5 ± 0.2 ^{b2}
	13-15	10	2.7 ± 0.1	2.6 ± 0.1	2.6 ± 0.1	2.7 ± 0.1	2.7 ± 0.1 $^{b3, c3}$

[1] Significantly different from BL: $^{a1}p<0.001$, $^{a2}p<0.005$, $^{a3}p<0.01$, $^{a4}p<0.05$
Significantly different from 4 mo: $^{b1}p<0.001$, $^{b2}p<0.005$, $^{b3}p<0.01$, $^{b4}p<0.05$
Significantly different from 8 mo: $^{c1}p<0.001$, $^{c2}p<0.005$, $^{c3}p<0.01$, $^{c4}p<0.05$
Significantly different from 12 mo: $^{d1}p<0.001$, $^{d2}p<0.005$, $^{d3}p<0.01$, $^{d4}p<0.05$

Table 4.24. Means (±SEM) of anthropometric parameters (IV) in 18 obese male students during the study

Parameters[1]	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
WC (cm)	9-12	8	97.1 ± 3.5	84.6 ± 3.0 ^{a1}	89.8 ± 3.9 $^{a2, b4}$	91.9 ± 3.9 $^{a2, b2}$	89.0 ± 4.2 ^{a3}
	13-15	10	97.3 ± 2.4	90.1 ± 2.2 ^{a3}	93.4 ± 2.9 ^{b3}	94.9 ± 3.3 ^{b4}	94.2 ± 2.9 ^{b4}
HC (cm)	9-12	8	104.1 ± 2.6	97.4 ± 2.8 ^{a1}	98.6 ± 2.7 ^{a2}	102.6 ± 2.9 $^{b1, c1}$	99.7 ± 3.1 ^{d4}
	13-15	10	106.5 ± 1.6	101.9 ± 1.7 ^{a2}	103.7 ± 1.6 $^{a4, c4}$	105.9 ± 2.0 $^{b2, c4}$	104.5 ± 2.4 ^{b4}
WHR	9-12	8	0.93 ± 0.01	0.87 ± 0.01 ^{a2}	0.91 ± 0.02 $^{a3, b4}$	0.89 ± 0.02 ^{a4}	0.89 ± 0.02 ^{a2}
	13-15	10	0.91 ± 0.02	0.88 ± 0.02	0.90 ± 0.02	0.89 ± 0.02	0.90 ± 0.02

[1] Significantly different from BL: $^{a1}p<0.001$, $^{a2}p<0.005$, $^{a3}p<0.01$, $^{a4}p<0.05$
Significantly different from 4 mo: $^{b1}p<0.001$, $^{b2}p<0.005$, $^{b3}p<0.01$, $^{b4}p<0.05$
Significantly different from 8 mo: $^{c1}p<0.001$, $^{c2}p<0.005$, $^{c3}p<0.01$, $^{c4}p<0.05$
Significantly different from 12 mo: $^{d1}p<0.001$, $^{d2}p<0.005$, $^{d3}p<0.01$, $^{d4}p<0.05$

Table 4.25. Changes of anthropometric parameters (I) in 18 obese male students during the study

Parameters	Age (y)	n	BL-4 mo (min,max)	n	4 mo-8 mo (min,max)	n	8 mo-12 mo (min,max)	n	12 mo-16 mo (min,max)
Weight (kg)									
Decrease	9-12	8	(-2.2, -9.4)	1	(-0.5)			6	(-0.6, -7.9)
	13-15	7	(-1.6, -15.1)	3	(-0.4, -2.7)	2	(-0.7, -1.4)	5	(-1.6, -4.9)
Stable	9-12							1	
	13-15								
Increase	9-12			7	(1.2, 4.5)	8	(0.8, 8.2)	1	(2.9)
	13-15	3	(0.1, 2.1)	7	(0.6, 7.3)	8	(0.2, 8.4)	5	(0.4, 3.7)
BMI (kg/m^2)									
Decrease	9-12	8	(-1.0, -3.2)	1	(-0.2)	3	(-0.7, -1.2)	6	(-0.2, -2.6)
	13-15	8	(-0.6, -4.8)	3	(-0.2, -0.9)	6	(-0.1, -3.3)	5	(-0.6, -1.8)
Stable	9-12							1	
	13-15	1							
Increase	9-12			7	(0.5, 1.9)	5	(0.2, 1.3)	1	(1.2)
	13-15	1	(0.5)	7	(0.2, 2.5)	4	(0.6, 2.5)	5	(0.1, 1.2)
Body fat (%bw)									
Decrease	9-12	8	(-2.1,-10.8)	5	(-0.5, -3.3)	3	(-0.1,-5.2)	7	(-0.4, -8.7)
	13-15	8	(-2.6,-13.7)	4	(-0.2, -4.2)	7	(-0.7,-9.2)	6	(-0.1, -11.3)
Stable	9-12								
	13-15							1	
Increase	9-12			3	(0.4, 1.6)	5	(0.4, 6.3)	1	(1.6)
	13-15	2	(0.3,4.3)	6	(1.9, 4.7)	3	(0.5, 8.4)	3	(0.7, 1.6)
Trunk fat (%bw)									
Decrease	9-12	8	(-0.3, -10.5)	6	(-0.7, -5.9)	2	(-1.0, -3.2)	7	(-3.6, -12.4)
	13-15	8	(-2.1, -13.0)	3	(-1.6, -7.4)	7	(-0.8, -8.9)	5	(-0.6, -8.3)
Stable	9-12								
	13-15					1			
Increase	9-12			2	(0.5, 1.3)	6	(0.8, 8.3)	1	(1.4)
	13-15	2	(1.6, 3.6)	7	(0.4, 5.8)	2	(4.3, 5.3)	5	(0.1, 1.9)
Trunk mm (kg)									
Decrease	9-12	3	(-0.2, -0.7)			3	(-0.4, -1.4)	2	(-0.3, -0.7)
	13-15	6	(-0.2, -3.6)	6	(-0.1, -2.1)	1	(-1.2)	4	(-0.2, -1.3)
Stable	9-12								
	13-15							1	
Increase	9-12	5	(0.5, 4.0)	8	(0.3, 3.0)	5	(1.0, 3.0)	6	(0.5, 3.6)
	13-15	4	(1.4, 3.6)	4	(0.2, 2.9)	9	(0.5, 8.4)	5	(0.2, 5.2)

Table 4.26. Changes of anthropometric parameters (II) in 18 obese male students during the study

Parameters	Age (y)	n	BL-4 mo (min,max)	n	4 mo-8 mo (min,max)	n	8 mo-12 mo (min,max)	n	12 mo-16 mo (min,max)
Right leg fat (%)									
Decrease	9-12	8	(-3.3, -10.2)	5	(-0.1, -2.6)	3	(-2.8, -7.7)	5	(-0.9, -5.1)
	13-15	9	(-0.7, -14.3)	4	(-0.6, -5.3)	7	(-0.4, -9.6)	4	(-0.4, -14.1)
Stable	9-12								
	13-15								
Increase	9-12			3	(1.9, 2.9)	5	(0.2, 6.1)	3	(0.9, 8.3)
	13-15	1	(5.2)	6	(1.1, 3.5)	3	(1.1, 11.1)	6	(0.1, 2.1)
Right leg mm (kg)									
Decrease	9-12	4	(-0.1, -0.3)	1	(-1.0)	3	(-0.2, -0.5)	5	(-0.2, -1.2)
	13-15	3	(-0.1, -0.5)	2	(-0.1, -0.2)	3	(-0.2, -3.2)	7	(-0.2, -1.4)
Stable	9-12	3						1	
	13-15			1					
Increase	9-12	1	(0.5)	7	(0.4, 0.8)	5	(0.3, 2.1)	2	(0.5, 0.5)
	13-15	7	(0.1, 1.1)	7	(0.1, 1.2)	7	(0.3, 1.1)	3	(0.5, 2.3)
Left leg fat (%)									
Decrease	9-12	8	(-3.7, -13.9)	4	(-0.4, -2.5)	4	(-0.7, -7.8)	5	(-1.5, -6.0)
	13-15	9	(-0.9, -15.7)	4	(-1.2, -6.3)	7	(-0.4, -10.6)	6	(-0.2, -14.1)
Stable	9-12								
	13-15								
Increase	9-12			4	(1.2, 2.7)	4	(3.1, 6.0)	3	(0.9, 6.0)
	13-15	1	(6.2)	6	(0.8, 4.1)	3	(1.3, 11.4)	4	(0.7, 2.7)
Left leg mm (kg)									
Decrease	9-12	2	(-0.3, -0.7)	1	(-1.0)	2	(-0.3, -0.8)	5	(-0.1, -1.0)
	13-15	2	(-0.4, -0.5)	2	(-0.1, -0.4)	3	(-0.2, -3.0)	7	(-0.1, -1.4)
Stable	9-12	1				2			
	13-15	1		1					
Increase	9-12	5	(0.1, 0.8)	7	(0.2, 0.8)	4	(0.6, 2.1)	3	(0.1, 0.4)
	13-15	7	(0.1, 1.2)	7	(0.1, 1.3)	7	(0.2, 1.1)	3	(0.5, 2.1)

Table 4.27. Changes of anthropometric parameters (III) in 18 obese male students during the study

Parameters	Age (y)	n	BL-4 mo (min,max)	n	4 mo-8 mo (min,max)	n	8 mo-12 mo (min,max)	n	12 mo-16 mo (min,max)
Right arm fat (%)									
Decrease	9-12	8	(-2.3, -8.3)	6	(-0.7, -1.8)	4	(-0.1, -3.4)	6	(-3.2, -7.7)
	13-15	8	(-1.2, -10.7)	3	(-0.7, -4.5)	8	(-0.9, -7.9)	6	(-1.0, -15.8)
Stable	9-12							1	
	13-15			1					
Increase	9-12			2	(2.6, 2.7)	4	(1.2, 4.5)	1	(1.4)
	13-15	2	(0.1, 4.1)	6	(1.3, 3.8)	2	(2.1, 12.4)	4	(0.2, 1.2)
Right arm mm (kg)									
Decrease	9-12	7	(-0.1, -0.2)					3	(-0.1, -0.2)
	13-15	3	(-0.1, -0.2)	2	(-0.1, -0.1)	1	(-0.3)	4	(-0.1, -0.3)
Stable	9-12	1				1		3	
	13-15	4		3		1		3	
Increase	9-12			8	(0.1, 0.2)	7	(0.1, 0.3)	2	(0.1, 0.1)
	13-15	3	(0.1, 0.1)	5	(0.1, 0.1)	8	(0.1, 0.5)	3	(0.1, 0.5)
Left arm fat (%)									
Decrease	9-12	8	(-1.2, -8.3)	4	(-0.2, -2.7)	4	(-0.4, -3.7)	7	(-1.6, -7.4)
	13-15	8	(-0.2, -10.4)	4	(-0.3, -3.6)	8	(-0.4, -6.9)	7	(-0.2, -15.8)
Stable	9-12								
	13-15								
Increase	9-12			4	(0.3, 2.2)	4	(1.6, 4.5)	1	(1.6)
	13-15	2	(1.3, 3.5)	6	(0.8, 3.7)	2	(2.0, 12.9)	3	(0.7, 0.9)
Left arm mm (kg)									
Decrease	9-12	7	(-0.1, -0.2)	1	(-0.1)			3	(-0.1, -0.2)
	13-15	4	(-0.1, -0.2)	1	(-0.1)	1	(-0.3)	5	(-0.1, -0.2)
Stable	9-12	1				1		3	
	13-15	4		5		1		2	
Increase	9-12			7	(0.1, 0.2)	7	(0.1, 0.3)	2	(0.1, 0.2)
	13-15	2	(0.1, 0.1)	4	(0.1, 0.1)	8	(0.1, 0.3)	3	(0.1, 0.3)

Table 4.28. Changes of anthropometric parameters (IV) in 18 obese male students during the study

Parameters	Age (y)	n	BL-4 mo (min,max)	n	4 mo-8 mo (min,max)	n	8 mo-12 mo (min,max)	n	12 mo-16 mo (min,max)
WC (cm)									
Decrease	9-12	8	(-5.0, -18.0)	1	(-7.0)	2	(-3.0, -3.3)	5	(-2.7, -13.0)
	13-15	8	(-0.5, -18.0)	1	(-2.0)	3	(-1.5, -5.0)	7	(-2.0, -5.0)
Stable	9-12					1			
	13-15	1				1			
Increase	9-12			7	(1.0, 13.0)	5	(1.0, 8.0)	3	(1.0, 6.3)
	13-15	1	(1.0, 1.0)	9	(1.0, 8.0)	6	(1.2, 8.7)	3	(2.2, 11.0)
HC (cm)									
Decrease	9-12	8	(-4.0, -9.0)	3	(-1.0, -2.5)			6	(-2.2, -6.0)
	13-15	8	(-1.5, -10.5)	2	(-1.0, -3.0)	1	(-0.2)	8	(-0.5, -4.3)
Stable	9-12			1					
	13-15	1				1			
Increase	9-12			4	(2.0, 6.0)	8	(2.0, 7.2)	2	(0.5, 1.3)
	13-15	1	(1.0)	8	(0.5, 6.0)	8	(0.5, 6.0)	2	(1.5, 2.2)
WHR									
Decrease	9-12	7	(-0.04, -0.11)	1	(-0.05)	5	(-0.02, -0.06)	3	(-0.01, -0.08)
	13-15	6	(-0.02, -0.16)	3		6	(-0.02, -0.05)	5	(-0.01, -0.03)
Stable	9-12					1		1	
	13-15	2						2	
Increase	9-12	1	(0.02)	7	(0.02, 0.10)	2	(0.01, 0.04)	4	(0.01, 0.05)
	13-15	2	(0.02, 0.04)	7	(0.02, 0.08)	4	(0.01, 0.04)	3	(0.02, 0.12)

4.3.2 Effect on anthropometric parameter in 31 obese female students

Means (±SEM) of anthropometric parameters in 31 obese female students during the study are shown in Tables 4.29-4.32 and changes of anthropometric parameters in 31 obese female students during the study are shown in Tables 4.33-4.36.

The mean height in both age groups were significant increased especially in 9-12 year obese male students had significant increased 2.6 cm/year, whereas in 13-15 year group increased 1.7 cm/year.

The mean weight in both age groups decreased in 4 mo with highest decrease 13.4, 4.9 kg in 9-12 year group and 13-15 year group, respectively (Table 4.33). Between 4 mo and 12 mo of study periods, body weight slightly increase but was not significant difference from baseline. At the end of study, 16 mo, the mean weight only in 9-12 year group less than that at BL and 12 mo, with significant different. However the mean weight only in 13-15 year group tended to be less than that at BL, but was not significant. These changes were also observed in BMI.

No drastic changes of body weight and BMI at the end of study, it may be due to child growth. So body fat is another parameter which high sensitive for obesity assessment which we also carried out in our study.

Percentages of total body fat and trunk fat in 9-12 year old obese female students had significant decreased from BL throughout the study. The similar changes were also observed in 13-15 year old obese female students, except at 8 mo was not significant difference but tended to be lower than that at BL (Tables 4.29-4.32).

Body trunk mm in both groups of obese female students had increased from BL throughout the study, at the end of study, 16 mo, trunk mm were significantly higher than those at BL and 4mo, whereas only in 9-12 year group at 16 mo was significantly higher than that at 12mo and only in 13-15 year group at 16 mo was significantly higher than that at 8 mo (Tables 4.29-4.32).

Percentages of fat in both legs in 9-12 year groups of obese female students at 4 mo, 8mo, 12mo, 16mo were significantly lower than that at BL. The similar changes were also observed in 13-15 year old obese female students, except at 8 mo was not significant difference but tended to be lower than that at BL.

Percentage of fat at right and left arm in 9-12 year old obese female students at 4 mo, 8mo, 12mo, 16mo were significantly lower than that at BL, whereas only at 16mo were significantly lower than that at BL, 4 mo, and 12 mo. Right arm fat in 13-15 year old obese female students only at 4 mo and 16 mo were significantly lower than that at BL, whereas left arm fat only at 4 mo and 12 mo were lower than that at BL (Tables 4.29-4.32).

Muscle mass at both legs and arms had increased throughout the study in both groups (Tables 4.29-4.32).

Waist/hip ratio in both groups were without normal limit throughout the study, in 9-12 year old obese female students at 4 mo, 12mo, 16mo were significantly lower than that at BL, in 13-15 year old obese female students, only at 4 mo was significant difference than at BL but at 12 mo and 16 mo tended to be lower than that at BL, but were not significant (Tables 4.32).

Tables 4.33-4.36 showed the numbers and mean net changes of anthropometric parameters in 31 obese female students during the study.

Obesity levels of 49 obese students classified by sex, age, and body fat during the study are shown in Table 4.41.

At the end of nutritional therapy 4 of 18 obese male students and 9 of 31 obese female students had normal body fat level.

Table 4.29. Means (±SEM) of anthropometric parameters (I) in 31 obese female students during the study

Parameters[1]	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
Height (cm)	9-12	15	155.3 ± 1.1	155.3 ± 1.1	155.3 ± 1.1	157.9 ± 1.1 ^{a1}	157.9 ± 1.1 ^{a1}
	13-15	16	158.8 ± 1.1	158.8 ± 1.1	158.8 ± 1.1	160.5 ± 1.2 ^{a4}	160.5 ± 1.2 ^{a4}
Weight (kg)	9-12	15	66.5 ± 2.7	63.6 ± 2.3 ^{a3}	64.5 ± 2.2 $^{a4, b3}$	64.4 ± 2.4	63.1 ± 2.2 $^{a3, d4}$
	13-15	16	66.8 ± 2.4	65.3 ± 2.5 ^{a4}	66.7 ± 2.7 ^{b3}	66.5 ± 2.5	66.5 ± 2.6
BMI (kg/m^2)	9-12	15	27.6 ± 1.1	26.4 ± 0.9 ^{a2}	26.6 ± 0.9 ^{a4}	25.9 ± 1.0 $^{a2, c4}$	25.3 ± 0.9 $^{a1, b4, c2, d4}$
	13-15	16	26.4 ± 0.8	25.6 ± 0.9 ^{a1}	26.3 ± 1.0 ^{b1}	25.8 ± 0.9	25.7 ± 0.9
Body fat (%bw)	9-12	15	42.4 ± 1.3	38.7 ± 1.5 ^{a1}	38.1 ± 1.4 ^{a1}	37.9 ± 1.5 ^{a1}	35.6 ± 1.3 $^{a1, b2, c2, d2}$
	13-15	16	39.9 ± 0.9	37.7 ± 1.5 ^{a1}	39.0 ± 1.7 ^{b4}	37.2 ± 1.2 ^{a4}	37.2 ± 1.1 ^{a3}
Trunk fat (%)	9-12	15	42.7 ± 1.6	39.4 ± 1.8 ^{a2}	38.2 ± 1.7 ^{a1}	39.5 ± 2.0 ^{a3}	35.7 ± 1.7 $^{a1, b2, c4, d1}$
	13-15	16	40.0 ± 1.1	37.6 ± 1.8 ^{a4}	38.9 ± 1.9 ^{b4}	37.0 ± 1.4 ^{a4}	36.9 ± 1.2 ^{a3}
Trunk mm (kg)	9-12	15	18.8 ± 0.4	18.9 ± 0.4	19.5 ± 0.4 $^{a2, b4}$	19.0 ± 0.5 ^{c4}	19.8 ± 0.4 $^{a1, b1, d1}$
	13-15	16	20.2 ± 0.4	20.4 ± 0.3	20.3 ± 0.4	21.4 ± 0.4 $^{a2, c4, b4}$	21.5 ± 0.5 $^{a1, b3, c4}$

[1] Significantly different from BL: ^{a1}p<0.001, ^{a2}p<0.005, ^{a3}p<0.01, ^{a4}p<0.05
Significantly different from 4 mo: ^{b1}p<0.001, ^{b2}p<0.005, ^{b3}p<0.01, ^{b4}p<0.05
Significantly different from 8 mo: ^{c1}p<0.001, ^{c2}p<0.005, ^{c3}p<0.01, ^{c4}p<0.05
Significantly different from 12 mo: ^{d1}p<0.001, ^{d2}p<0.005, ^{d3}p<0.01, ^{d4}p<0.05

Table 4.30. Means (±SEM) of anthropometric parameters (II) in 31 obese female students during the study

Parameters[1]	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
Right leg fat (%)	9-12	15	42.9 ± 1.0	38.2 ± 1.2 ^{a1}	38.6 ± 1.1 ^{a1}	36.2 ± 0.9 $^{a1, b4, c3}$	36.0 ± 1.0 $^{a1, c3}$
	13-15	16	40.5 ± 0.8	38.5 ± 1.1 ^{a3}	39.9 ± 1.6 ^{b4}	38.1 ± 0.9 ^{a2}	38.1 ± 0.9 ^{a3}
Right leg mm (kg)	9-12	15	6.6 ± 0.2	6.9 ± 0.2 ^{a1}	6.9 ± 0.2 ^{a1}	7.3 ± 0.3 $^{a1, b4, c4}$	7.2 ± 0.2 ^{a1}
	13-15	16	6.8 ± 0.2	6.9 ± 0.2	6.8 ± 0.2	6.9 ± 0.2	6.9 ± 0.2
Left leg fat (%)	9-12	15	42.5 ± 0.9	38.2 ± 1.1 ^{a1}	38.5 ± 1.0 ^{a1}	36.0 ± 0.8 $^{a1, b4, c3}$	35.7 ± 0.8 $^{a1, b4, c3}$
	13-15	16	40.5 ± 0.8	38.4 ± 1.3 ^{a4}	40.0 ± 1.5 ^{b3}	38.2 ± 1.0 ^{c4}	38.3 ± 0.9 ^{a4}
Left leg mm (kg)	9-12	15	6.7 ± 0.2	6.9 ± 0.2 ^{a2}	7.0 ± 0.2 ^{a1}	7.3 ± 0.3 $^{a1, b4, c4}$	7.3 ± 0.3 $^{a2, b4}$
	13-15	16	6.8 ± 0.2	6.8 ± 0.2	6.8 ± 0.2	6.9 ± 0.2	6.8 ± 0.2

[1] Significantly different from BL: $^{a1}p<0.001$, $^{a2}p<0.005$, $^{a3}p<0.01$, $^{a4}p<0.05$
Significantly different from 4 mo: $^{b1}p<0.001$, $^{b2}p<0.005$, $^{b3}p<0.01$, $^{b4}p<0.05$
Significantly different from 8 mo: $^{c1}p<0.001$, $^{c2}p<0.005$, $^{c3}p<0.01$, $^{c4}p<0.05$
Significantly different from 12 mo: $^{d1}p<0.001$, $^{d2}p<0.005$, $^{d3}p<0.01$, $^{d4}p<0.05$

Table 4.31. Means (±SEM) of anthropometric parameters (III) in 31 obese female students during the study

Parameters[1]	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
Right arm fat (%)	9-12	15	38.8 ± 1.7	35.8 ± 1.7 ^{a1}	35.2 ± 1.5 ^{a2}	35.8 ± 1.7 ^{a2}	33.2 ± 1.6 $^{a1, b4, d1}$
	13-15	16	36.2 ± 1.1	34.0 ± 1.6 ^{a4}	35.3 ± 1.8 ^{b4}	34.3 ± 1.3	34.1 ± 1.2 ^{a4}
Right arm mm (kg)	9-12	15	1.9 ± 0.1	1.8 ± 0.1 ^{a4}	1.9 ± 0.1 ^{b3}	1.8 ± 0.1 ^{c4}	1.9 ± 0.1 ^{b4}
	13-15	16	1.9 ± 0.1	1.9 ± 0.1	1.9 ± 0.1	1.9 ± 0.1	1.9 ± 0.1
Left arm fat (%)	9-12	15	40.8 ± 1.6	37.6 ± 1.6 ^{a1}	37.1 ± 1.5 ^{a1}	37.5 ± 1.8 ^{a2}	34.7 ± 1.6 $^{a1, b4, c4, d2}$
	13-15	16	38.2 ± 1.1	35.9 ± 1.6 ^{a4}	37.3 ± 1.7 ^{b2}	35.9 ± 1.3 ^{a4}	35.8 ± 1.2
Left arm mm (kg)	9-12	15	1.8 ± 0.1	1.8 ± 0.1	1.8 ± 0.1 ^{b3}	1.8 ± 0.1	1.8 ± 0.1
	13-15	16	1.8 ± 0.1	1.8 ± 0.1	1.8 ± 0.1	1.8 ± 0.1	1.8 ± 0.1

[1] Significantly different from BL: $^{a1}p<0.001$, $^{a2}p<0.005$, $^{a3}p<0.01$, $^{a4}p<0.05$
Significantly different from 4 mo: $^{b1}p<0.001$, $^{b2}p<0.005$, $^{b3}p<0.01$, $^{b4}p<0.05$
Significantly different from 8 mo: $^{c1}p<0.001$, $^{c2}p<0.005$, $^{c3}p<0.01$, $^{c4}p<0.05$
Significantly different from 12 mo: $^{d1}p<0.001$, $^{d2}p<0.005$, $^{d3}p<0.01$, $^{d4}p<0.05$

Table 4.32. Means (±SEM) of anthropometric parameters (IV) in 31 obese female students during the study

Parameters[1]	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
WC (cm)	9-12	15	86.9 ± 1.9	78.1 ± 1.6 ^{a1}	84.2 ± 1.9 $^{a4, b1}$	82.0 ± 1.7 $^{a1, b1, c4}$	79.6 ± 1.7 $^{a1, c1, d4}$
	13-15	16	86.5 ± 1.5	79.2 ± 1.9 ^{a1}	85.3 ± 2.1 ^{b1}	83.9 ± 2.0 $^{a4, b1}$	82.8 ± 1.9 $^{a3, b2, c2}$
HC (cm)	9-12	15	102.5 ± 1.6	98.1 ± 1.4 ^{a1}	99.9 ± 1.4 $^{a2, b3}$	99.0 ± 1.5 ^{b1}	98.5 ± 1.3 ^{a1}
	13-15	16	102.5 ± 1.4	97.9 ± 1.5 ^{a2}	101.2 ± 1.7 ^{b2}	101.7 ± 1.5	94.5 ± 5.8
WHR	9-12	15	0.85 ± 0.01	0.80 ± 0.01 ^{a1}	0.84 ± 0.01 ^{b1}	0.83 ± 0.01 $^{a4, b1, c4}$	0.81 ± 0.01 $^{a2, c2}$
	13-15	16	0.84 ± 0.01	0.81 ± 0.01 ^{a4}	0.84 ± 0.01 ^{b2}	0.82 ± 0.01 ^{c4}	0.82 ± 0.01 ^{c4}

[1] Significantly different from BL: $^{a1}p<0.001$, $^{a2}p<0.005$, $^{a3}p<0.01$, $^{a4}p<0.05$
Significantly different from 4 mo: $^{b1}p<0.001$, $^{b2}p<0.005$, $^{b3}p<0.01$, $^{b4}p<0.05$
Significantly different from 8 mo: $^{c1}p<0.001$, $^{c2}p<0.005$, $^{c3}p<0.01$, $^{c4}p<0.05$
Significantly different from 12 mo: $^{d1}p<0.001$, $^{d2}p<0.005$, $^{d3}p<0.01$, $^{d4}p<0.05$

Table 4.33. Changes of anthropometric parameters (I) in 31 obese female students during the study

Parameters	Age (y)	BL-4 mo n (min,max)	4 mo-8 mo n (min,max)	8 mo-12 mo n (min,max)	12 mo-16 mo n (min,max)
Weight (kg)					
Decrease	9-12	12 (-0.4, -13.4)	2 (-0.4, -1.5)	7 (-0.3, -4.9)	8 (-0.6, -5.3)
	13-15	14 (-0.2, - 4.9)	2 (-0.1, - 3.8)	9 (-0.5, - 3.2)	6 (-0.2, - 4.2)
Stable	9-12				
	13-15				
Increase	9-12	3 (0.1, 1.2)	13 (0.2, 2.5)	8 (0.6, 3.4)	7 (0.1, 1.7)
	13-15	2 (1.0, 1.2)	14 (0.1, 4.1)	7 (0.2, 3.0)	10 (0.2, 2.9)
BMI (kg/m^2)					
Decrease	9-12	12 (-0.2, -5.2)	5 (-0.1, -1.1)	10 (-0.4, -2.7)	8 (-0.2, -2.2)
	13-15	14 (-0.1, - 4.5)	1 (-0.4)	11 (-0.2, -2.2)	7 (-0.1, -1.6)
Stable	9-12	1			1
	13-15		1		1
Increase	9-12	2 (0.4, 0.5)	10 (0.2, 1.0)	5 (0.1, 1.6)	6 (0.1, 0.7)
	13-15	2 (0.4, 0.4)	14 (0.1, 1.5)	5 (0.3, 1.3)	8 (0.2, 1.1)
Body fat (%bw)					
Decrease	9-12	14 (- 0.8, -10.2)	8 (- 0.4, -4.4)	8 (- 0.7, -4.9)	12 (- 1.0, -6.8)
	13-15	12 (- 0.7, -1 2.8)	4 (- 0.1, -1.5)	11 (- 0.4, -10.3)	8 (- 0.1, - 5.5)
Stable	9-12			1	
	13-15	1			1
Increase	9-12	1 (0.6)	7 (0.1, 2.9)	6 (0.1, 4.7)	3 (0.1, 2.7)
	13-15	3 (1.1, 1.6)	12 (0.4, 5.1)	5 (0.2, 1.9)	7 (0.2, 5.4)
Trunk fat (%bw)					
Decrease	9-12	13 (- 1.0, -10.8)	10 (- 0.3, -6.8)	6 (-0.1, -3.9)	13 (-0.6, -10.6)
	13-15	11 (- 0.1, -15.5)	3 (- 0.9, - 2.6)	10 (-0.5, -11.2)	9 (-0.1, - 6.9)
Stable	9-12				
	13-15	1		1	1
Increase	9-12	2 (0.2, 2.8)	5 (0.1, 3.8)	9 (0.4, 6.9)	2 (0.3, 1.3)
	13-15	4 (0.4, 2.0)	13 (0.1, 4.2)	5 (1.6, 1.9)	6 (0.2, 6.6)
Trunk mm (kg)					
Decrease	9-12	5 (-0.1, -0.8)	2 (-0.3, -1.2)	9 (-0.3, -2.4)	2 (-0.1, -0.1)
	13-15	5 (-0.3, -0.9)	9 (-0.1, -1.3)	5 (-0.1, -1.3)	6 (-0.1, -1.4)
Stable	9-12	2	1		
	13-15		2		2
Increase	9-12	8 (0.1, 0.9)	12 (0.2, 2.9)	6 (0.1, 0.6)	13 (0.2, 2.5)
	13-15	11 (0.1, 3.1)	5 (0.3, 1.1)	11 (0.1, 5.8)	8 (0.3, 1.9)

Table 4.34. Changes of anthropometric parameters (II) in 31 obese female students during the study

Parameters	Age (y)	BL-4 mo n (min,max)	4 mo-8 mo n (min,max)	8 mo-12 mo n (min,max)	12 mo-16 mo n (min,max)
Right leg fat (%)					
Decrease	9-12	15 (-2.4, -9.7)	7 (-0.3, -4.1)	11 (-1.0, -6.8)	12 (-0.2, -4.9)
	13-15	12 (-0.3, - 8.4)	6 (-0.1, - 0.9)	9 (-0.3, -10.1)	8 (-0.2, - 3.9)
Stable	9-12				
	13-15		1	1	
Increase	9-12		8 (0.2, 4.8)	4 (0.8, 1.9)	3 (4.2, 5.5)
	13-15	4 (0.3, 1.2)	9 (0.5, 7.6)	6 (0.4, 2.5)	8 (0.2, 4.0)
Right leg mm (kg)					
Decrease	9-12	1 (-0.1)	5 (-0.1, -0.4)	3 (-0.2, -0.6)	8 (-0.1, -1.0)
	13-15	6 (-0.1, -0.2)	6 (-0.2, -0.6)	4 (-0.1, -0.5)	8 (-0.1, -0.7)
Stable	9-12		2	2	1
	13-15	2	3	1	1
Increase	9-12	14 (0.1, 0.8)	8 (0.1, 0.5)	10 (0.1, 1.4)	6 (0.1, 0.8)
	13-15	8 (0.1, 0.4)	7 (0.1, 0.4)	11 (0.1, 0.7)	7 (0.1, 0.7)
Left leg fat (%)					
Decrease	9-12	15 (-0.9, -9.5)	8 (-0.2, -4.0)	12 (-0.1, -6.4)	11 (-0.2, -4.7)
	13-15	12 (-0.2, - 8.7)	4 (-0.1, - 1.0)	10 (-0.3, - 9.9)	8 (-0.1, - 3.4)
Stable	9-12				
	13-15				
Increase	9-12		7 (0.6, 3.3)	3 (1.4, 2.1)	4 (0.3, 5.0)
	13-15	4 (0.5, 1.5)	12 (0.1, 5.3)	6 (0.2, 2.3)	8 (0.3, 4.0)
Left leg mm (kg)					
Decrease	9-12	3 (-0.1, -0.1)	4 (-0.1, -0.3)	4 (-0.1, -0.6)	7 (-0.1, -0.9)
	13-15	6 (-0.1, -0.3)	7 (-0.1, -0.3)	3 (-0.1, -0.7)	8 (-0.1, -0.8)
Stable	9-12		2	2	2
	13-15	3	1	5	1
Increase	9-12	12 (0.1, 0.6)	9 (0.1, 0.4)	9 (0.1, 1.4)	6 (0.1, 0.8)
	13-15	7 (0.1, 0.4)	8 (0.1, 0.4)	8 (0.1, 0.6)	7 (0.1, 0.6)

Table 4.35. Changes of anthropometric parameters (III) in 31 obese female students during the study

Parameters	Age (y)	BL-4 mo n (min,max)	4 mo-8 mo n (min,max)	8 mo-12 mo n (min,max)	12 mo-16 mo n (min,max)
Right arm fat (%)					
Decrease	9-12	13 (-1.0, -9.2)	8 (-0.6, -7.1)	5 (-0.5, -9.9)	13 (-0.3, -8.0)
	13-15	13 (-0.3, -13.7)	4 (-0.2, -2.1)	8 (-0.4, -7.2)	7 (-0.7, - 4.4)
Stable	9-12				1
	13-15			1	
Increase	9-12	2 (0.8, 2.0)	7 (0.1, 3.3)	10 (0.4, 6.3)	1 (0.7)
	13-15	3 (0.6, 1.0)	12 (0.4, 5.1)	7 (0.5, 2.1)	9 (0.1, 3.8)
Right arm mm (kg)					
Decrease	9-12	7 (-0.1, -0.3)		7 (-0.1, -0.1)	1 (-0.1)
	13-15	1 (-0.2)	1 (-0.1)	5 (-0.1, -0.2)	5 (-0.1, -0.2)
Stable	9-12	7	8	7	8
	13-15	14	9	7	4
Increase	9-12	1 (0.1)	7 (0.1, 0.2)	1 (0.1)	6 (0.1, 0.1)
	13-15	1 (0.1)	6 (0.1, 0.1)	4 (0.1, 0.1)	7 (0.1, 0.2)
Left arm fat (%)					
Decrease	9-12	14 (-0.9, -10.5)	10 (-0.1, -5.5)	7 (-0.2, -9.2)	13 (-0.3, -9.1)
	13-15	12 (-0.2, -13.5)	3 (-0.2, -2.0)	10 (-0.4, -8.9)	7 (-0.2, -7.0)
Stable	9-12				
	13-15				
Increase	9-12	1 (2.7)	5 (0.4, 3.7)	8 (0.4, 4.9)	2 (0.5, 1.0)
	13-15	4 (0.4, 2.4)	13 (0.2, 4.6)	6 (0.4, 3.2)	9 (0.2, 4.5)
Left arm mm (kg)					
Decrease	9-12	7 (-0.1, -0.2)		6 (-0.1, -0.2)	2 (-0.1, -0.1)
	13-15	2 (-0.1, -0.1)	3 (-0.1, -0.1)	4 (-0.1, -0.1)	4 (-0.1, -0.2)
Stable	9-12	6	9	7	10
	13-15	11	8	9	8
Increase	9-12	2 (0.1, 0.1)	6 (0.1, 0.1)	2 (0.1, 0.1)	3 (0.1, 0.1)
	13-15	3 (0.1, 0.1)	5 (0.1, 0.1)	3 (0.1, 0.2)	4 (0.1, 0.2)

Table 4.36. Changes of anthropometric parameters (IV) in 31 obese female students during the study

Parameters	Age (y)	BL-4 mo n (min,max)	4 mo-8 mo n (min,max)	8 mo-12 mo n (min,max)	12 mo-16 mo n (min,max)
WC (cm)					
Decrease	9-12	15 (-3.0, -18.0)		10 (-0.5, -8.6)	12 (- 0.5, -10.0)
	13-15	14 (-5.5, -1 4.0)	1 (-2.0)	10 (-1.0, -6.0)	9 (- 1.0, - 6.5)
Stable	9-12			3	
	13-15		1	2	
Increase	9-12		15 (2.5, 11.0)	2 (2.0, 2.0)	3 (1.0, 3.6)
	13-15	2 (1.5, 5.5)	14 (1.0, 12.0)	4 (0.5, 4.0)	7 (1.0, 2.7)
HC (cm)					
Decrease	9-12	15 (-0.5, -9.0)	1 (-3.5)	9 (-0.5, -5.6)	9 (-0.1, -4.0)
	13-15	15 (-1.0, -9.0)	1 (-2.0)	5 (-1.0, -1.7)	9 (-0.7, -6.5)
Stable	9-12		4		1
	13-15	1	1	1	1
Increase	9-12		10 (1.0, 5.0)	6 (1.0, 2.0)	5 (1.0, 2.6)
	13-15		14 (1.0, 13.0)	10 (0.5, 3.0)	6 (0.2, 2.7)
WHR					
Decrease	9-12	14 (-0.03, -0.13)		10 (-0.01, -0.07)	11 (-0.01, -0.08)
	13-15	14 (-0.01, -0.10)	2 (-0.02, -0.06)	11 (-0.01, -0.08)	7 (-0.01, -0.08)
Stable	9-12		1	1	
	13-15		2	1	1
Increase	9-12	1 (0.02)	14 (0.02, 0.11)	4 (0.01, 0.02)	4 (0.01, 0.04)
	13-15	2 (0.05, 0.12)	12 (0.01, 0.10)	4 (0.01, 0.04)	8 (0.02, 0.04)

4.3.3 Biochemical parameters in 18 male obese students

Means (±SEM) of biochemical parameters in 18 male obese students during the study were improved at the end of this study (Table 4.37).

In 9-12 and 13-15 year old obese male group, mean serum TC at BL was at hypercholesterolemia level (221 and 206 mg/dL) after receiving nutritional therapy for 8mo serum TC (189 and 171 mg/dL) was significantly lower than that at BL, however at 12 mo and 16 mo their mean serum TC tended to be lower than that at BL but did not reach significant defference. These changes were also observed in serm LDL levels during the study. All of them had normal serum TG and HDL levels throughout the study. Their mean serum FBG levels in both groups at 8mo, 12mo, and 16mo were significantly lower than those at BL.

Tables 4.39 showed the numbers and mean net changes of biochemical parameters in 18 obese male students during the study.

Table 4.37. Means (±SEM) of biochemical parameters in 18 obese male students during the study

Parameters[1]	Age (y)	n	BL	8 mo	12 mo	16 mo
TC (mg/dL)	9-12	8	221 ± 12	189 ± 12 ^{a4}	205 ± 13	187 ± 12
	13-15	10	206 ± 17	171 ± 14 ^{a1}	191 ± 14 ^{c4}	184 ± 15
TG (mg/dL)	9-12	8	74 ± 5	146 ± 24 ^{a4}	59 ± 8 ^{c2}	118 ± 12 $^{a4, d2}$
	13-15	10	90 ± 12	103 ± 17	62 ± 8 $^{a2, c3}$	111 ± 15 ^{d2}
HDL (mg/dL)	9-12	8	56 ± 4	48 ± 2 ^{a4}	48 ± 1	43 ± 1 $^{a4, d4}$
	13-15	10	53 ± 4	44 ± 1	45 ± 1 ^{a4}	44 ± 1
LDL (mg/dL)	9-12	8	150 ± 12	111 ± 10 ^{a2}	145 ± 12 ^{c3}	121 ± 12
	13-15	10	135 ± 19	107 ± 14 ^{a3}	134 ± 14 ^{c4}	118 ± 12
FBG (mg/dL)	9-12	8	113 ± 5	91 ± 2 ^{a2}	94 ± 3 ^{a4}	92 ± 2 ^{a1}
	13-15	10	103 ± 3	89 ± 2 ^{a1}	88 ± 1 ^{a2}	93 ± 2 $^{a2, d4}$

[1] Significantly different from BL: $^{a1}p<0.001$, $^{a2}p<0.005$, $^{a3}p<0.01$, $^{a4}p<0.05$
Significantly different from 4 mo: $^{b1}p<0.001$, $^{b2}p<0.005$, $^{b3}p<0.01$, $^{b4}p<0.05$
Significantly different from 8 mo: $^{c1}p<0.001$, $^{c2}p<0.005$, $^{c3}p<0.01$, $^{c4}p<0.05$
Significantly different from 12 mo: $^{d1}p<0.001$, $^{d2}p<0.005$, $^{d3}p<0.01$, $^{d4}p<0.05$

4.3.4 Biochemical parameters in 31 female obese students

Means (±SEM) of biochemical parameters in 31 female obese students during the study were improved at the end of this study (Table 4.38).

In 9-12 year old obese female group, mean serum TC at BL was at borderline of hypercholesterolemia level (181 mg/dL) tended to be lower than that at BL but did not reach significant difference during the study. In 9-12 year old obese female group, mean serum TC at BL was at borderline of hypercholesterolemia level (194 mg/dL) after receiving nutritional therapy for 8 mo and 12 mo serum TC were significantly lower than that at BL, however at 16 mo their mean serum TC tended to be lower than that at BL but did not reach significant difference. Only in 13-15 year group, mean serum LDL at BL was at borderline level of LDL (118 mg/dL) after receiving nutritional therapy for 8 mo serum LDL was significantly lower than that at BL.

All of them had normal serum TG and HDL levels throughout the study. Their mean serum FBG levels in both groups at 8mo, 12mo, and 16mo were significantly lower than those at BL.

Tables 4.40 showed the numbers and mean net changes of biochemical parameters in 31 obese female students during the study.

Table 4.38. Means (±SEM) of biochemical parameters in 31 obese female students during the study

Parameters[1]	Age (y)	n	BL	8 mo	12 mo	16 mo
TC (mg/dL)	9-12	15	181 ± 10	176 ± 8	179 ± 7	178 ± 7
	13-15	16	194 ± 8	171 ± 7 [a1]	167 ± 6 [a1]	182 ± 7 [d4]
TG (mg/dL)	9-12	15	79 ± 8	84 ± 11	56 ± 6 [a1, c3]	97 ± 12 [d1]
	13-15	16	89 ± 10	92 ± 11	60 ± 6 [c4]	92 ± 11 [d]
HDL (mg/dL)	9-12	15	61 ± 2	52 ± 2 [a3]	53 ± 1 [a1]	54 ± 3
	13-15	16	58 ± 2	53 ± 1 [a4]	53 ± 1 [a4]	52 ± 1 [a2]
LDL (mg/dL)	9-12	15	104 ± 11	107 ± 8	115 ± 7	104 ± 6
	13-15	16	118 ± 8	100 ± 7 [a4]	101 ± 6	112 ± 7
FBG (mg/dL)	9-12	15	100 ± 3	87 ± 2 [a1]	87 ± 2 [a2]	88 ± 2 [a2]
	13-15	16	105 ± 3	87 ± 1 [a1]	88 ± 2 [a1]	91 ± 2 [a3, c4]

[1] Significantly different from BL: [a1]p<0.001, [a2]p<0.005, [a3]p<0.01, [a4]p<0.05
Significantly different from 4 mo: [b1]p<0.001, [b2]p<0.005, [b3]p<0.01, [b4]p<0.05
Significantly different from 8 mo: [c1]p<0.001, [c2]p<0.005, [c3]p<0.01, [c4]p<0.05
Significantly different from 12 mo: [d1]p<0.001, [d2]p<0.005, [d3]p<0.01, [d4]p<0.05

Table 4.39. Changes of biochemical parameters in 18 obese male students during the study

Parameters	Age (y)	BL-8 mo n	BL-8 mo (min,max)	8 mo-12 mo n	8 mo-12 mo (min,max)	12 mo-16 mo n	12 mo-16 mo (min,max)
TC (mg/dL)							
Decrease	9-12	7	(-12, -55)	1	(-15)	5	(-6, -56)
	13-15	10	(-8, -62)	2	(-1, -22)	6	(-3, -51)
Stable	9-12			1			
	13-15						
Increase	9-12	1	(23)	6	(7, 46)	3	(6, 12)
	13-15			8	(11, 56)	4	(1, 65)
TG (mg/dL)							
Decrease	9-12	1	(-11)	8	(-6, -187)		
	13-15	5	(-3, -25)	9	(-6, -93)	1	(-2)
Stable	9-12						
	13-15			1			
Increase	9-12	7	(28, 190)			8	(18, 133)
	13-15	5	(27, 79)			9	(2, 131)
HDL (mg/dL)							
Decrease	9-12	7	(-1, -19)	3	(-1, -14)	7	(-1, -13)
	13-15	8	(-2, -32)	5	(-1, -5)	7	(-1, -7)
Stable	9-12			2			
	13-15						
Increase	9-12	1	(2)	3	(2, 12)	1	(1)
	13-15	2	(4, 9)	5	(1, 8)	3	(4, 9)
LDL (mg/dL)							
Decrease	9-12	7	(-17, -76)	1	(-1)	6	(0, -65)
	13-15	8	(-3, -69)	2	(-3, -21)	7	(-12, -60)
Stable	9-12	1					
	13-15						
Increase	9-12			7	(13, 83)	2	(3, 11)
	13-15	2	(1, 13)	8	(12, 71)	3	(3, 53)
FBG (mg/dL)							
Decrease	9-12	7	(-14, -39)	2	(-12, -14)	5	(-4, -17)
	13-15	9	(-3, -33)	6	(-1, -13)	1	(-4)
Stable	9-12	1		1			
	13-15	1				1	
Increase	9-12			5	(3, 17)	3	(1, 16)
	13-15			4	(1, 9)	8	(1, 13)

Table 4.40. Changes of biochemical parameters in 31 obese female students during the study

Parameters	Age (y)	BL-8 mo n	BL-8 mo (min,max)	8 mo-12 mo n	8 mo-12 mo (min,max)	12 mo-16 mo n	12 mo-16 mo (min,max)
TC (mg/dL)							
Decrease	9-12	8	(-1.0, -41.0)	7	(-4.0, -28.0)	9	(-4.0, -38.0)
	13-15	14	(-1.0, -70.0)	8	(-1.0, -89.0)	4	(-4.0, -30.0)
Stable	9-12					1	
	13-15					1	
Increase	9-12	7	(2.0, 14.0)	8	(1.0, 37.0)	5	(7.0, 42.0)
	13-15	2	(6.0, 16.0)	8	(1.0, 24.0)	11	(3.0, 63.0)
TG (mg/dL)							
Decrease	9-12	7	(-11.0, -44.0)	13	(-1.0, -89.0)		
	13-15	8	(-3.0, -111.0)	12	(-6.0, -138.0)	2	(-8.0, -2 0.0)
Stable	9-12	1					
	13-15						
Increase	9-12	7	(8.0, 66.0)	2	(2.0, 40.0)	15	(4.0, 95.0)
	13-15	8	(6.0, 113.0)	4	(5.0, 23.0)	14	(8.0, 101.0)
HDL (mg/dL)							
Decrease	9-12	12	(-2.0, -25.0)	6	(-3.0, -10.0)	8	(-2.0, -9.0)
	13-15	12	(-2.0, -26.0)	6	(-1.0, -7.0)	10	(-1.0, - 8.0)
Stable	9-12			1			
	13-15	1		3			
Increase	9-12	3	(5.0, 10.0)	8	(1.0, 15.0)	7	(1.0, 44.0)
	13-15	3	(1.0, 7.0)	7	(1.0, 12.0)	6	(3.0, 3.0)
LDL (mg/dL)							
Decrease	9-12	4	(-2.2, -35.2)	5	(-6.2, -21.4)	11	(-5.0, -49.0)
	13-15	11	(-2.6, -78.8)	7	(-1.2, -73.6)	6	(-1.4, -33.4)
Stable	9-12						
	13-15						
Increase	9-12	11	(1.8, 31.2)	10	(1.4, 35.8)	4	(7.2, 26.2)
	13-15	5	(0.4, 23.8)	9	(11.0, 27.6)	10	(0.8, 61.6)
FBG (mg/dL)							
Decrease	9-12	13	(-2.0, -34.0)	7	(-2.0, -9.0)	7	(-1.0, -15.0)
	13-15	16	(-1.0, -4 9.0)	6	(-1.0, -6.0)	3	(-2.0, -1 2.0)
Stable	9-12					1	
	13-15			1		1	
Increase	9-12	2	(1.0, 5.0)	8	(1.0, 12.0)	7	(2.0, 16.0)
	13-15			9	(1.0, 8.0)	12	(1.0, 1 2.0)

Table 4.41. Obesity levels of 49 obese students classified by sex, age, and body fat during the study

	By Body fat Kromeyer 2001	BL N (%[1])	4 mo N (%)	8 mo N (%)	12 mo N (%)	16 mo N (%)
Male						
9-12 (y)	Normal			1 (2.0)		1 (2.0)
n = 8	Over fat	1 (2.0)	2 (4.1)	2 (4.1)	2 (4.1)	2 (4.1)
	Obesity	7 (14.3)	6 (12.2)	5 (10.2)	6 (12.2)	5 (10.2)
13-15 (y)	Normal		3 (6.1)	1 (2.0)	3 (6.1)	3 (6.1)
n = 10	Over fat	2 (4.1)	2 (4.1)	4 (8.2)	1 (2.0)	1 (2.0)
	Obesity	8 (16.3)	5 (10.2)	5 (10.2)	6 (12.2)	6 (12.2)
Female						
9-12 (y)	Normal		2 (4.1)	3 (6.1)	4 (8.2)	4 (8.2)
n = 15	Over fat		3 (6.1)	2 (4.1)	3 (6.1)	5 (10.2)
	Obesity	15 (30.6)	10 (20.4)	10 (20.4)	8 (16.3)	6 (12.2)
13-15 (y)	Normal		3 (6.1)	2 (4.1)	5 (10.2)	5 (10.2)
n = 16	Over fat	8 (16.3)	8 (16.3)	7 (14.3)	5 (10.2)	9 (18.4)
	Obesity	8 (16.3)	5 (10.2)	7 (14.3)	6 (12.2)	2 (4.1)

[1] % of 49 obese students

4.3.5 Effect on anthropometric parameter of 20 hypercholesterolemic male students

Means (±SEM) of anthropometric parameters in 20 hypercholesterolemic male students during the study are shown in Tables 4.42-4.45

The mean height in 9-12 year and 13-15 year old hypercholesterolemic male students were significant increased especially in 9-12 year old hypercholesterolemic male students had significant increased 5.9 cm/year and in 13-15 year group increased 2 cm/year, but student in 16.1 year was not change.

The mean weight in 9-12 year old hypercholesterolemic male students at 4 mo and 12mo were significantly lower than that at BL, except at 8 mo was not significant difference but tended to be lower than that at BL. In 13-15 year group and age 16.1 year tended to be higher than that at BL. These changes were also observed in BMI, except in 13-15 year group at 4 mo was significantly lower than that at BL but at 16 mo was not change from BL.

No drastic changes of body weight and BMI in 9-12 year group and in 13-15 year group at the end of study, it may be due to child growth.

Percentages of total body fat and trunk fat in 9-12 year old hypercholesterolemic male students at 4 mo, 8mo, 16mo were significantly lower than that at BL, except trunk fat at 12mo was not significant difference but tended to be lower than that at BL. The similar changes were also observed in 13-15 year old obese male students, total body fat and trunk fat at 4mo, 12 mo and 16mo were significantly lower than that at BL, whereas percentages of total body fat and trunk fat in 16.1 year were increase during the study (Tables 4.42-4.45).

Body trunk mm in all groups of hypercholesterolemic male students had increased from BL throughout the study, at the end of study, 16 mo, trunk mm were significantly higher than those at BL, 4mo, and 8mo, whereas only in 9-12 year group at 16 mo was significantly higher than that at 12mo.

Percentage of fat in both leg in 13-15 year group of hypercholesterolemic male students at 4 mo, 12 mo, and 16 mo were significantly lower than that at BL. Percentage of fat in both leg in 13-15 year group of hypercholesterolemic male students at 4 mo, 8 mo, 12 mo, and 16 mo were significantly lower than that at BL. Percentage of fat at both arm in 13-15 year old hypercholesterolemic male students at

12 mo was significantly lower than that at BL, whereas percentage of fat at both leg and both arm trended higher durinf the study (Tables 4.42-4.45).

Muscle mass at both legs and arms had increased throughout the study in both groups (Tables 4.42-4.45).

Waist/hip ratio in all groups were within normal limit throughout the study. (Tables 4.45).

Table 4.42. Means (±SEM) of anthropometric parameters (I) in 20 hypercholesterolemic male students during the study

Parameters[1]	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
Height (cm)	9-12	7	154.4 ± 4.4	154.4 ± 4.4	154.4 ± 4.4	160.3 ± 4.1^{a1}	160.3 ± 4.1^{a1}
	13-15	12	167.3 ± 1.6	167.3 ± 1.6	167.3 ± 1.6	169.3 ± 1.7^{a2}	169.3 ± 1.7^{a2}
	16-18	1	180.0	180.0	180.0	180.0	180.0
Weight (kg)	9-12	7	63.1 ± 8.6	59.4 ± 8.0^{a2}	61.8 ± 8.0^{b3}	65.3 ± 8.6$^{a4, b1, c2}$	63.6 ± 7.9^{b4}
	13-15	12	66.9 ± 5.8	64.1 ± 4.7	66.9 ± 5.1^{b2}	69.0 ± 5.9^{b2}	68.4 ± 6.0^{b4}
	16-18	1	56.8	59.7	60.7	61.2	66.8
BMI (kg/m^2)	9-12	7	25.8 ± 2.5	24.2 ± 2.4^{a1}	25.3 ± 2.3^{b2}	24.8 ± 2.4^{a4}	24.3 ± 2.2$^{a4, c4}$
	13-15	12	23.6 ± 1.6	22.5 ± 1.3^{a4}	23.6 ± 1.4^{b2}	23.8 ± 1.7^{b4}	23.7 ± 1.7^{b4}
	16-18	1	17.5	18.4	18.7	18.9	20.6
Body fat (%bw)	9-12	7	35.6 ± 5.8	29.6 ± 5.8^{a1}	30.7 ± 4.9^{a4}	29.6 ± 5.4^{a4}	27.0 ± 4.9$^{a1, c4}$
	13-15	12	21.2 ± 2.6	18.6 ± 2.3^{a4}	20.8 ± 2.3^{b2}	18.0 ± 2.4$^{a2, c4}$	18.1 ± 2.3$^{a4, c4}$
	16-18	1	8.2	8.1	9.2	10.5	14.7
Trunk fat (%)	9-12	7	34.2 ± 6.0	29.6 ± 6.3^{a4}	30.0 ± 5.2^{a4}	30.1 ± 6.1	24.6 ± 4.4$^{a2, c4, d4}$
	13-15	12	20.2 ± 2.8	17.5 ± 2.6^{a4}	20.3 ± 2.7^{b2}	17.5 ± 2.9$^{a3, c4}$	17.5 ± 2.9$^{a4, c4}$
	16-18	1	6.5	5.4	6.5	9.0	13.7
Trunk mm (kg)	9-12	7	16.8 ± 1.6	17.4 ± 1.3	18.2 ± 1.6	19.1 ± 1.0^{b4}	20.4 ± 1.2$^{a4, b2, c4, d4}$
	13-15	12	25.1 ± 1.2	24.5 ± 1.0	24.8 ± 1.0	27.3 ± 1.3$^{a3, b1, c2}$	27.3 ± 1.2$^{a3, b1, c2}$
	16-18	1	27.3	28.5	29.0	28.3	29.8

[1] Significantly different from BL: $^{a1}p<0.001$, $^{a2}p<0.005$, $^{a3}p<0.01$, $^{a4}p<0.05$
Significantly different from 4 mo: $^{b1}p<0.001$, $^{b2}p<0.005$, $^{b3}p<0.01$, $^{b4}p<0.05$
Significantly different from 8 mo: $^{c1}p<0.001$, $^{c2}p<0.005$, $^{c3}p<0.01$, $^{c4}p<0.05$
Significantly different from 12 mo: $^{d1}p<0.001$, $^{d2}p<0.005$, $^{d3}p<0.01$, $^{d4}p<0.05$

Table 4.43. Means (±SEM) of anthropometric parameters (II) in 20 hypercholesterolemic male students during the study

Parameters[1]	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
Right leg fat (%)	9-12	7	37.9 ± 5.4	30.8 ± 5.5^{a1}	32.4 ± 4.7^{a2}	30.0 ± 4.8^{a2}	30.3 ± 5.4^{a2}
	13-15	12	23.1 ± 2.4	20.3 ± 2.1^{a4}	22.1 ± 2.0^{b4}	19.1 ± 1.9$^{a2, c4}$	19.2 ± 1.8$^{a4, c4}$
	16-18	1	10.2	11.1	12.8	12.4	16.3
Right leg mm (kg)	9-12	7	8.0 ± 1.1	8.2 ± 1.0	8.4 ± 1.0	9.0 ± 1.0$^{a2, b3}$	8.7 ± 0.8
	13-15	12	9.5 ± 0.6	9.7 ± 0.6^{a4}	9.9 ± 0.7^{a2}	10.1 ± 0.7^{a2}	9.9 ± 0.8
	16-18	1	8.9	9.4	9.2	9.4	9.7
Left leg fat (%)	9-12	7	39.6 ± 5.5	31.0 ± 5.4^{a1}	32.9 ± 4.7^{a2}	30.7 ± 4.9^{a3}	30.3 ± 5.2^{a1}
	13-15	12	23.7 ± 2.5	21.0 ± 2.1^{a4}	22.5 ± 2.0	19.6 ± 1.8$^{a4, c4}$	19.9 ± 1.7$^{a4, c4}$
	16-18	1	10.7	11.2	12.8	12.0	16.0
Left leg mm (kg)	9-12	7	7.7 ± 1.1	8.1 ± 1.0	8.2 ± 1.0	8.8 ± 1.0$^{a3, b4}$	8.6 ± 0.8
	13-15	12	9.2 ± 0.6	9.4 ± 0.6	9.7 ± 0.6^{a2}	9.8 ± 0.7	9.6 ± 0.7
	16-18	1	8.7	9.3	9.1	9.4	9.6

[1] Significantly different from BL: $^{a1}p<0.001$, $^{a2}p<0.005$, $^{a3}p<0.01$, $^{a4}p<0.05$
Significantly different from 4 mo: $^{b1}p<0.001$, $^{b2}p<0.005$, $^{b3}p<0.01$, $^{b4}p<0.05$
Significantly different from 8 mo: $^{c1}p<0.001$, $^{c2}p<0.005$, $^{c3}p<0.01$, $^{c4}p<0.05$
Significantly different from 12 mo: $^{d1}p<0.001$, $^{d2}p<0.005$, $^{d3}p<0.01$, $^{d4}p<0.05$

Table 4.44. Means (±SEM) of anthropometric parameters (III) in 20 hypercholesterolemic male students during the study

Parameters[1]	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
Right arm fat (%)	9-12	7	30.2 ± 5.6	25.3 ± 5.5^{a1}	26.5 ± 4.7^{a4}	25.0 ± 5.0^{a3}	22.1 ± 4.4$^{a2, c3}$
	13-15	12	17.4 ± 2.1	16.1 ± 2.0	17.6 ± 1.9^{b4}	15.3 ± 1.8$^{a4, c3}$	15.3 ± 1.8^{c4}
	16-18	1	10.3	11.0	11.6	12.3	15.0
Right arm mm (kg)	9-12	7	2.0 ± 0.2	1.9 ± 0.2	2.0 ± 0.2^{b4}	2.2 ± 0.2$^{a2, b1, c3}$	2.2 ± 0.2$^{a4, b2, c4}$
	13-15	12	2.4 ± 0.2	2.4 ± 0.1	2.4 ± 0.1	2.6 ± 0.2$^{a2, b1, c1}$	2.6 ± 0.2$^{a2, b1, c2}$
	16-18	1	2.3	2.4	2.5	2.4	2.5
Left arm fat (%)	9-12	7	29.2 ± 4.9	25.4 ± 5.0^{a2}	26.8 ± 4.2^{a4}	25.2 ± 4.7^{a4}	22.3 ± 4.0$^{a2, c2, d4}$
	13-15	12	17.5 ± 2.0	16.4 ± 2.0	17.9 ± 1.8^{b4}	15.9 ± 1.8$^{a4, c3}$	15.9 ± 1.8^{c4}
	16-18	1	9.8	9.9	10.2	11.5	13.9
Left arm mm (kg)	9-12	7	2.0 ± 0.2	1.9 ± 0.2	2.0 ± 0.2^{b1}	2.1 ± 0.2$^{a2, c4}$	2.2 ± 0.2$^{b3, c4}$
	13-15	12	2.3 ± 0.1	2.3 ± 0.1	2.3 ± 0.1	2.5 ± 0.1$^{a1, b1, c1}$	2.5 ± 0.1$^{a3, b1, c2}$
	16-18	1	2.3	2.5	2.5	2.4	2.5

[1] Significantly different from BL: $^{a1}p<0.001$, $^{a2}p<0.005$, $^{a3}p<0.01$, $^{a4}p<0.05$
Significantly different from 4 mo: $^{b1}p<0.001$, $^{b2}p<0.005$, $^{b3}p<0.01$, $^{b4}p<0.05$
Significantly different from 8 mo: $^{c1}p<0.001$, $^{c2}p<0.005$, $^{c3}p<0.01$, $^{c4}p<0.05$
Significantly different from 12 mo: $^{d1}p<0.001$, $^{d2}p<0.005$, $^{d3}p<0.01$, $^{d4}p<0.05$

Table 4.45. Means (±SEM) of anthropometric parameters (IV) in 20 hypercholesterolemic male students during the study

Parameters[1]	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
WC (cm)	9-12	7	88.8 ± 7.1	77.4 ± 5.5^{a2}	82.8 ± 6.6$^{a4, b4}$	84.5 ± 6.4$^{a4, b1}$	81.2 ± 6.7^{a3}
	13-15	12	82.3 ± 4.1	77.7 ± 3.8^{a2}	81.0 ± 4.1^{b2}	84.2 ± 4.6^{b4}	80.5 ± 4.5^{b4}
	16-18	1	68.5	74.0	72.5	76.0	74.0
HC (cm)	9-12	7	97.6 ± 4.9	90.5 ± 4.8^{a1}	92.1 ± 5.0^{a2}	95.4 ± 5.2$^{a2, b2, c2}$	92.4 ± 5.1$^{a3, d4}$
	13-15	12	96.0 ± 3.2	92.9 ± 3.0^{a2}	94.8 ± 3.1^{b2}	96.3 ± 3.4^{c4}	95.2 ± 3.6^{b4}
	16-18	1	87.0	87.0	87.0	89.0	94.0
WHR	9-12	7	0.90 ± 0.03	0.85 ± 0.02	0.89 ± 0.03^{b4}	0.88 ± 0.02^{b4}	0.87 ± 0.0
	13-15	12	0.85 ± 0.02	0.83 ± 0.02^{a4}	0.85 ± 0.02^{b4}	0.87 ± 0.02	0.84 ± 0.0
	16-18	1	0.79	0.85	0.83	0.85	0.79

[1] Significantly different from BL: $^{a1}p<0.001$, $^{a2}p<0.005$, $^{a3}p<0.01$, $^{a4}p<0.05$
Significantly different from 4 mo: $^{b1}p<0.001$, $^{b2}p<0.005$, $^{b3}p<0.01$, $^{b4}p<0.05$
Significantly different from 8 mo: $^{c1}p<0.001$, $^{c2}p<0.005$, $^{c3}p<0.01$, $^{c4}p<0.05$
Significantly different from 12 mo: $^{d1}p<0.001$, $^{d2}p<0.005$, $^{d3}p<0.01$, $^{d4}p<0.05$

4.3.6 Effect on anthropometric parameter of 38 hypercholesterolemic female students

Means (±SEM) of anthropometric parameters in 38 hypercholesterolemic female students during the study are shown in Tables 4.46-4.49

The mean height in 9-15 year old hypercholesterolemic female students were significant increased especially in 9-12 year old hypercholesterolemic female students had significant increased 2.9 cm/year and in 13-15 year group increased 1.5 cm/year, and student in 16.1 year group increased 0.3 cm/year.

The mean weight of all group of hypercholesterolemic female students trended to be higher than that at BL throughout the study, especially in 9-12 year and 13-15 year group at 8 mo were significantly higher than that at BL. However their change at 16 mo were not significant difference than that at BL.

These changes were also observed in BMI, but in 9-12 year at 16 mo trended to be lower than that at BL.

No drastic changes of body weight and BMI in hypercholesterolemic female students at the end of study, it may be due to child growth.

Percentages of total body fat and trunk fat in all group of hypercholesterolemic female students at 16 mo trended to be lower than that at BL, except trunk fat in 16-18 year group 16 mo trended to be higher than that at BL, but was not significant (Tables 4.46-4.49).

Body trunk mm in all groups of hypercholesterolemic female students had increased from BL throughout the study, at the end of study, 16 mo, the mean of trunk mm in 9-12 year group at 8 mo and 16 mo were significantly higher than those at BL, in 13-15 year group at 12 mo and 16 mo were significantly higher than those at BL, whereas only in 16-18 year group at 16 mo trended to be lower than that at BL, but was not significant.

Percentage of fat in both leg in 9-12 and 13-15 year group of hypercholesterolemic female students trended at 16 mo trended to be lower than that at BL, especially in 13-15 year group at 4 mo, 12 mo, and 16 mo were significantly lower than that at BL, whereas in 16-18 year group at 16 mo trended to be higher than that at BL. These changes were also observed in both arm, but were not significant at BL throughout the study period (Tables 4.46-4.49).

Muscle mass at both legs and arms had increased throughout the study in 9-12 year and 13-15 year groups, whereas 16-18 year group only at 16 mo trended to be lower than that at BL. (Tables 4.46-4.49).

Waist/hip ratios in all groups were within normal limit throughout the study, and only in 13-15 year group at 12 mo, 16 mo were significant decreased at BL (Tables 4.49).

Table 4.46. Means (±SEM) of anthropometric parameters (I) in 38 hypercholesterolemic female students during the study

Parameters[1]	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
Height (cm)	9-12	8	154.6 ± 1.9	154.6 ± 1.9	154.6 ± 1.9	157.5 ± 1.8 ^{a2}	157.5 ± 1.8 ^{a2}
	13-15	24	156.3 ± 1.0	156.3 ± 1.0	156.3 ± 1.0	157.8 ± 1.0 ^{a1}	157.8 ± 1.0 ^{a1}
	16-18	6	155.2 ± 1.3	155.2 ± 1.3	155.2 ± 1.3	155.5 ± 1.2	155.5 ± 1.2
Weight (kg)	9-12	8	48.9 ± 3.2	50.1 ± 2.6 ^{b3}	51.7 ± 2.6 ^{a4}	50.8 ± 2.3	50.6 ± 1.7
	13-15	24	54.1 ± 2.8	53.6 ± 2.6	55.2 ± 2.7 $^{a4, b1}$	54.6 ± 2.6 ^{b4}	55.0 ± 2.6 $^{b3, c4}$
	16-18	6	49.7 ± 1.8	49.1 ± 1.7	51.3 ± 2.0 ^{b3}	51.0 ± 2.0 ^{b4}	50.5 ± 2.2
BMI (kg/m^2)	9-12	8	20.5 ± 1.2	20.9 ± 1.0	21.4 ± 1.0 $^{a4, b4}$	20.5 ± 0.9 ^{c4}	20.4 ± 0.6
	13-15	24	21.9 ± 0.9	21.8 ± 0.9	22.4 ± 0.9 $^{a4, b1}$	21.8 ± 0.8 ^{c1}	21.9 ± 0.8 ^{c3}
	16-18	6	20.7 ± 0.8	20.5 ± 0.8	21.4 ± 1.0 ^{b3}	21.1 ± 1.0	21.0 ± 1.1
Body fat (%bw)	9-12	8	28.0 ± 3.7	28.6 ± 3.0	28.2 ± 2.6	27.2 ± 2.7	27.2 ± 1.9
	13-15	24	30.6 ± 1.8	29.6 ± 1.8	31.0 ± 1.9 ^{b4}	29.7 ± 1.6 ^{c4}	29.7 ± 1.5
	16-18	6	28.4 ± 1.1	27.8 ± 1.1	29.6 ± 1.6 ^{b4}	29.3 ± 1.7	29.7 ± 1.7
Trunk fat (%)	9-12	8	25.6 ± 4.3	27.1 ± 3.6	26.1 ± 3.1	25.3 ± 3.5	24.8 ± 2.2
	13-15	24	28.8 ± 2.2	28.1 ± 2.2	29.2 ± 2.2	28.0 ± 1.9	28.1 ± 1.7
	16-18	6	26.7 ± 1.3	26.1 ± 1.3	28.1 ± 1.8	28.3 ± 2.0	28.5 ± 1.9 ^{b4}
Trunk mm (kg)	9-12	8	18.0 ± 0.4	18.0 ± 0.3	18.9 ± 0.4 $^{a3, b1}$	18.7 ± 0.3 ^{b4}	19.0 ± 0.3 $^{a4, b2}$
	13-15	24	18.9 ± 0.3	18.8 ± 0.4	19.1 ± 0.4	19.6 ± 0.4 $^{a3, b2}$	19.8 ± 0.4 $^{a1, b1, c4}$
	16-18	6	19.2 ± 0.4	18.9 ± 0.3	19.5 ± 0.3 ^{b2}	19.1 ± 0.3 $^{b4, c2}$	19.3 ± 0.3

[1] Significantly different from BL: $^{a1}p<0.001$, $^{a2}p<0.005$, $^{a3}p<0.01$, $^{a4}p<0.05$
Significantly different from 4 mo: $^{b1}p<0.001$, $^{b2}p<0.005$, $^{b3}p<0.01$, $^{b4}p<0.05$
Significantly different from 8 mo: $^{c1}p<0.001$, $^{c2}p<0.005$, $^{c3}p<0.01$, $^{c4}p<0.05$
Significantly different from 12 mo: $^{d1}p<0.001$, $^{d2}p<0.005$, $^{d3}p<0.01$, $^{d4}p<0.05$

Table 4.47. Means (±SEM) of anthropometric parameters (II) in 38 hypercholesterolemic female students during the study

Parameters[1]	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
Right leg fat (%)	9-12	8	32.1 ± 3.0	31.0 ± 2.3	31.4 ± 2.1	30.1 ± 1.8	31.3 ± 1.9
	13-15	24	33.8 ± 1.3	32.1 ± 1.4 ^{a2}	33.9 ± 1.5 ^{b2}	32.6 ± 1.2 $^{a4,\ c4}$	32.5 ± 1.1 $^{a4,\ c4}$
	16-18	6	31.3 ± 0.7	30.6 ± 0.8 ^{a4}	32.2 ± 1.2 ^{b4}	31.2 ± 1.3 ^{c2}	32.2 ± 1.2 $^{b4,\ d4}$
Right leg mm (kg)	9-12	8	5.8 ± 0.2	6.1 ± 0.2 ^{a4}	6.3 ± 0.2 ^{b4}	6.3 ± 0.2 ^{a2}	6.2 ± 0.3 ^{a4}
	13-15	24	6.1 ± 0.2	6.4 ± 0.2 ^{a1}	6.3 ± 0.2 ^{a3}	6.3 ± 0.2 ^{a3}	6.4 ± 0.2 ^{a2}
	16-18	6	5.9 ± 0.2	5.9 ± 0.2	5.9 ± 0.2	6.0 ± 0.2	5.8 ± 0.3 $^{b4,\ c4,\ d4}$
Left leg fat (%)	9-12	8	32.0 ± 2.8	31.5 ± 2.3	32.1 ± 1.9	30.2 ± 1.8	31.4 ± 1.7
	13-15	24	34.0 ± 1.3	32.4 ± 1.3 ^{a3}	34.3 ± 1.4 ^{b1}	32.9 ± 1.1 $^{a4,\ c4}$	33.0 ± 1.1 $^{a4,\ c4}$
	16-18	6	31.6 ± 0.7	31.1 ± 0.7	32.5 ± 1.1 ^{b4}	31.7 ± 1.2 ^{c1}	32.5 ± 1.2 $^{b4,\ d4}$
Left leg mm (kg)	9-12	8	5.8 ± 0.2	6.1 ± 0.2 ^{a4}	6.2 ± 0.2 $^{a4,\ b4}$	6.3 ± 0.2 ^{a2}	6.2 ± 0.2 ^{a4}
	13-15	24	6.1 ± 0.2	6.3 ± 0.2 ^{a1}	6.3 ± 0.2 ^{a4}	6.2 ± 0.2 ^{a4}	6.3 ± 0.2 ^{a3}
	16-18	6	5.7 ± 0.2	5.7 ± 0.3	5.7 ± 0.2	5.9 ± 0.2 ^{a4}	5.6 ± 0.3 ^{d4}

[1] Significantly different from BL: $^{a1}p<0.001$, $^{a2}p<0.005$, $^{a3}p<0.01$, $^{a4}p<0.05$
Significantly different from 4 mo: $^{b1}p<0.001$, $^{b2}p<0.005$, $^{b3}p<0.01$, $^{b4}p<0.05$
Significantly different from 8 mo: $^{c1}p<0.001$, $^{c2}p<0.005$, $^{c3}p<0.01$, $^{c4}p<0.05$
Significantly different from 12 mo: $^{d1}p<0.001$, $^{d2}p<0.005$, $^{d3}p<0.01$, $^{d4}p<0.05$

Table 4.48. Means (±SEM) of anthropometric parameters (III) in 38 hypercholesterolemic female students during the study

Parameters[1]	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
Right arm fat (%)	9-12	8	24.4 ± 3.4	25.4 ± 2.9	25.6 ± 3.0	24.5 ± 2.7	23.8 ± 1.8
	13-15	24	26.8 ± 1.9	26.4 ± 1.8	27.5 ± 1.9 ^{b4}	26.4 ± 1.6 ^{c4}	26.4 ± 1.6
	16-18	6	25.3 ± 1.3	24.4 ± 1.4	26.5 ± 1.9 ^{b4}	26.3 ± 2.1	26.1 ± 2.2
Right arm mm (kg)	9-12	8	1.5 ± 0.1	1.5 ± 0.0	1.6 ± 0.1 ^{a4}	1.6 ± 0.0	1.6 ± 0.1
	13-15	24	1.6 ± 0.1	1.6 ± 0.1	1.7 ± 0.1 $^{a4, b1}$	1.6 ± 0.1	1.7 ± 0.1 ^{b4}
	16-18	6	1.5 ± 0.1	1.5 ± 0.1	1.5 ± 0.1	1.5 ± 0.1	1.5 ± 0.1
Left arm fat (%)	9-12	8	25.7 ± 3.8	26.7 ± 3.1	26.3 ± 2.8	25.3 ± 2.9	24.8 ± 1.7
	13-15	24	28.2 ± 2.0	27.7 ± 1.9	28.8 ± 1.9 ^{b4}	28.0 ± 1.7	27.8 ± 1.6
	16-18	6	27.0 ± 1.3	26.3 ± 1.3	28.2 ± 1.8 ^{b4}	28.2 ± 1.9	28.2 ± 2.2
Left arm mm (kg)	9-12	8	1.5 ± 0.0	1.5 ± 0.0	1.6 ± 0.1 ^{a4}	1.5 ± 0.1	1.5 ± 0.0 ^{a4}
	13-15	24	1.5 ± 0.1	1.6 ± 0.1	1.6 ± 0.1 $^{a2, b4}$	1.5 ± 0.1 ^{c4}	1.6 ± 0.1
	16-18	6	1.4 ± 0.1	1.4 ± 0.1	1.4 ± 0.1	1.4 ± 0.1	1.3 ± 0.1

[1] Significantly different from BL: $^{a1}p<0.001$, $^{a2}p<0.005$, $^{a3}p<0.01$, $^{a4}p<0.05$
Significantly different from 4 mo: $^{b1}p<0.001$, $^{b2}p<0.005$, $^{b3}p<0.01$, $^{b4}p<0.05$
Significantly different from 8 mo: $^{c1}p<0.001$, $^{c2}p<0.005$, $^{c3}p<0.01$, $^{c4}p<0.05$
Significantly different from 12 mo: $^{d1}p<0.001$, $^{d2}p<0.005$, $^{d3}p<0.01$, $^{d4}p<0.05$

Table 4.49. Means (±SEM) of anthropometric parameters (IV) in 38 hypercholesterolemic female students during the study

Parameters[1]	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
WC (cm)	9-12	8	72.9 ± 3.7	69.1 ± 2.8 ^{a4}	75.1 ± 3.3 ^{b2}	71.5 ± 3.3 ^{c4}	69.6 ± 2.0 ^{c4}
	13-15	24	75.0 ± 2.2	69.9 ± 1.9 ^{a1}	74.4 ± 2.3 ^{b1}	72.8 ± 2.3 $^{a4, b2, c2}$	73.0 ± 2.2 $^{a3, b1, c4}$
	16-18	6	73.3 ± 1.7	69.4 ± 1.7 ^{a4}	71.8 ± 2.4 ^{b4}	70.7 ± 1.6	71.5 ± 2.0
HC (cm)	9-12	8	90.8 ± 2.8	88.8 ± 2.0	91.6 ± 2.2 ^{b4}	89.8 ± 2.1	89.9 ± 1.7
	13-15	24	94.3 ± 1.8	91.1 ± 1.7 ^{a1}	94.1 ± 1.7 ^{b1}	93.6 ± 1.7	89.4 ± 3.7 ^{b3}
	16-18	6	92.2 ± 1.4	89.3 ± 1.7 ^{a4}	92.3 ± 1.7 ^{b2}	90.8 ± 1.1	91.0 ± 1.6
WHR	9-12	8	0.80 ± 0.02	0.78 ± 0.02	0.82 ± 0.02 ^{b4}	0.79 ± 0.02 ^{c4}	0.77 ± 0.01 ^{c4}
	13-15	24	0.79 ± 0.01	0.77 ± 0.01 ^{a2}	0.79 ± 0.01 ^{b4}	0.77 ± 0.01 $^{a4, c4}$	0.78 ± 0.01 ^{a4}
	16-18	6	0.79 ± 0.01	0.78 ± 0.01	0.78 ± 0.01	0.78 ± 0.01	0.79 ± 0.01

[1] Significantly different from BL: $^{a1}p<0.001$, $^{a2}p<0.005$, $^{a3}p<0.01$, $^{a4}p<0.05$
Significantly different from 4 mo: $^{b1}p<0.001$, $^{b2}p<0.005$, $^{b3}p<0.01$, $^{b4}p<0.05$
Significantly different from 8 mo: $^{c1}p<0.001$, $^{c2}p<0.005$, $^{c3}p<0.01$, $^{c4}p<0.05$
Significantly different from 12 mo: $^{d1}p<0.001$, $^{d2}p<0.005$, $^{d3}p<0.01$, $^{d4}p<0.05$

4.3.7 Biochemical parameters in 20 hypercholesterolemic male students

Means (±SEM) of biochemical parameters in 20 hypercholesterolemic male students during the study are shown in Table 4.50.

The mean serum TC and LDL of 9-12 year old, 13-15 year old, and 16-18 year old hypercholesterolemic female students were at high risk level, 249, 240, 247, 173, 169, 173 mg/dL, respectively. After nutritional therapy, 16 mo their serum TC and LDL in 9-12 and 13-15 year groups were significantly lower than that at BL, however in 16-18 year group (n=1) his TC and LDL levels tended to be higher than that at BL. Only at 8 mo in 9-12 year group, their mean serum TG was significantly higher than that at BL and was hypertriglyceridemia level. Those at other periods were within normal limit. Their mean serum HDL levels were within normal limits throughout the study. Their mean FBG levels were within normal limits thoughout the study, except in 13-15 year group at BL their mean FBG was 114 mg/dL, IFBG level, however FBG at 16 mo became normal level.

Table 4.52 shows the numbers and mean net changes of serum lipid levels in 20 hypercholesterolemic male students during the study.

Table 4.50. Means (±SEM) of biochemical parameters in 20 hypercholesterolemic male students during the study

Parameters[1]	Age (y)	n	BL	8 mo	12 mo	16 mo
TC (mg/dL)	9-12	7	249 ± 9	224 ± 16	224 ± 14	202 ± 14^{a4}
	13-15	12	240 ± 9	195 ± 10^{a1}	205 ± 9^{a1}	201 ± 8^{a1}
	16-18	1	247	305	268	284
TG (mg/dL)	9-12	7	81 ± 9	166 ± 23^{a4}	65 ± 9^{c2}	111 ± 15^{d4}
	13-15	12	75 ± 3	115 ± 17^{a4}	55 ± 3^{a1}	127 ± 13$^{a2, c2, d1}$
	16-18	1	86	82	53	108
HDL (mg/dL)	9-12	7	60 ± 6	54 ± 5	48 ± 1	42 ± 1$^{a4, d4}$
	13-15	12	56 ± 4	47 ± 1^{a4}	44 ± 1^{a3}	46 ± 1^{a4}
	16-18	1	57	53	71	49
LDL (mg/dL)	9-12	7	173 ± 5	136 ± 13^{a4}	163 ± 13	138 ± 14
	13-15	12	169 ± 10	125 ± 9^{a1}	151 ± 9$^{a4, c3}$	131 ± 8^{a1}
	16-18	1	173	236	186	213
FBG (mg/dL)	9-12	7	106 ± 4	89 ± 2^{a3}	94 ± 3	90 ± 1^{a3}
	13-15	12	114 ± 7	88 ± 2^{a2}	86 ± 2^{a2}	90 ± 3^{a2}
	16-18	1	101	87	81	96

[1] Significantly different from BL: $^{a1}p<0.001$, $^{a2}p<0.005$, $^{a3}p<0.01$, $^{a4}p<0.05$
Significantly different from 4 mo: $^{b1}p<0.001$, $^{b2}p<0.005$, $^{b3}p<0.01$, $^{b4}p<0.05$
Significantly different from 8 mo: $^{c1}p<0.001$, $^{c2}p<0.005$, $^{c3}p<0.01$, $^{c4}p<0.05$
Significantly different from 12 mo: $^{d1}p<0.001$, $^{d2}p<0.005$, $^{d3}p<0.01$, $^{d4}p<0.05$

4.3.8 Biochemical parameters in 38 hypercholesterolemic female students

Means (±SEM) of biochemical parameters in 38 hypercholesterolemic female students during the study are shown in Table 4.51.

The mean serum TC and LDL of 9-12 year old, 13-15 year old, and 16-18 year old hypercholesterolemic female students were at high risk level, 244, 244, 267, 171, 166, 193 mg/dL, respectively. After nutritional therapy, 16 mo their serum TC and LDL in 9-12 and 13-15 year groups were significantly lower than that at BL, however in 16-18 year group (n=6) their TC and LDL levels tended to be lower than that at BL. Only at 16 mo in 9-12 year group and in 13-15 year group, their mean serum TG was significantly higher than that at BL but were within normal limit during the study period. Their mean serum HDL levels were within normal limits throughout the study. Their mean FBG levels were within normal limits thoughout the study.

Table 4.53 shows the numbers and mean net changes of serum lipid levels in 38 hypercholesterolemic female students during the study.

At the end of nutritional therapy 4 of 20 hypercholesterolemic male students and 6 of 38 hypercholesterolemic female students had normal serum LDL (Table 4.54)

Table 4.51. Means (±SEM) of biochemical parameters in 38 hypercholesterolemic female students during the study

Parameters[1]	Age (y)	n	BL	8 mo	12 mo	16 mo
TC (mg/dL)	9-12	8	244 ± 8	222 ± 13	209 ± 9 [a1]	208 ± 11 [a4]
	13-15	24	244 ± 5	220 ± 7 [a1]	208 ± 7 [a1, c4]	216 ± 7 [a1]
	16-18	6	267 ± 20	249 ± 29	231 ± 30 [a4]	239 ± 30
TG (mg/dL)	9-12	8	84 ± 10	125 ± 16	77 ± 16 [c4]	143 ± 10 [a2 , d3]
	13-15	24	89 ± 8	109 ± 10	60 ± 4 [a1, c1]	106 ± 14 [a2]
	16-18	6	73 ± 5	76 ± 8	66 ± 7	71 ± 7
HDL (mg/dL)	9-12	8	56 ± 4	53 ± 3	52 ± 1	54 ± 3
	13-15	24	61 ± 2	57 ± 1	56 ± 1	55 ± 1 [a4]
	16-18	6	60 ± 3	63 ± 4	55 ± 1	57 ± 3
LDL (mg/dL)	9-12	8	171 ± 9	145 ± 12 [a4]	141 ± 8 [a1]	126 ± 11 [a3]
	13-15	24	166 ± 4	141 ± 6 [a1]	140 ± 7 [a1]	140 ± 7 [a1]
	16-18	6	193 ± 19	171 ± 28	163 ± 30	168 ± 28
FBG (mg/dL)	9-12	8	103 ± 5	89 ± 3 [a2]	87 ± 4 [a4]	86 ± 2 [a2]
	13-15	24	100 ± 3	87 ± 1 [a1]	87 ± 1 [a1]	89 ± 1 [a1]
	16-18	6	97 ± 7	84 ± 4	81 ± 2	88 ± 2

[1] Significantly different from BL: [a1]p<0.001, [a2]p<0.005, [a3]p<0.01, [a4]p<0.05
Significantly different from 4 mo: [b1]p<0.001, [b2]p<0.005, [b3]p<0.01, [b4]p<0.05
Significantly different from 8 mo: [c1]p<0.001, [c2]p<0.005, [c3]p<0.01, [c4]p<0.05
Significantly different from 12 mo: [d1]p<0.001, [d2]p<0.005, [d3]p<0.01, [d4]p<0.05

Table 4.52. Changes of serum lipid levels in 20 hypercholesterolemic male students during the study

Parameter change	Age (y)	n	BL-8 mo (min, max)	n	8 mo-12 mo (min, max)	n	12 mo-16 mo (min, max)
Total cholesterol (mg/dL)							
Decreased	9-12	5	(-22.0, -55.0)	3	(-15.0, -39.0)	5	(-6.0, -56.0)
	13-15	12	(-12.0, -70.0)	5	(-15.0, -27.0)	7	(-3.0, -42.0)
	16-18			1	(-37)		
Stabled	9-12						
	13-15						
	16-18						
Increased	9-12	2	(21.0, 23.0)	4	(7.0, 46.0)	1	(12.0)
	13-15			7	(12.0, 48.0)	5	(2.0, 65.0)
	16-18	1	(58)			1	(16)
HDL cholesterol (mg/dL)							
Decreased	9-12	5	(-1.0, -15.0)	4	(-1.0, -20.0)	6	(-3.0, -13.0)
	13-15	8	(-2.0, -35.0)	9	(-1.0, -15.0)	3	(-1.0, -6.0)
	16-18	1	(-4)			1	(-22)
Stabled	9-12			2			
	13-15	1		1		1	
	16-18						
Increased	9-12	2	(2.0, 2.0)	1	(12.0, 12.0)	1	(1.0)
	13-15	3	(3.0, 9.0)	2	(4.0, 6.0)	8	(1.0, 9.0)
	16-18			1	(18)		
LDL cholesterol (mg/dL)							
Decreased	9-12	6	(-17.0, -76.2)	1	(-6.8)	5	(-0.4, -64.6)
	13-15	12	(-15.0, -68.8)	2	(-12.2, -21.0)	10	(-7.0, -60.2)
	16-18			1	(-49.2)		
Stabled	9-12						
	13-15						
	16-18						
Increased	9-12	1	(20.2)	6	(3.4, 83.4)	2	(2.6, 7)
	13-15			10	(2.6, 62.6)	2	(16.2, 53.2)
	16-18	1	(63)			1	(27)

Table 4.53. Changes of serum lipid levels in 38 hypercholesterolemic female students during the study

Parameter change	Age (y)	BL-8 mo n	BL-8 mo (min, max)	8 mo-12 mo n	8 mo-12 mo (min, max)	12 mo-16 mo n	12 mo-16 mo (min, max)
Total cholesterol (mg/dL)							
Decrease	9-12	7	(-2.0, -84.0)	5	(-22.0, -55.0)	5	(-4.0, -67.0)
	13-15	20	(-6.0, -71.0)	15	(-1.0, -89.0)	10	(-1.0, -36.0)
	16-18	4	(-22.0, -58.0)	3	(-3.0, -99.0)	4	(-1.0, -51.0)
Stabled	9-12						
	13-15						
	16-18			1			
Increase	9-12	1	(20)	3	(7.0, 47.0)	3	(28.0, 42.0)
	13-15	4	(2.0, 33.0)	9	(1.0, 38.0)	14	(3.0, 63.0)
	16-18	2	(10.0, 64.0)	2	(13.0, 29.0)	2	(22.0, 90.0)
HDL cholesterol (mg/dL)							
Decrease	9-12	6	(-2.0, -15.0)	3	(-3.0, -20.0)	3	(-2.0, -10.0)
	13-15	15	(-1.0, -32.0)	13	(-1.0, -18.0)	10	(-2.0, -18.0)
	16-18	2	(-2.0, -17.0)	5	(-4.0, -28.0)	3	(-1.0, -9.0)
Stable	9-12						
	13-15	2		1			
	16-18					1	
Increase	9-12	2	(5.0, 9.0)	5	(1.0, 6.0)	5	(1.0, 10.0)
	13-15	7	(1.0, 10.0)	10	(1.0, 12.0)	14	(1.0, 7.0)
	16-18	4	(2.0, 21.0)	1	(5.0)	2	(8.0, 18.0)
LDL cholesterol (mg/dL)							
Decrease	9-12	7	(-0.2, -75.0)	5	(-0.2, -39.6)	5	(-6.0, -81.6)
	13-15	20	(-0.8, -79.4)	11	(-12.6, -73.6)	14	(-0.2, -44.2)
	16-18	4	(-31.2, -66.8)	2	(-36.6, -71.0)	4	(-6.6, -45.2)
Stable	9-12						
	13-15			1			
	16-18						
Increase	9-12	1	(9.0)	3	(16.0, 53.2)	3	(10.0, 17.2)
	13-15	4	(0.4, 42.0)	12	(1.0, 66.8)	10	(5.0, 49.8)
	16-18	2	(11.6, 44.4)	4	(3.8, 27.6)	2	(32.0, 70.4)

Table 4.54. Hypercholesterolemic levels of 58 hypercholesterolemic students classified by sex, age, and LDL cholesterol during the study

	By LDL cholesterol levels NCEP 1991	BL N (%[1])	8 mo N (%)	12 mo N (%)	16 mo N (%)
Male					
9-12 (y)	Normal		2 (3.5)		1 (1.7)
n = 7	Borderline		1 (1.8)	1 (1.7)	2 (3.4)
	High	7 (12.1)	4 (7.0)	6 (10.3)	4 (6.9)
13-15 (y)	Normal		4 (7.0)		3 (5.2)
n = 12	Borderline		4 (7.0)	2 (3.4)	4 (6.9)
	High	12 (20.7)	4 (7.0)	10 (17.2)	5 (8.6)
16-18(y)	Normal				
n = 1	Borderline				
	High	1 (1.7)	1 (1.8)	1 (1.7)	1 (1.7)
Female					
9-12 (y)	Normal		2 (3.5)	1 (1.7)	3 (5.2)
n = 8	Borderline		1 (1.8)	2 (3.4)	1 (1.7)
	High	8 (13.8)	5 (8.8)	5 (8.6)	4 (6.9)
13-15 (y)	Normal		3 (5.3)	6 (10.3)	3 (5.2)
n = 24	Borderline		6 (10.5)	3 (5.2)	10 (17.2)
	High	24 (41.4)	14 (24.6)	15 (25.9)	11 (19.0)
16-18 (y)	Normal		1 (1.8)	1 (1.7)	
n = 6	Borderline		1 (1.8)		2 (3.4)
	High	6 (10.3)	4 (7.0)	5 (8.6)	4 (6.9)

[1] %of 58 hypercholesterolemic students

4.3.9 Effect on anthropometric parameter of 2 hypertriglyceridemic male students

Means (±SEM) of anthropometric parameters in 2 hypertriglyceridemic male students during the study are shown in Tables 4.55-4.58

The mean height in 13-15 year old hypertriglyceridemic male student was increased 2 cm/year, and in 16-18 year old hypertriglyceridemic male student was increased 1 cm/year.

Body weight in hypertriglyceridemic male student at 16 mo trended to be higher than that at BL. These changes in 13-15 year group were also observed in BMI, whereas in 16-18 year group was not change in BMI.

Percentages of total body fat and trunk fat in 13-15 year group decreased throughout the study period, except trunk fat only at 16 mo higher than that a BL, while in 16-18 year group at 16 mo trended to be higher than that at BL throughout the study period (Tables 4.55-4.58).

Body trunk mm in 13-15 year group increased throughout the study period, whereas in 16-18 year group at 16 mo was not change from BL.

Percentage of fat in both leg in both year group of hypertriglyceridemic male students trended to be lower than that at BL throughout the study period, except in 16-18 year group at 8 mo was rapidly increased then decreased as same as at BL. These changes in hypertriglyceridemic male students were also observed in both arm (Tables 4.55-4.58).

Muscle mass at both legs and arms in 13-15 year group had increased throughout the study, whereas 16-18 year group at 8 mo and 16 mo trended to be lower than that at BL. (Tables 4.55-4.58).

Waist/hip ratios in all groups were within normal limit and increased throughout the study (Tables 4.58).

Table 4.55. Anthropometric parameters (I) in 2 hypertriglyceridemic male students during the study

Parameters	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
Height (cm)	13-15	1	175.0	175.0	175.0	177.0	177.0
	16-18	1	162.0	162.0	162.0	163.0	163.0
Weight (kg)	13-15	1	77.0	72.1	74.2	79.0	79.4
	16-18	1	49.0	50.9	51.4	48.7	49.7
BMI (kg/m^2)	13-15	1	25.1	23.5	24.2	25.2	25.3
	16-18	1	18.7	19.4	19.6	18.3	18.7
Body fat (%bw)	13-15	1	26.6	24.0	26.6	23.7	25.1
	16-18	1	10.7	12.4	20.5	8.3	11.6
Trunk fat (%)	13-15	1	24.0	21.9	23.6	22.3	24.2
	16-18	1	7.8	10.5	15.6	4.4	9.7
Trunk mm (kg)	13-15	1	26.7	26.3	26.5	29.4	29.0
	16-18	1	24.2	24.2	22.0	24.6	24.1

Table 4.56. Means (±SEM) of anthropometric parameters (II) in 2 hypertriglyceridemic male students during the study

Parameters	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
Right leg fat (%)	13-15	1	30.5	27.4	30.9	26.2	27.3
	16-18	1	15.4	15.2	27.8	13.7	15.1
Right leg mm (kg)	13-15	1	10.8	10.3	10.1	11.1	10.9
	16-18	1	6.6	7.1	6.5	6.9	6.8
Left leg fat (%)	13-15	1	30.5	27.6	31.7	26.4	27.1
	16-18	1	15.8	16.3	28.8	14.4	15.8
Left leg mm (kg)	13-15	1	10.7	10.2	9.8	10.9	10.8
	16-18	1	6.6	6.9	6.3	6.8	6.7

Table 4.57. Means (±SEM) of anthropometric parameters (III) in 2 hypertriglyceridemic male students during the study

Parameters	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
Right arm fat (%)	13-15	1	22.9	19.9	21.5	19.6	20.8
	16-18	1	9.2	10.9	16.5	8.8	9.5
Right arm mm (kg)	13-15	1	2.6	2.5	2.6	2.9	2.8
	16-18	1	2.1	2.1	1.9	2.1	2.1
Left arm fat (%)	13-15	1	21.9	19.6	21.0	19.9	20.8
	16-18	1	9.9	11.6	18.3	9.6	10.9
Left arm mm (kg)	13-15	1	2.7	2.6	2.6	2.8	2.8
	16-18	1	2.0	2.0	1.8	2.0	1.9

Table 4.58. Means (±SEM) of anthropometric parameters (IV) in 2 hypertriglyceridemic male students during the study

Parameters	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
WC (cm)	13-15	1	92.0	87.0	88.0	88.0	99.0
	16-18	1	66.0	68.0	68.5	66.0	67.0
HC (cm)	13-15	1	104.0	98.0	100.5	103.0	102.0
	16-18	1	85.0	82.0	85.5	84.0	82.0
WHR	13-15	1	0.88	0.89	0.88	0.85	0.97
	16-18	1	0.78	0.83	0.80	0.79	0.82

4.3.10 Effect on anthropometric parameter of 11 hypertriglyceridemic female students

Means (±SEM) of anthropometric parameters in 11 hypertriglyceridemic female students during the study are shown in Tables 4.59-4.62.

The mean height in 9-12 year old hypertriglyceridemic female students had increased 5 cm/year and in 13-15 year group increased 1 cm/year, whereas in 16-18 year group were not change.

The value weight of one student in 9-12 year old hyperglycemic female student decreased while another one student increased weight throughout the study period. The mean weight in13-15 year group trended to be increase. The value weight of both students in 16-18 year old hyperglycemic female student trended to be decrease at 16 mo. However, the mean BMI in all group of hypertriglyceridemic female students trended to be lower than that at BL (Tables 4.59-4.62).

No drastic changes of body weight and BMI in hypertriglyceridemic female students at the end of study, it may be due to child growth.

Percentages of total body fat and trunk fat in all group of hypertriglyceridemic female students trended to be lower than that at BL throughout the study period.

Body trunk mm in 9-12 year and 13-15 year groups of hypertriglyceridemic female students had increased from BL throughout the study, whereas both students in 16-18 year group were not change throughout the study period.

Percentage of fat in both leg in all group trended to be decrease throughout the study, whereas one student in 9-12 year and one student in 16-18 year group trended to be increase at 16 mo. These changes were also observed in muscle mass at both arms (Tables 4.59-4.62).

Muscle mass at both legs in all group trended to be increase throughout the study, whereas one student in 16-18 year group trended to be decrease at 16 mo. These changes were also observed in muscle mass at both arms.

Waist/hip ratios in all groups were within normal limit throughout the study, whereas in 13-15 year group at 4 mo was significant decreased at (Tables 4.62).

Table 4.59. Means (±SEM) of anthropometric parameters (I) in 11 hypertriglyceridemic female students during the study

Parameters[1]	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
Height (cm)	9-12	2	155.0, 152.0	155.0, 152.0	155.0, 152.0	160.0, 157.0	160.0, 157.0
	13-15	7	158.0 ± 3.0	158.0 ± 3.0	158.0 ± 3.0	159.3 ± 3.1 ^{a2}	159.3 ± 3.1 ^{a2}
	16-18	2	158.0, 167.0	158.0, 167.0	158.0, 167.0	158.0, 167.0	158.0, 167.0
Weight (kg)	9-12	2	79.5, 44.8	76.5, 45.3	75.0, 46.3	77.0, 46.6	73.8, 47.7
	13-15	7	55.5 ± 5.7	55.3 ± 5.9	56.2 ± 6.3	55.3 ± 5.5	56.1 ± 5.7
	16-18	2	54.4, 56.9	52.2, 56.8	52.1, 57.6	53.0, 54.5	53.0, 55.5
BMI (kg/m^2)	9-12	2	33.1, 19.4	31.8, 19.6	31.2, 20.0	30.1, 18.9	28.8, 19.4
	13-15	7	21.9 ± 1.5	21.9 ± 1.6	22.2 ± 1.8	21.5 ± 1.4	21.8 ± 1.5
	16-18	2	21.8, 20.4	20.9, 20.4	20.9, 20.7	21.2, 19.5	21.2, 19.8
Body fat (%bw)	9-12	2	47.1, 22.0	46.3, 23.9	43.1, 24.7	42.2, 21.9	38.5, 23.4
	13-15	7	29.9 ± 3.5	29.2 ± 4.0	30.7 ± 4.4 ^{b4}	28.7 ± 2.9	28.9 ± 2.9
	16-18	2	28.9, 29.2	27.8, 28.6	28.1, 29.2	27.7, 25.9	29.9, 27.0
Trunk fat (%)	9-12	2	45.7, 18.5	45.9, 21.3	43.0, 21.4	43.8, 18.9	38.0, 20.5
	13-15	7	27.7 ± 4.2	27.1 ± 4.9	28.7 ± 5.2 ^{b4}	26.2 ± 3.6	26.7 ± 3.7
	16-18	2	27.3, 28.1	25.8, 27.2	26.4, 28.1	25.9, 24.0	28.9, 25.5
Trunk mm (kg)	9-12	2	20.7, 17.9	19.9, 17.7	20.7, 18.2	21.0, 18.4	22.2, 18.9
	13-15	7	19.7 ± 1.0	19.5 ± 1.0	19.4 ± 1.0	20.5 ± 1.1	20.6 ± 1.1
	16-18	2	20.3, 22.6	20.5, 22.6	20.1, 22.6	20.2, 22.1	20.2, 22.4

[1] Significantly different from BL: ^{a1}p<0.001, ^{a2}p<0.005, ^{a3}p<0.01, ^{a4}p<0.05
Significantly different from 4 mo: ^{b1}p<0.001, ^{b2}p<0.005, ^{b3}p<0.01, ^{b4}p<0.05
Significantly different from 8 mo: ^{c1}p<0.001, ^{c2}p<0.005, ^{c3}p<0.01, ^{c4}p<0.05
Significantly different from 12 mo: ^{d1}p<0.001, ^{d2}p<0.005, ^{d3}p<0.01, ^{d4}p<0.05

Table 4.60. Means (±SEM) of anthropometric parameters (II) in 11 hypertriglyceridemic female students during the study

Parameters[1]	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
Right leg fat (%)	9-12	2	51.2, 27.1	48.1, 27.7	44.0, 29.3	41.3, 25.8	40.4, 28.0
	13-15	7	33.6 ± 2.4	32.7 ± 2.9	34.5 ± 3.3 ^{b4}	32.7 ± 1.9	32.6 ± 2.0
	16-18	2	31.5, 32.0	31.5, 31.6	31.1, 31.6	30.9, 29.6	32.3, 30.5
Right leg mm (kg)	9-12	2	7.0, 6.0	7.1, 6.0	7.5, 5.9	8.0, 6.5	7.8, 6.3
	13-15	7	6.3 ± 0.3	6.4 ± 0.3	6.2 ± 0.3	6.2 ± 0.3	6.4 ± 0.3
	16-18	2	6.5, 6.1	6.0, 6.2	6.1, 6.4	6.4, 6.3	6.0, 6.3
Left leg fat (%)	9-12	2	48.2, 28.2	47.3, 28.7	43.3, 31.0	39.4, 27.3	38.3, 29.1
	13-15	7	33.8 ± 2.4	32.8 ± 2.8	34.5 ± 3.3 ^{b4}	32.9 ± 1.9	32.7 ± 2.0
	16-18	2	31.5, 32.1	31.6, 31.7	30.9, 32.0	30.9, 29.7	32.2, 31.5
Left leg mm (kg)	9-12	2	7.4, 5.9	7.3, 5.9	7.6, 5.7	8.4, 6.2	8.2, 6.1
	13-15	7	6.3 ± 0.4	6.4 ± 0.3	6.2 ± 0.3	6.2 ± 0.3	6.4 ± 0.3
	16-18	2	6.5, 6.0	5.9, 6.1	6.2, 6.2	6.4, 6.3	5.9, 6.2

[1] Significantly different from BL: $^{a1}p<0.001$, $^{a2}p<0.005$, $^{a3}p<0.01$, $^{a4}p<0.05$
Significantly different from 4 mo: $^{b1}p<0.001$, $^{b2}p<0.005$, $^{b3}p<0.01$, $^{b4}p<0.05$
Significantly different from 8 mo: $^{c1}p<0.001$, $^{c2}p<0.005$, $^{c3}p<0.01$, $^{c4}p<0.05$
Significantly different from 12 mo: $^{d1}p<0.001$, $^{d2}p<0.005$, $^{d3}p<0.01$, $^{d4}p<0.05$

Table 4.61. Means (±SEM) of anthropometric parameters (III) in 11 hypertriglyceridemic female students during the study

Parameters[1]	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
Right arm fat (%)	9-12	2	44.2, 17.7	42.4, 19.6	40.5, 19.4	40.0, 17.6	37.2, 18.6
	13-15	7	26.3 ± 3.6	26.1 ± 3.9	27.0 ± 4.3	25.7 ± 3.2	26.1 ± 3.2
	16-18	2	26.6, 24.5	24.2, 24.2	25.1, 25.0	24.7, 21.8	26.5, 23.5
Right arm mm (kg)	9-12	2	2.2, 1.6	2.2, 1.5	2.2, 1.6	2.2, 1.6	2.2, 1.6
	13-15	7	1.7 ± 0.1	1.7 ± 0.1	1.7 ± 0.1	1.7 ± 0.1	1.7 ± 0.1
	16-18	2	1.7, 1.7	1.6, 1.7	1.6, 1.7	1.7, 1.7	1.6, 1.7
Left arm fat (%)	9-12	2	44.6, 19.2	43.7, 21.4	41.8, 21.5	41.6, 19.5	38.2, 20.3
	13-15	7	27.5 ± 3.7	27.2 ± 4.4	28.3 ± 4.6 ^{b4}	26.5 ± 3.3	27.2 ± 3.2
	16-18	2	28.5, 26.8	26.3, 26.6	27.4, 27.4	27.1, 23.9	28.6, 25.0
Left arm mm (kg)	9-12	2	2.2, 1.5	2.1, 1.4	2.1, 1.5	2.1, 1.5	2.1, 1.5
	13-15	7	1.6 ± 0.1	1.6 ± 0.1	1.6 ± 0.1	1.6 ± 0.1	1.6 ± 0.1
	16-18	2	1.5, 1.5	1.5, 1.5	1.4, 1.6	1.5, 1.6	1.4, 1.6

[1] Significantly different from BL: $^{a1}p<0.001$, $^{a2}p<0.005$, $^{a3}p<0.01$, $^{a4}p<0.05$
Significantly different from 4 mo: $^{b1}p<0.001$, $^{b2}p<0.005$, $^{b3}p<0.01$, $^{b4}p<0.05$
Significantly different from 8 mo: $^{c1}p<0.001$, $^{c2}p<0.005$, $^{c3}p<0.01$, $^{c4}p<0.05$
Significantly different from 12 mo: $^{d1}p<0.001$, $^{d2}p<0.005$, $^{d3}p<0.01$, $^{d4}p<0.05$

Table 4.62. Means (±SEM) of anthropometric parameters (IV) in 11 hypertriglyceridemic female students during the study

Parameters[1]	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
WC (cm)	9-12	2	94.0, 70.0	87.0, 64.0	96.0, 67.0	87.4, 67.0	91.0, 66.0
	13-15	7	75.8 ± 4.4	70.4 ± 4.4 ^{a3}	75.1 ± 5.7 ^{b4}	74.0 ± 5.2 ^{b4}	73.0 ± 4.7 ^{b4}
	16-18	2	74.0, 74.0	67.0, 75.0	71.5, 78.0	72.0, 71.0	71.0, 73.0
HC (cm)	9-12	2	108.5, 87.5	105.0, 86.0	107.0, 88.0	105.6, 87.0	105.5, 87.0
	13-15	7	95.6 ± 3.3	92.4 ± 3.7 ^{a3}	94.1 ± 4.0 ^{b4}	93.7 ± 3.4 ^{a4}	79.0 ± 11.6
	16-18	2	96.0, 93.0	91.0, 91.0	90.0, 93.0	91.0, 89.0	90.0, 92.5
WHR	9-12	2	0.87, 0.80	0.83, 0.74	0.90, 0.76	0.83, 0.77	0.86, 0.76
	13-15	7	0.79 ± 0.03	0.76 ± 0.02 ^{a4}	0.79 ± 0.03	0.79 ± 0.03	0.78 ± 0.02
	16-18	2	0.77, 0.80	0.74, 0.82	0.79, 0.84	0.79, 0.80	0.79, 0.79

[1] Significantly different from BL: $^{a1}p<0.001$, $^{a2}p<0.005$, $^{a3}p<0.01$, $^{a4}p<0.05$
Significantly different from 4 mo: $^{b1}p<0.001$, $^{b2}p<0.005$, $^{b3}p<0.01$, $^{b4}p<0.05$
Significantly different from 8 mo: $^{c1}p<0.001$, $^{c2}p<0.005$, $^{c3}p<0.01$, $^{c4}p<0.05$
Significantly different from 12 mo: $^{d1}p<0.001$, $^{d2}p<0.005$, $^{d3}p<0.01$, $^{d4}p<0.05$

4.3.11 Biochemical parameters in 2 hypertriglyceridemic male students

Means (±SEM) of biochemical parameters in 2 hypertriglyceridemic male students during the study are shown in Table 4.63.

The value serum TC of 9-12 year old and 13-15 year old hyperglycemic male students were at borderline to high risk level, 194, 225 mg/dL, respectively. After nutritional therapy, 16 mo their serum TC trended lower than that at BL. The value serum LDL of 9-12 year old and 13-15 year old hyperglycemic male students were at normal to borderline risk level, 89 and 126 mg/dL, respectively. After nutritional therapy, 16 mo their serum LDL were not different than that at BL.

Their mean serum HDL, FBG levels were within normal limits throughout the study.Their serum TG in hypertriglyceridemic male students were within hypertriglyceridemic levels at BL, however TG in all group trended to be lower than that at 16 mo.

Table 4.67 shows the numbers and mean net changes of TG levels in 2 hypertriglyceridemic male students during the study.

Table 4.63. Means (±SEM) of biochemical parameters in 2 hypertriglyceridemic male students during the study

Parameters	Age (y)	n	BL	8 mo	12 mo	16 mo
TC (mg/dL)	13-15	1	194.0	169.0	180.0	168.0
	16-18	1	225.0	198.0	233.0	193.0
TG (mg/dL)	13-15	1	169.0	197.0	104.0	125.0
	16-18	1	158.0	136.0	60.0	122.0
HDL (mg/dL)	13-15	1	71.0	39.0	47.0	43.0
	16-18	1	67.0	40.0	50.0	44.0
LDL (mg/dL)	13-15	1	89.2	90.6	112.2	100.0
	16-18	1	126.4	130.8	171.0	124.6
FBG (mg/dL)	13-15	1	86.0	83.0	92.0	94.0
	16-18	1	83.0	105.0	82.0	103.0

4.3.12. Biochemical parameters in 11 hypertriglyceridemic female students

Means (±SEM) of biochemical parameters in 11 hypertriglyceridemic female students during the study are shown in Table 4.64.

The value serum TC of 9-12 year old, 16-18 year old hyperglycemic female students were at borderline to high risk level, 185, 217, 228, 157 mg/dL, respectively, whereas the mean serum TC in 13-15 year age group was at high risk levels, 212 mg/dL. After nutritional therapy, 16 mo their serum TC trended lower than that at BL, especially TC was significant lower than that at BL. The value serum LDL of 9-12 year old, 16-18 year old hyperglycemic female students were at normal to borderline risk level, 79, 122, 122, 76 mg/dL, respectively, whereas the mean serum LDL in 13-15 year age group was at borderline risk levels, 115 mg/dL. After nutritional therapy, 16 mo their serum LDL were not different than that at BL.

Their mean serum HDL levels were within normal limits throughout the study.Their serum TG in hypertriglyceridemic female students were within hypertriglyceridemic levels at BL, however TG in all group trended to be lower than that at 16 mo, except in 9-12 year group trended to be higher than BL at 16 mo.

Their mean FBG levels were within normal limits throughout the study, except in one student of 9-12 year group at BL their mean FBG was 122 mg/dL, IFBG, however FBG in all of hypertriglyceridemic female student at 8 mo, 12 mo, and 16 mo became normal level.

Table 4.66 shows the numbers and mean net changes of TG levels in 11 hypertriglyceridemic female students during the study.

At the end of nutritional therapy all of hypertriglyceridemic male students and 6 of 11 hypertriglyceridemic female students had normal serum TG (Table 4.67)

Table 4.64. Means (±SEM) of biochemical parameters in 11 hypertriglyceridemic female students during the study

Parameters[1]	Age (y)	n	BL	8 mo	12 mo	16 mo
TC (mg/dL)	9-12	2	185, 217	173, 195	197, 227	193, 196
	13-15	7	212 ± 10	194 ± 11	187 ± 11	189 ± 4 [a4]
	16-18	2	228, 157	226, 179	255, 162	194, 161
TG (mg/dL)	9-12	2	164, 151	197, 129	108, 78	181, 197
	13-15	7	183 ± 12	116 ± 12 [a2]	101 ± 18 [a4]	109 ± 15 [a3]
	16-18	2	174, 153	162, 89	150, 72	169, 95
HDL (mg/dL)	9-12	2	73, 65	50, 66	56, 62	49, 54
	13-15	7	61 ± 6	53 ± 3	53 ± 2	52 ± 2
	16-18	2	71, 50	63, 54	62, 54	49, 47
LDL (mg/dL)	9-12	2	79, 122	84, 103	119, 149	108, 103
	13-15	7	115 ± 12	118 ± 11	114 ± 8	115 ± 3
	16-18	2	122, 76	131, 107	163, 94	111, 95
FBG (mg/dL)	9-12	2	122, 101	91, 87	93, 90	93, 86
	13-15	7	104 ± 3	85 ± 2 [a2]	88 ± 3 [a2]	88 ± 3 [a2]
	16-18	2	86, 108	86, 95	87, 100	101, 96

[1] Significantly different from BL: [a1]p<0.001, [a2]p<0.005, [a3]p<0.01, [a4]p<0.05
Significantly different from 4 mo: [b1]p<0.001, [b2]p<0.005, [b3]p<0.01, [b4]p<0.05
Significantly different from 8 mo: [c1]p<0.001, [c2]p<0.005, [c3]p<0.01, [c4]p<0.05
Significantly different from 12 mo: [d1]p<0.001, [d2]p<0.005, [d3]p<0.01, [d4]p<0.05

Table 4.65. Changes of serum triglyceride levels in 2 hypertriglyceridemic male students during the study

Parameters	Age (y)	BL-8 mo n Value	8 mo-12 mo n Value	12 mo-16 mo n Value
TG (mg/dL)				
Decrease	9-12			
	13-15		1 (-93)	
	16-18	1 (-22)	1 (-76)	
Stable	9-12			
	13-15			
	16-18			
Increase	9-12			
	13-15	1 (28)		1 (21)
	16-18			1 (62)

Table 4.66. Changes of serum triglyceride levels in 11 hypertriglyceridemic female students during the study

Parameters	Age (y)	BL-8 mo n (min, max)	8 mo-12 mo n (min, max)	12 mo-16 mo n (min, max)
TG (mg/dL)				
Decrease	9-12	1 (-22.0)	2 (-51.0, -89.0)	
	13-15	6 (-52.0, -111.0)	5 (-4.0, -79.0)	2 (-3.0, -79.0)
	16-18	2 (-12.0, -64.0)	2 (-12.0, -17.0)	
Stable	9-12			
	13-15			
	16-18			
Increase	9-12	1 (33.0)		2 (73.0, 119.0)
	13-15	1 (11.0)	2 (23.0, 88.0)	5 (6.0, 61.0)
	16-18			2 (19.0, 23.0)

Table 4.67. Hypertriglyceridemic levels of 13 hypertriglyceridemic students classified by sex, age, and TG during the study

	By triglyceride levels NCEP 1991	BL N (%[1])	8 mo N (%)	12 mo N (%)	16 mo N (%)
Male					
9-12 (y)	Normal				
	High				
13-15 (y)	Normal			1 (7.7)	1 (7.7)
n = 1	High	1 (7.7)	1 (7.7)		
16-18 (y)	Normal		1 (7.7)	1 (7.7)	1 (7.7)
n = 1	High	1 (7.7)			
Female					
9-12 (y)	Normal		1 (7.7)		
n = 2	High	2 (15.4)	1 (7.7)	2 (15.4)	2 (15.4)
13-15 (y)	Normal		6 (46.2)	6 (46.2)	5 (38.5)
n = 7	High	7 (53.8)	1 (7.7)	1 (7.7)	2 (15.4)
16-18 (y)	Normal		1 (7.7)	1 (7.7)	1 (7.7)
n = 2	High	2 (15.4)	1 (7.7)	1 (7.7)	1 (7.7)

[1] % of 13 hypertriglyceridemic students

4.3.13. Effect on anthropometric parameter in 18 hyperglycemic male students

Means (±SEM) of anthropometric parameters in 18 hyperglycemic male students during the study are shown in Tables 4.68-4.71.

The mean height in both age groups were significant increased especially in 9-12 year hyperglycemic male students had significant increased 6 cm/year, whereas in 13-15 year group increased 2.4 cm/year.

The mean weight in both age groups decreased in 4 mo with highest decrease 4.9, 0.7 kg in 9-12 year group and 13-15 year group, respectively (Table 4.25). Between 4 mo and 12 mo of study periods, body weight increased but was not significant difference from baseline. At the end of study, 16 mo, the mean weight in both groups tended to be less than that at 12 mo, but was not significant. These changes were also observed in BMI. No drastic changes of body weight and BMI at the end of study, it may be due to child growth.

Percentages of total body fat and trunk fat in 9-12 year and 13-15 year old hyperglycemic male students at 16mo trended to be lower than that at BL, especially in 13-15 year group at 12 mo were significantly lower than that at BL (Tables 4.68-4.71).

Body trunk mm in both groups of hyperglycemic male students had increased from BL throughout the study, at 12 mo and the end of study, 16 mo, trunk mm were significantly higher than those at BL, 4mo, and 8mo, whereas the mean of trunk mm in 9-12 year group at 12 mo was not significantly than that at 8 mo (Tables 4.68-4.71).

Percentages of fat in both legs in 9-12 groups of hyperglycemic male students at 4 mo and 16mo were significantly lower than that at BL. Percentage of fat in right leg in 13-15 year group at 4 mo, 12 mo, and 16 mo were significantly lower than that at BL, whereas in left leg at 4 mo and 16 mo were significantly lower than that at BL. Percentage of fat in both arms in both groups of hyperglycemic male students at 16 mo trended to be lower than that at BL (Tables 4.68-4.71).

Muscle mass at both legs and arms had increased throughout the study in both groups (Tables 4.68-4.71).

Waist/hip ratio in both groups were within normal limit throughout the study, in 13-15 year old hyperglycemic male students at 4 mo and 16mo were significantly lower than that at BL, however these changes were not observed in 9-12 year group (Tables 4.71).

Table 4.68. Means (±SEM) of anthropometric parameters (I) in 18 hyperglycemic male students during the study

Parameters[1]	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
Height (cm)	9-12	5	160.2 ± 2.9	160.2 ± 2.9	160.2 ± 2.9	166.2 ± 2.6 ^{a2}	166.2 ± 2.6 ^{a2}
	13-15	13	164.8 ± 1.7	164.8 ± 1.7	164.8 ± 1.7	167.2 ± 1.7 ^{a2}	167.2 ± 1.7 ^{a2}
Weight (kg)	9-12	5	70.9 ± 9.8	66.0 ± 8.2	68.6 ± 7.9 ^{b4}	73.7 ± 9.2 $^{b2, c4}$	72.8 ± 8.9 $^{b3, c4}$
	13-15	13	55.7 ± 1.9	55.0 ± 1.8	57.3 ± 1.7 ^{b1}	57.5 ± 1.8 ^{b1}	57.4 ± 1.7 ^{b2}
BMI (kg/m^2)	9-12	5	27.3 ± 3.1	25.5 ± 2.6	26.5 ± 2.5 ^{b4}	26.4 ± 2.7	26.1 ± 2.6
	13-15	13	20.5 ± 0.7	20.2 ± 0.6	21.0 ± 0.6 ^{b1}	20.6 ± 0.5 $^{b4, c3}$	20.5 ± 0.5 ^{c4}
Body fat (%bw)	9-12	5	36.1 ± 7.7	30.9 ± 6.2	30.1 ± 5.7	30.9 ± 6.1	29.8 ± 6.0
	13-15	13	15.5 ± 2.1	13.5 ± 1.3	16.2 ± 1.3 ^{b1}	12.4 ± 1.5 $^{a4, c1}$	13.0 ± 1.4 ^{c1}
Trunk fat (%)	9-12	5	34.6 ± 8.1	30.3 ± 6.8	28.6 ± 5.9	29.9 ± 6.7	26.4 ± 5.5
	13-15	13	13.5 ± 2.0	11.7 ± 1.3	14.6 ± 1.3 ^{b1}	10.3 ± 1.7 $^{a4, c1}$	11.1 ± 1.4 ^{c1}
Trunk mm (kg)	9-12	5	17.7 ± 1.6	19.0 ± 1.3	20.1 ± 1.5 ^{b4}	21.5 ± 1.3 $^{a4, b4}$	22.4 ± 1.2 $^{a4, b4, c4}$
	13-15	13	23.2 ± 0.7	23.2 ± 0.6	23.4 ± 0.6	25.2 ± 0.6 $^{a1, b1, c1}$	25.0 ± 0.7 $^{a1, b1, c1}$

[1] Significantly different from BL: ^{a1}p<0.001, ^{a2}p<0.005, ^{a3}p<0.01, ^{a4}p<0.05
Significantly different from 4 mo: ^{b1}p<0.001, ^{b2}p<0.005, ^{b3}p<0.01, ^{b4}p<0.05
Significantly different from 8 mo: ^{c1}p<0.001, ^{c2}p<0.005, ^{c3}p<0.01, ^{c4}p<0.05
Significantly different from 12 mo: ^{d1}p<0.001, ^{d2}p<0.005, ^{d3}p<0.01, ^{d4}p<0.05

Table 4.69. Means (±SEM) of anthropometric parameters (II) in 18 hyperglycemic male students during the study

Parameters[1]	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
Right leg fat (%)	9-12	5	38.8 ± 7.1	32.7 ± 5.7 ^{a4}	32.5 ± 5.4	33.0 ± 5.8 ^{a4}	34.4 ± 6.5
	13-15	13	18.6 ± 2.2	16.1 ± 1.5 ^{a4}	18.5 ± 1.4 ^{b1}	15.3 ± 1.5 $^{a4, c1}$	15.4 ± 1.5 $^{a4, c1}$
Right leg mm (kg)	9-12	5	9.1 ± 0.9	9.1 ± 0.8	9.7 ± 0.9 $^{a2, b2}$	9.9 ± 0.9 $^{a4, b4}$	9.6 ± 0.8 $^{a3, b3}$
	13-15	13	8.5 ± 0.2	8.8 ± 0.3 ^{a3}	8.9 ± 0.3 ^{a2}	8.9 ± 0.3 ^{a1}	8.9 ± 0.3 ^{a2}
Left leg fat (%)	9-12	5	39.2 ± 7.4	32.5 ± 5.6 ^{a4}	32.6 ± 5.5	33.3 ± 5.8	34.0 ± 6.3
	13-15	13	19.0 ± 2.2	16.5 ± 1.3 ^{a4}	18.9 ± 1.2 ^{b1}	16.0 ± 1.3 ^{c1}	16.1 ± 1.3 $^{a4, c1}$
Left leg mm (kg)	9-12	5	8.9 ± 0.8	9.0 ± 0.8	9.6 ± 0.8 $^{a4, b3}$	9.8 ± 0.9 ^{b3}	9.6 ± 0.8 $^{a4, b2}$
	13-15	13	8.3 ± 0.2	8.6 ± 0.3 ^{a4}	8.7 ± 0.3 ^{a2}	8.7 ± 0.3 ^{a2}	8.7 ± 0.3 ^{a3}

[1] Significantly different from BL: $^{a1}p<0.001$, $^{a2}p<0.005$, $^{a3}p<0.01$, $^{a4}p<0.05$
Significantly different from 4 mo: $^{b1}p<0.001$, $^{b2}p<0.005$, $^{b3}p<0.01$, $^{b4}p<0.05$
Significantly different from 8 mo: $^{c1}p<0.001$, $^{c2}p<0.005$, $^{c3}p<0.01$, $^{c4}p<0.05$
Significantly different from 12 mo: $^{d1}p<0.001$, $^{d2}p<0.005$, $^{d3}p<0.01$, $^{d4}p<0.05$

Table 4.70. Means (±SEM) of anthropometric parameters (III) in 18 hyperglycemic male students during the study

Parameters[1]	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
Right arm fat (%)	9-12	5	31.1 ± 7.1	26.3 ± 5.8 [a4]	26.4 ± 5.3	26.5 ± 5.5	24.5 ± 5.0
	13-15	13	13.0 ± 1.7	11.5 ± 1.2	13.6 ± 1.2 [b1]	11.0 ± 1.2 [c1]	11.5 ± 1.0 [c1]
Right arm mm (kg)	9-12	5	2.2 ± 0.2	2.1 ± 0.2 [a4]	2.3 ± 0.2 [b2]	2.4 ± 0.2 [a4, b3]	2.4 ± 0.2 [a2, b2, c4]
	13-15	13	2.2 ± 0.1	2.2 ± 0.1	2.2 ± 0.1	2.4 ± 0.1 [a1, b1, c1]	2.4 ± 0.1 [a1, b1, c1]
Left arm fat (%)	9-12	5	30.3 ± 6.3	26.4 ± 5.3	25.8 ± 4.8	26.6 ± 5.1	24.4 ± 4.7
	13-15	13	13.6 ± 1.6	12.3 ± 1.0	14.2 ± 1.1 [b1]	12.1 ± 1.0 [c1]	12.6 ± 0.9 [c1]
Left arm mm (kg)	9-12	5	2.3 ± 0.2	2.2 ± 0.2 [a4]	2.3 ± 0.2 [b2]	2.4 ± 0.2 [a1, b2]	2.5 ± 0.2 [a2, b2, c4]
	13-15	13	2.1 ± 0.1	2.2 ± 0.1	2.2 ± 0.1	2.3 ± 0.1 [a1, b1, c1]	2.3 ± 0.1 [a1, b1, c2]

[1] Significantly different from BL: [a1]p<0.001, [a2]p<0.005, [a3]p<0.01, [a4]p<0.05
Significantly different from 4 mo: [b1]p<0.001, [b2]p<0.005, [b3]p<0.01, [b4]p<0.05
Significantly different from 8 mo: [c1]p<0.001, [c2]p<0.005, [c3]p<0.01, [c4]p<0.05
Significantly different from 12 mo: [d1]p<0.001, [d2]p<0.005, [d3]p<0.01, [d4]p<0.05

Table 4.71. Means (±SEM) of anthropometric parameters (IV) in 18 hyperglycemic male students during the study

Parameters[1]	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
WC (cm)	9-12	5	91.6 ± 8.4	81.6 ± 6.0 ^{a4}	86.4 ± 7.5	88.1 ± 7.4 ^{b4}	87.3 ± 7.9
	13-15	13	74.4 ± 2.3	68.9 ± 1.6 ^{a2}	72.0 ± 1.4 ^{b2}	74.6 ± 1.9 ^{b2}	71.0 ± 1.2 $^{b3, d4}$
HC (cm)	9-12	5	100.7 ± 5.8	96.2 ± 5.0 ^{a4}	97.1 ± 4.8	100.5 ± 5.6 $^{b3, c4}$	99.2 ± 5.5
	13-15	13	89.2 ± 1.6	87.3 ± 1.3	88.8 ± 1.2 ^{b2}	89.6 ± 1.0 ^{b3}	88.7 ± 1.1 ^{b4}
WHR	9-12	5	0.90 ± 0.04	0.84 ± 0.02	0.88 ± 0.03	0.87 ± 0.03	0.87 ± 0.03
	13-15	13	0.83 ± 0.02	0.79 ± 0.01 ^{a4}	0.81 ± 0.01 ^{b4}	0.83 ± 0.02 ^{b4}	0.80 ± 0.01 ^{a4}

[1] Significantly different from BL: $^{a1}p<0.001$, $^{a2}p<0.005$, $^{a3}p<0.01$, $^{a4}p<0.05$
Significantly different from 4 mo: $^{b1}p<0.001$, $^{b2}p<0.005$, $^{b3}p<0.01$, $^{b4}p<0.05$
Significantly different from 8 mo: $^{c1}p<0.001$, $^{c2}p<0.005$, $^{c3}p<0.01$, $^{c4}p<0.05$
Significantly different from 12 mo: $^{d1}p<0.001$, $^{d2}p<0.005$, $^{d3}p<0.01$, $^{d4}p<0.05$

4.3.14 Effect on anthropometric parameter of 24 hyperglycemic female students

Means (±SEM) of anthropometric parameters in 24 hyperglycemic female students during the study are shown in Tables 4.72-4.75

The mean height in 9-15 year old hyperglycemic female students were significant increased especially in 9-12 year old hyperglycemic female students had significant increased 3.5 cm/year and in 13-15 year group increased 1.6 cm/year, and one student in 16-18 year group increased 2 cm/year, whereas another one in 16-18 was not change. However, the mean BMI in all group of hyperglycemic female students trended to be lower than that at BL (Tables 4.72-4.75).

No drastic changes of body weight and BMI in hyperglycemic female students at the end of study, it may be due to child growth.

Percentages of total body fat and trunk fat in all group of hyperglycemic female students trended to be lower than that at BL throughout the study period.

Body trunk mm in 9-12 year and 13-15 year groups of hyperglycemic female students had increased from BL throughout the study, at the end of study, 16 mo, the mean of trunk mm in 9-12 year group at 8 mo, 12 mo and 16 mo were significantly higher than those at BL, in 13-15 year group at 12 mo and 16 mo were significantly higher than those at BL, whereas only one student in 16-18 year group at 4 mo, 16 mo trended to be lower than that at BL.

Percentage of fat in both leg in all group of hyperglycemic female students trended at 16 mo trended to be lower than that at BL. These changes were also observed in both arm, but were not significant at BL throughout the study period (Tables 4.72-4.75).

Muscle mass at both legs in 9-12 year group had increased throughout the study, especially at 8 mo, 12 mo, and 16 mo were significant increased at BL, whereas in 13-15 year and 16-18 year group were not difference at BL throughout the study. These changes were also observed in muscle mass at both arms.

Waist/hip ratios in all groups were within normal limit throughout the study, whereas in 9-12 year group at 4 mo was significant decreased at BL and in 13-15 year group at 4 mo, 16 mo were significant decreased at BL (Tables 4.75).

Table 4.72. Means (±SEM) of anthropometric parameters (I) in 24 hyperglycemic female students during the study

Parameters	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
Height (cm)	9-12	9	152.6 ± 1.9	152.6 ± 1.9	152.6 ± 1.9	156.1 ± 1.8 ^{a2}	156.1 ± 1.8 ^{a2}
	13-15	13	156.4 ± 1.2	156.4 ± 1.2	156.4 ± 1.2	158.0 ± 1.2 ^{a2}	158.0 ± 1.2
	16-18	2	157.0, 151.0	157.0, 151.0	157.0, 151.0	157.0, 153.0	157.0, 153.0
Weight (kg)	9-12	9	51.9 ± 5.5	52.2 ± 5.0	53.1 ± 4.7	54.0 ± 5.0	53.4 ± 4.5
	13-15	13	54.1 ± 3.9	54.1 ± 3.8	55.1 ± 3.9	54.4 ± 4.0	54.8 ± 3.8
	16-18	2	47.4, 55.7	46.0, 53.7	47.5, 53.7	47.2, 53.2	46.1, 52.5
BMI (kg/m^2)	9-12	9	22.3 ± 2.3	22.3 ± 2.1	22.6 ± 2.0	22.2 ± 2.1	21.9 ± 1.9
	13-15	13	22.0 ± 1.4	21.9 ± 1.3	22.3 ± 1.4	21.7 ± 1.4 ^{c2}	21.8 ± 1.3 ^{c3}
	16-18	2	19.2, 24.4	18.7, 23.6	19.3, 23.6	19.1, 22.7	18.7, 22.4
Body fat (%bw)	9-12	9	29.0 ± 4.2	28.6 ± 3.9	28.9 ± 3.3	27.8 ± 3.9	28.1 ± 3.3
	13-15	13	29.3 ± 2.9	29.2 ± 2.7	30.0 ± 2.9	28.3 ± 2.6	28.7 ± 2.3
	16-18	2	28.9, 35.7	27.2, 33.6	27.8, 33.3	27.2, 32.9	27.7, 31.8
Trunk fat (%)	9-12	9	27.1 ± 5.0	27.0 ± 4.7	27.2 ± 4.2	26.6 ± 5.1	26.7 ± 4.1
	13-15	13	27.1 ± 3.5	27.4 ± 3.3	28.1 ± 3.4	26.3 ± 3.1	26.7 ± 2.8
	16-18	2	28.0, 35.3	25.8, 32.7	26.5, 32.4	25.7, 32.2	26.5, 30.8
Trunk mm (kg)	9-12	9	17.7 ± 0.6	17.8 ± 0.5	18.4 ± 0.5 $^{a2, b1}$	18.4 ± 0.7 ^{a4}	18.6 ± 0.6 $^{a1, b4}$
	13-15	13	19.1 ± 0.5	19.0 ± 0.5	19.1 ± 0.5	19.8 ± 0.6 ^{a4}	20.1 ± 0.6 $^{a3, b3, c4, d4}$
	16-18	2	19.0, 19.8	18.7, 19.3	19.1, 19.5	18.9, 19.6	18.7, 19.5

[1] Significantly different from BL: ^{a1}p<0.001, ^{a2}p<0.005, ^{a3}p<0.01, ^{a4}p<0.05
Significantly different from 4 mo: ^{b1}p<0.001, ^{b2}p<0.005, ^{b3}p<0.01, ^{b4}p<0.05
Significantly different from 8 mo: ^{c1}p<0.001, ^{c2}p<0.005, ^{c3}p<0.01, ^{c4}p<0.05
Significantly different from 12 mo: ^{d1}p<0.001, ^{d2}p<0.005, ^{d3}p<0.01, ^{d4}p<0.05

Table 4.73. Means (±SEM) of anthropometric parameters (II) in 24 hyperglycemic female students during the study

Parameters[1]	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
Right leg fat (%)	9-12	9	32.2 ± 3.3	31.1 ± 3.0	31.6 ± 2.3	30.1 ± 2.4 ^{c4}	30.5 ± 2.2
	13-15	13	32.6 ± 2.1	32.2 ± 2.0	33.0 ± 2.3	31.5 ± 1.9	32.0 ± 1.6
	16-18	2	31.5, 36.9	30.3, 35.2	30.6, 35.3	30.0, 34.5	30.7, 33.8
Right leg mm (kg)	9-12	9	6.1 ± 0.3	6.3 ± 0.3	6.4 ± 0.3 ^{a4}	6.7 ± 0.3 $^{a1, b4, c2}$	6.6 ± 0.3 $^{a1, c2}$
	13-15	13	6.3 ± 0.2	6.4 ± 0.2	6.4 ± 0.2	6.4 ± 0.2	6.3 ± 0.3
	16-18	2	5.2, 5.7	5.3, 5.9	5.4, 5.8	5.5, 5.8	5.2, 5.9
Left leg fat (%)	9-12	9	32.1 ± 2.9	31.3 ± 2.8	31.8 ± 2.1	30.0 ± 2.2 ^{c4}	30.5 ± 1.9
	13-15	13	33.1 ± 2.2	32.8 ± 2.0	33.5 ± 2.3	32.0 ± 1.9	32.4 ± 1.6
	16-18	2	31.0, 37.0	30.0, 35.4	30.4, 35.6	29.8, 35.0	30.3, 34.2
Left leg mm (kg)	9-12	9	6.1 ± 0.4	6.4 ± 0.3	6.4 ± 0.4 ^{a4}	6.8 ± 0.4 $^{a1, b4, c3}$	6.7 ± 0.4 $^{a1, c4}$
	13-15	13	6.2 ± 0.2	6.3 ± 0.2	6.3 ± 0.2	6.2 ± 0.2	6.2 ± 0.3
	16-18	2	5.2, 5.4	5.2, 5.6	5.4, 5.6	5.5, 5.5	5.2, 5.6

[1] Significantly different from BL: $^{a1}p<0.001$, $^{a2}p<0.005$, $^{a3}p<0.01$, $^{a4}p<0.05$
Significantly different from 4 mo: $^{b1}p<0.001$, $^{b2}p<0.005$, $^{b3}p<0.01$, $^{b4}p<0.05$
Significantly different from 8 mo: $^{c1}p<0.001$, $^{c2}p<0.005$, $^{c3}p<0.01$, $^{c4}p<0.05$
Significantly different from 12 mo: $^{d1}p<0.001$, $^{d2}p<0.005$, $^{d3}p<0.01$, $^{d4}p<0.05$

Table 4.74. Means (±SEM) of anthropometric parameters (III) in 24 hyperglycemic female students during the study

Parameters[1]	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
Right arm fat (%)	9-12	9	26.4 ± 4.8	26.0 ± 4.2	26.2 ± 3.7	25.9 ± 4.4	26.0 ± 3.9
	13-15	13	25.9 ± 2.9	25.5 ± 2.7	26.5 ± 2.7	25.2 ± 2.7	25.4 ± 2.5
	16-18	2	25.0, 32.7	23.3, 31.1	24.7, 30.4	24.4, 29.6	23.9, 28.8
Right arm mm (kg)	9-12	9	1.6 ± 0.1	1.6 ± 0.1	1.6 ± 0.1[a3, b4]	1.7 ± 0.1 [a2]	1.6 ± 0.1[a3]
	13-15	13	1.7 ± 0.1	1.7 ± 0.1	1.7 ± 0.1	1.6 ± 0.1	1.7 ± 0.1
	16-18	2	1.3, 1.5	1.3, 1.5	1.3, 1.6	1.3, 1.5	1.3, 1.5
Left arm fat (%)	9-12	9	27.2 ± 4.6	27.0 ± 4.3	27.3 ± 3.9	26.7 ± 4.5	26.8 ± 3.8
	13-15	13	26.9 ± 3.0	26.9 ± 2.9	27.7 ± 3.0	26.4 ± 2.7	26.7 ± 2.5
	16-18	2	26.6, 33.8	24.9, 32.0	25.9, 31.8	25.4, 30.8	25.2, 30.0
Left arm mm (kg)	9-12	9	1.5 ± 0.1	1.6 ± 0.1	1.6 ± 0.1[a4, b4]	1.6 ± 0.1	1.6 ± 0.1
	13-15	13	1.6 ± 0.1	1.6 ± 0.1	1.6 ± 0.1	1.6 ± 0.1	1.6 ± 0.1
	16-18	2	1.2, 1.4	1.2, 1.4	1.2, 1.4	1.2, 1.4	1.2, 1.4

[1] Significantly different from BL: $^{a1}p<0.001$, $^{a2}p<0.005$, $^{a3}p<0.01$, $^{a4}p<0.05$
Significantly different from 4 mo: $^{b1}p<0.001$, $^{b2}p<0.005$, $^{b3}p<0.01$, $^{b4}p<0.05$
Significantly different from 8 mo: $^{c1}p<0.001$, $^{c2}p<0.005$, $^{c3}p<0.01$, $^{c4}p<0.05$
Significantly different from 12 mo: $^{d1}p<0.001$, $^{d2}p<0.005$, $^{d3}p<0.01$, $^{d4}p<0.05$

Table 4.75. Means (±SEM) of anthropometric parameters (IV) in 24 hyperglycemic female students during the study

Parameters[1]	Age (y)	n	BL	4 mo	8 mo	12 mo	16 mo
WC (cm)	9-12	9	73.0 ± 4.5	68.8 ± 3.7 ^{a2}	72.6 ± 4.4 ^{b4}	70.8 ± 3.8	71.3 ± 3.9
	13-15	13	76.5 ± 3.1	71.8 ± 3.0 ^{a1}	75.3 ± 3.4 ^{b3}	73.9 ± 3.4 $^{a4, b4}$	72.4 ± 3.1 $^{a3, c4}$
	16-18	2	75.0, 77.0	66.0, 74.0	67.0, 76.0	68.0, 75.0	68.0, 74.0
HC (cm)	9-12	9	92.4 ± 3.8	90.7 ± 3.0	92.2 ± 3.3	91.7 ± 3.3	92.2 ± 3.0
	13-15	13	94.4 ± 2.5	92.0 ± 2.4 ^{a3}	93.8 ± 2.6 ^{b4}	93.4 ± 2.6	85.9 ± 6.6
	16-18	2	91.0, 96.5	85.0, 95.0	88.5, 95.0	88.0, 91.0	87.0, 94.0
WHR	9-12	9	0.79 ± 0.02	0.76 ± 0.02 ^{a2}	0.78 ± 0.03	0.77 ± 0.02	0.77 ± 0.02
	13-15	13	0.81 ± 0.01	0.78 ± 0.02 ^{a4}	0.80 ± 0.02	0.79 ± 0.02	0.77 ± 0.02 $^{a4, c4}$
	16-18	2	0.82, 0.80	0.78, 0.78	0.76, 0.80	0.77, 0.82	0.78, 0.79

[1] Significantly different from BL: $^{a1}p<0.001$, $^{a2}p<0.005$, $^{a3}p<0.01$, $^{a4}p<0.05$
Significantly different from 4 mo: $^{b1}p<0.001$, $^{b2}p<0.005$, $^{b3}p<0.01$, $^{b4}p<0.05$
Significantly different from 8 mo: $^{c1}p<0.001$, $^{c2}p<0.005$, $^{c3}p<0.01$, $^{c4}p<0.05$
Significantly different from 12 mo: $^{d1}p<0.001$, $^{d2}p<0.005$, $^{d3}p<0.01$, $^{d4}p<0.05$

4.3.15 Biochemical parameters in 18 hyperglycemic male students

Means (±SEM) of biochemical parameters in 18 hyperglycemic male students during the study are shown in Table 4.76.

The mean serum TC and LDL of 9-12 year old and 13-15 year old hyperglycemic male students were at borderline risk level, 187, 185, 115, 113 mg/dL, respectively. After nutritional therapy, 16 mo their serum TC and LDL in 9-12 year groups were not different than that at BL, however in 13-15 year groups were lower than that at BL, especially TC was significant lower than that at BL during the study. Their mean serum TG and HDL levels were within normal limits throughout the study.

Their mean FBG levels were within normal limits throughout the study, except in 9-12 and in 13-15 year group at BL their mean FBG was 125, 131 mg/dL, IFBG and DM level respectively, however FBG at 8 mo, 12 mo, and 16 mo became normal level.

Table 4.78 shows the numbers and mean net changes of FBG levels in 18 hyperglycemic male students during the study.

Table 4.76. Means (±SEM) of biochemical parameters in 18 hyperglycemic male students during the study

Parameters[1]	Age (y)	n	BL	8 mo	12 mo	16 mo
TC (mg/dL)	9-12	5	187 ± 11	174 ± 19	191 ± 20	187 ± 20 ^{c3}
	13-15	13	185 ± 11	159 ± 6 ^{a2}	166 ± 8 ^{a3}	166 ± 8 ^{a4}
TG (mg/dL)	9-12	5	67 ± 6	125 ± 33	61 ± 12	106 ± 14 ^{d4}
	13-15	13	63 ± 4	75 ± 10	46 ± 4 $^{a2, c2, d2}$	78 ± 11
HDL (mg/dL)	9-12	5	59 ± 4	46 ± 2	47 ± 1	42 ± 2 ^{a4}
	13-15	13	60 ± 3	45 ± 1 ^{a1}	43 ± 1 ^{a1}	47 ± 3 ^{a2}
LDL (mg/dL)	9-12	5	115 ± 14	103 ± 12	131 ± 17	123 ± 19
	13-15	13	113 ± 9	99 ± 6	115 ± 8 ^{c4}	104 ± 6
FBG (mg/dL)	9-12	5	125 ± 2	94 ± 2 ^{a2}	95 ± 2 ^{a1}	95 ± 3 ^{a2}
	13-15	13	131 ± 5	95 ± 3 ^{a1}	88 ± 1 $^{a1, c4}$	94 ± 3 ^{a1}

[1] Significantly different from BL: ^{a1}p<0.001, ^{a2}p<0.005, ^{a3}p<0.01, ^{a4}p<0.05
Significantly different from 4 mo: ^{b1}p<0.001, ^{b2}p<0.005, ^{b3}p<0.01, ^{b4}p<0.05
Significantly different from 8 mo: ^{c1}p<0.001, ^{c2}p<0.005, ^{c3}p<0.01, ^{c4}p<0.05
Significantly different from 12 mo: ^{d1}p<0.001, ^{d2}p<0.005, ^{d3}p<0.01, ^{d4}p<0.05

4.3.8 Biochemical parameters in 24 hyperglycemic female students

Means (±SEM) of biochemical parameters in 24 hyperglycemic female students during the study are shown in Table 4.77.

The mean serum TC of 9-12 year old and 13-15 year old hyperglycemic female students were at borderline risk level, 192 and 185 mg/dL, while serum LDL were at normal level at BL. However, the value serum TC and LDL of one students of 16-18 year old hyperglycemic female students (n=2) was at high risk level, 277 and 195 mg/dL, respectively, but another student of 16-18 year group was at borderline risk level of TC, 173 mg/dL and at normal level of LDL, 92 mg/dL.

After nutritional therapy, 16 mo their serum TC and LDL in 9-12 and 13-15 year groups were not difference than that at BL, however in 16-18 year group (n=2) their TC and LDL levels tended to be lower than that at BL. At 12 mo in 9-12 year group and in 13-15 year group, their mean serum TG was significantly lower than that at BL and were within normal limit throughout the study period. The mean serum HDL levels of 9-12 year group and 13-15 year group were within normal limits throughout the study, whereas only one students in 16-18 year group was lower than that at BL. Their mean FBG levels were within DM levels thoughout the study, however FBG at 8 mo, 12 mo, and 16 mo became normal level.

Table 4.79 shows the numbers and mean net changes of serum FBG levels in 24 hyperglycemic female students during the study.

At the end of nutritional therapy all of hyperglycemic male students and all of hyperglycemic female students had normal FBG (Table 4.80)

Table 4.77. Means (±SEM) of biochemical parameters in 24 hyperglycemic female students during the study

Parameters[1]	Age (y)	n	BL	8 mo	12 mo	16 mo
TC (mg/dL)	9-12	9	192 ± 9	196 ± 9	183 ± 6	189 ± 7
	13-15	13	185 ± 6	188 ± 6	176 ± 8	193 ± 8
	16-18	2	277, 173	219, 166	248, 173	197, 141
TG (mg/dL)	9-12	9	83 ± 12	96 ± 15	58 ± 10 $^{a4, c4}$	102 ± 17 ^{d4}
	13-15	13	88 ± 12	80 ± 9	63 ± 7 ^{a2}	98 ± 13 ^{d3}
	16-18	2	67, 133	78, 193	60, 83	76, 108
HDL (mg/dL)	9-12	9	67 ± 3	55 ± 3 ^{a2}	55 ± 2 ^{a2}	56 ± 3
	13-15	13	59 ± 2	54 ± 2	54 ± 1 ^{a4}	55 ± 1
	16-18	2	69, 54	52, 39	57, 52	48, 39
LDL (mg/dL)	9-12	9	109 ± 9	122 ± 9 ^{a2}	116 ± 5	113 ± 6
	13-15	13	109 ± 6	118 ± 5	110 ± 7	119 ± 8
	16-18	2	195, 92	151, 88	179, 104	134, 80
FBG (mg/dL)	9-12	9	126 ± 3	90 ± 2 ^{a1}	90 ± 1 ^{a1}	92 ± 2 ^{a1}
	13-15	13	126 ± 1	88 ± 1 ^{a1}	89 ± 2 ^{a1}	92 ± 2 ^{a1}
	16-18	2	121, 125	93, 89	76, 103	96, 94

[1] Significantly different from BL: $^{a1}p<0.001$, $^{a2}p<0.005$, $^{a3}p<0.01$, $^{a4}p<0.05$
Significantly different from 4 mo: $^{b1}p<0.001$, $^{b2}p<0.005$, $^{b3}p<0.01$, $^{b4}p<0.05$
Significantly different from 8 mo: $^{c1}p<0.001$, $^{c2}p<0.005$, $^{c3}p<0.01$, $^{c4}p<0.05$
Significantly different from 12 mo: $^{d1}p<0.001$, $^{d2}p<0.005$, $^{d3}p<0.01$, $^{d4}p<0.05$

Table 4.78. Changes of blood glucose levels in 18 hyperglycemic male students during the study

Parameters	Age (y)	n	BL-8 mo (min, max)	n	8 mo-12 mo (min, max)	n	12 mo-16 mo (min, max)
FBG (mg/dL)							
Decrease	9-12	5	(-18.0, -43.0)	1	(-14.0)	3	(- 4.0, -7.0)
	13-15	12	(-22.0, -90.0)	12	(-1.0, -39.0)	2	(- 2.0, -25.0)
Stable	9-12			1			
	13-15					1	
Increase	9-12			3	(3.0, 9.0)	2	(1.0, 16.0)
	13-15	1	(2.0)	1	(5.0)	10	(3.0, 21.0)

Table 4.79. Changes of blood glucose levels in 24 hyperglycemic female students during the study

Parameters	Age (y)	n	BL-8 mo (min, max)	n	8 mo-12 mo (min, max)	n	12 mo-16 mo (min, max)
FBG (mg/dL)							
Decrease	9-12	9	(-20.0, -58.0)	3	(- 4.0, -12.0)	2	(- 3.0,- 3.0)
	13-15	13	(-24.0, -49.0)	6	(- 1.0, -14.0)	3	(- 5.0,-11.0)
	16-18	2	(-28.0, -36.0)	1	(-17.0)	1	(- 9.0)
Stable	9-12			2		2	
	13-15					2	
	16-18						
Increase	9-12			4	(2.0, 7.0)	5	(1.0, 10.0)
	13-15			7	(1.0, 15.0)	8	(3.0, 18.0)
	16-18			1	(14.0)	1	(20.0)

Table 4.80. Hyperglycemic levels of 42 hyperglycemic students classified by sex, age, and FBG during the study

	By blood glucose levels ADA	BL N (%[1])	8 mo N (%)	12 mo N (%)	16 mo N (%)
Male					
9-12 (y)	Normal		5 (11.9)	5 (11.9)	5 (11.9)
	IFBG	3 (7.1)			
	DM	2 (4.8)			
13-15(y)	Normal		12 (28.6)	13 (31.0)	13 (31.0)
	IFBG	5 (11.9)			
	DM	8 (19.0)	1 (2.4)		
16-18 (y)	Normal				
	IFBG				
	DM				
Female					
9-12 (y)	Normal		9 (21.4)	9 (21.4)	9 (21.4)
	IFBG	5 (11.9)			0 (2.0)
	DM	4 (9.5)			
13-15 (y)	Normal		13 (31.0)	13 (31.0)	13 (31.0)
	IFBG	6 (14.3)			
	DM	7 (16.7)			
16-18 (y)	Normal		2 (4.8)	2 (4.8)	2 (4.8)
	IFBG	2 (4.8)			
	DM				

[1] % of 42 hyperglycemic students

CHAPTER V
DISSCUSSION

Our previous study (Leelahagul P, et al 2009: unpublished data) in 820 students of PCCCR found that the prevalence of obesity, hypercholesterolemia, hypertriglyceridemia, and hyperglycemia were 25.8%, 21.1%, 2.4%, and 11.3%, respectively. Many studies have demonstrated that the atherosclerotic process begins in childhood in association with high blood cholesterol levels (62-64). Lipid levels show a strong familial aggregation that has both a genetic and environmental component (65). Monogenic disorders including familial hypercholesterolemia and familial combined hyperlipidemia are expressed in childhood, although adverse diet, polygenic disorders, and environmental causes (including obesity) are the most common causes of high cholesterol levels in children.

Healthy diets and regular, adequate physical activity are major factors in the promotion and maintenance of good health throughout the entire life course. Unhealthy diets and physical inactivity are two of the main risk factors for raised blood pressure, raised blood glucose, abnormal blood lipids, overweight/obesity, and for the major chronic diseases such as cardiovascular diseases, cancer, and diabetes (26).

This study was designed to evaluate the efficiency of nutritional therapy in secondary school-age students of PCCCR school on lowering obesity and risk factors of CVD. Numerous school-based health promotion interventions improved cardiovascular health, behaviors, and reduced risk factors for CVD (28-35). In 2002, McMurry RG, et al studied the efficacy of a school-based health promotion intervention program for African-American adolescents. The results showed that the intervention program was efficacious in knowledge ($p = .0001$), exercise ($p = .0001$), as well as fruit and vegetable intake ($p = .0001$) (33). In 2007, Huang SH, et al studied the effects of a classroom-based weight-control intervention on cardiovascular disease in elementary-school obese children. The results showed that weight, BMI, body fat,

TC, TG, LDL, sugar, insulin and HOMA-IR had decreased, but HDL had increased in the intervention group at the end of study (34). Our study gave a nutrition therapy to students by nutrition education, individual and group nutrition counseling, and modification of school meals, using anthropometric assessment, biochemical assessment, and dietary assessment for evaluation.

PCCCR is a boarding school where some or all students study and live during the school year with their fellow students and possibly teachers or administrators. The word “boarding” is used in the sense of “bed and board” that is, food and lodging. Most boarding schools also have day students who are students that live off-campus with their families, but PCCCR does not have day students.

PCCCR students reside in 8 provinces of the northern part of Thailand. PCCCR is secondary science school. For health promotion, some activities have been motivated in this school, e.g., no smoking, no alcohol, no biking but walk instead. School meals were modified by control cooking oils, salt, and sugar, restrict organ meat, egg yolk, serve various fruits after lunch three times a week, prepare food depend on student’s prefer such as serve instant noodle with meat and vegetables (31). Moreover, students were recommended to avoid junk foods and snacks, motivated to drink skim milk.

5.1 Characteristics of subjects

Subjects in this study consisted of 49 obese, 58 hypercholesterolmic, 13 hypertrigeceridemic, and 42 hyperglycemic students.

Forty-nine obese students (male = 18, female = 31) which classified by body fat according to sex and age (59) 40.8%, 6.1%, and 20.4% of these obese students had high LDL, high TG, and high FBG, respectively.

Fifty-eight hypercholesterolmic students (male = 20, female = 38) 34.5%, 3.4%, and 17.2% of these hypercholesterolmic students had high body fat, high TG, and high FBG, respectively.

Thirteen hypertriglyceridemic students (male = 2, female = 11) 23.1%, 15.4%, and 15.4% of these hypertriglyceridemic students had high body fat, high LDL, and high FBG, respectively.

Forty-two hyperglycemic students (male = 18, female = 24) 23.8%, 23.8%, and 4.8% of these hypertriglyceridemic students had high body fat, high LDL, and high TG, respectively.

Overweight and obese adolescents are likely to stay obese into adulthood and more likely to develop diet-related chronic diseases like diabetes, dylipidemia and CVD at a younger age. Overweight and obesity, as well as their related diseases, are largely preventable. Prevention of adolescents obesity and other diet-related chronic diseases therefore needs high priority, especially in one who had multiple CVD risk factors.

5.2 Effect of dietary counseling

The efficiency of nutritional therapy were evidently improving nutritional status at second visit, 4mo. The changes were stand still at third visit 8mo. At forth visit, 12mo, during summer-school holidays, their nutritional status of all groups had regressed but did not worse than beginning. After nutritional therapy at 16mo, the first semester of academic year, the nutritional status of all groups had improved but less than at the first visit, 4mo. In 2008, Kain, J., et al. studied the effectiveness of a school-based obesity prevention programmed in Chilean children the result shown BMIZ declined in both genders and all age categories in the intervention group during the first year (significant only in younger boys). No changes occurred during the summer, while during the second year, BMIZ increased in boys and girls from both groups (significant only in the younger control boys) (61).

This nutrition therapy was an effective program to reduce body fat in obese students, which 14.8% of BL. Moreover, the mean extremities fat percentage in all parts decreased, especially at right leg and left leg had the highest reduction, 15.9% and 16.8%, respectively which related to type of exercise, walking at least 30 minutes everyday. In contrast muscle mass increased 5.5%, 5.7% at right leg and left leg, respectively. Reducing of body fat and increasing muscle mass indicated that nutrition education was given accurately, feasible, and practical. In collaboration with school provided the school meals with high quality and quantity foods suitable for child growth.

Reductions of serum TC and LDL levels were relative with decreasing of body fat percentage, weight, and BMI in obese students. These indicated that obese students reduced their total caloric intake and selected more nutritious foods which suitable for their nutritional status, these evidences were also observed from their dietary records.

After nutritional therapy, 16 mo, the mean serum LDL levels of hypercholesterolemic students decreased 18.2 % of BL. Twenty-nine of 58 hypercholesterolmic students had normal LDL levels, 46 of them had lower serum LDL levels than BL, average 79.3% of BL. However, twelve of them had higher serum LDL levels than BL, average 20.7% of BL.

The successful of dietary therapy for hypercholesterolemic subjects was not depend on their dietary intake but also depend on their causes, especially from genetic cause the rate reduction of serum LDL was slightly lower than dietary cause.

After nutritional therapy, 16 mo, the mean serum TG levels of hypertriglyceridemic students decreased 26.5% of BL. Eight of 13 hypercholesterolmic students had normal TG levels, 11 of them had lower serum TG levels than BL, average 84.6% of BL. However, two of them had higher serum TG levels than BL, average 15.4% of BL.

However, the mean serum TG levels during the summer period were lower than those during the study period. This evidence may be explained by the dietary records of hypertriglyceridemic students which showed that they had consumed more bread and snacks during school time.

The hyperglycemic students were successful to reduce their fasting blood glucose at second time of blood test, 8 mo, the values were remained normal level over period of study.

Some students had rapid decreased body fat from 20% to 8% during summer due to healthy food prepared by mothers and exercise with family every day.

CHAPTER VI
CONCLUSION

Cardiovascular risk reduction program in PCCCR were satisfied positive changes to healthier lifestyle. The classroom-based intervention was conducted in 49 obese, 58 hypercholesterolemia, 13 hypertriglyceridemia , 21 students had FBG 110-125 mg/dL, and 21 students had FBG ≥ 126 mg/dL age ranged from 12 to 18 years, all of them receiving the 16 month program of nutrition therapy. The main findings of this study were the reductions of obesity level and severity of CVD risk factors in these students by nutritional therapy.

In obese male students, 50% of them : weight decreased range 0.5kg to 9.8 kg, 61.1% of them : BMI decreased range 0.7 kg/m^2 to 5.3 kg/m^2, 88.9% of them : body fat decreased range 1.5%bw to 15.0%bw, 66.7% of them : LDL decreased range 6.4 mg/dL to 87.2 mg/dL, 33.3% of them : TG decreased range 3 mg/dL to 44 mg/dL, and 88.9% of them : FBG decreased range 6 mg/dL to 35 mg/dL.

In obese female students, 64.5% of them : weight decreased range 0.1 kg to 14.9 kg, 77.4% of them : BMI decreased range 0.1 kg/m^2 to 6.8 kg/m^2, 90.3% of them : body fat decreased range 0.3%bw to 12.4%bw, 48.4% of them : LDL decreased range 0.6 mg/dL to 76.8 mg/dL, 45.1% of them : TG decreased range 5 mg/dL to 56 mg/dL, and 80.6% of them : FBG decreased range 2 mg/dL to 52 mg/dL.

In hypercholesterolemic male students, 80% of them : body fat decreased range 0.5%bw to 12.8%bw, 80% of them : LDL decreased range 7.8 mg/dL to 87.2 mg/dL. In hypercholesterolemic female students, 55.3% of them : body fat decreased range 0.3%bw to 12.4%bw and 81.6% of them : LDL decreased range 0.2 mg/dL to 79.4 mg/dL.

In hypertriglyceridemic male students, one of them : body fat decreased 1.5 %bw, both of them : TG decreased 36.0 mg/dL and 42.0 mg/dL. In hypertriglyceridemic female students, 45.5% of them : body fat decreased range 0.1%bw to 8.6%bw, 81.8% of them : TG decreased range 5.0 mg/dL to 159.0 mg/dL.

In hyperglycemic male students, 61.1% of them : body fat decreased range 0.8 %bw to 15.0 %bw, 100% of them : FBG decreased range 16.0 mg/dL to 78.0 mg/dL. In hyperglycemic female students, 66.7% of them : body fat decreased range 0.5%bw to 8.6%bw, 100% of them : FBG decreased range 16.0 mg/dL and 58.0 mg/dL.

In conclusion, this nutritional therapy can reduce obesity and risk factors of CVD efficiently by simplifying the nutrition education knowledge and providing suggestions which are easy to understand and practice. Regular follow-up, individual and class consultation, nutrition boards (both in dormitory and school areas), and modification of school meals contributed to successful results. Moreover, this nutritional therapy had benefits to and promoted good health in teachers, parents and staff of the school, as they learned and applied nutritional concepts to their health. It is noticeable from this study that the assessment of dietary record by students was not suitable for the student population, since the compliance of students was low. However, it did not affect the nutritional therapy in this study.

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APPENDICES

APPENDIX A

เอกสารชี้แจงข้อมูล/คำแนะนำแก่ผู้เข้าร่วมโครงการ

(Patient/Participant Information Sheet)

ชื่อโครงการ ภาวะโภชนาการของนักเรียนระดับมัธยมศึกษาโรงเรียนจุฬาภรณราชวิทยาลัย เชียงราย

ชื่อผู้วิจัย รศ.ดร. ปรียา ลีฬหกุล

นส. ยุภาวดี รัตนยอศรี

นส. สาวิตรี ผิวอ่อนดี

นาย อวยชัย โรจนนิรันดร์กิจ

นาง อุมาพร อุดมทรัพย์พยากุล

นาย กิตติโชติ ห้อยยี่ภู่

นส. พัชรี คงพันธ์

นาย กิจจา กล้าวิเศษ

สถานที่วิจัย สำนักงานวิจัย คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี

โรงเรียนจุฬาภรณราชวิทยาลัย เชียงราย

บุคคลและวิธีการติดต่อเมื่อมีเหตุฉุกเฉินหรือความผิดปกติที่เกี่ยวข้องกับการวิจัย

1. รศ.ดร. ปรียา ลีฬหกุล
   สำนักงานวิจัย คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี
   มหาวิทยาลัยมหิดล
   (081) 8699839 02-2011483
2. นายกิจจา กล้าวิเศษ
   โรงเรียนจุฬาภรณราชวิทยาลัย เชียงราย
   (081) 8818129

3. นส. สาวิตรี ผิวอ่อนดี
สำนักงานวิจัย คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี
มหาวิทยาลัยมหิดล
(081) 6057008

ความเป็นมาของโครงการ

สังคมที่ดีจำเป็นต้องมีการพัฒนาในทุกๆด้าน ทั้งในด้านเศรษฐกิจ สังคม การเมือง การพัฒนาจำเป็นต้องอาศัยทรัพยากรบุคคลที่มีคุณภาพ ซึ่งบุคคลที่มีคุณภาพนั้นจะต้องมีคุณสมบัติทั้งทางด้านสมรรถภาพร่างกายที่แข็งแรงและจิตใจที่ดี มีสติปัญญา มีความรู้ความสามารถ มีการศึกษาที่ดี สำหรับประเทศไทยก็เช่นเดียวกัน ได้มุ่งหวังให้เด็กไทยแต่ละคนมีพัฒนาการที่สมวัย ทั้งทางด้านร่างกาย สติปัญญา อารมณ์ จิตใจ สังคม และจริยธรรม โดยรัฐบาลได้ประกาศยุทธศาสตร์เมืองไทยแข็งแรงเป็นวาระแห่งชาติ โดยตั้งเป้าหมายปี 2560 เด็กไทยสุขภาพดีแข็งแรง คนไทยได้รับการบริโภคอาหารที่ปลอดภัย มีคุณค่าทางโภชนาการและเพียงพอต่อความต้องการของร่างกาย เพราะการสร้างชีวิตมีรากฐานที่สมบูรณ์และแข็งแรงนำไปสู่การเป็นคนเก่ง ดี มี สุขนั้นเป็นเป้าหมายการพัฒนาเด็กไทยโดยเฉพาะเด็กวัยเรียนละวัยรุ่น เป็นกลุ่มประชากรที่มีความสำคัญยิ่งเพราะเป็นวัยที่กำลังเจริญเติบโต เป็นกำลังสำคัญของประเทศชาติต่อไปในอนาคต

โดยพบว่าภาวะโภชนาการเป็นตัวบ่งชี้ภาวะสุขภาพโดยรวม ภาวะโภชนาการมีผลโดยตรงในการเสริมสร้างสุขภาพให้สมบูรณ์ทั้งทางด้านร่างกาย จิตใจ และสติปัญญา ซึ่งทั้งหมดเป็นกระบวนการต่อเนื่องและเกี่ยวข้องกัน และพบว่าอาหารและโภชนาการมีอิทธิพลเกี่ยวข้องทุกช่วงอายุของมนุษย์ ตั้งแต่ในครรภ์มารดาจนกระทั่งวัยสูงอายุ

โดยเฉพาะภาวะโภชนาการได้มีการศึกษาพบว่ามีความสัมพันธ์กับพัฒนาการด้านสติปัญญาและผลสัมฤทธิ์ทางการศึกษา ดังนั้นหากวัยรุ่นได้รับอาหารที่ไม่ถูกหลักโภชนาการ ไม่เพียงพอกับการเปลี่ยนแปลงดังกล่าวก็ทำให้เกิดการเจริญเติบโตช้าส่งผลต่อพัฒนาการในช่วงวัยผู้ใหญ่ต่อมา เกิดภาวะการเจ็บป่วย ความสามารถในการเรียนรู้ด้อย ผลสัมฤทธิ์ทางการศึกษาต่ำและสมรรถภาพในการกิจกรรมต่ำ การสำรวจพัฒนาการด้านสติปัญญาของเด็กไทยทั่วประเทศก็พบว่าเด็กไทยมีไอคิวต่ำกว่าค่าเฉลี่ยทั้งกลุ่มวัยเรียนและกลุ่มวัยรุ่น คือ มีค่าไอคิวเฉลี่ย 88.1 และ 86.7 ตามลำดับ และพบว่าเด็กในภาคเหนือมีค่าไอคิวต่ำสุดเมื่อเปรียบเทียบกันทุกภูมิภาคในประเทศไทยทั้งกลุ่มวัยเรียนและกลุ่มวัยรุ่น และพบว่าค่าเฉลี่ยไอคิวของเด็กไทยในการศึกษาครั้งนี้ ต่ำกว่าการศึกษาในปี พ.ศ. 2538 ดังนั้นจึงจำเป็นต้องศึกษาหาความสัมพันธ์ระหว่างภาวะโภชนาการ กับพัฒนาการด้านสติปัญญา และประสิทธิผลการเรียนในนักเรียนไทยต่อไป

ปัจจุบันสังคมไทยมีการเปลี่ยนแปลงไปมาก ส่งผลต่อการเปลี่ยนแปลงวิถีชีวิตของผู้คนในสังคม พฤติกรรมการบริโภคและภาวะโภชนาการก็มีการเปลี่ยนแปลงไป อาหารจานด่วนเข้ามามีอิทธิพลมากขึ้น สื่อโฆษณาต่างๆส่งผลต่อพฤติกรรมการบริโภคของเด็กและวัยรุ่นมีมากขึ้นเช่นกัน ปัจจุบันจึงพบว่ากลุ่มวัยรุ่น มักมีพฤติกรรมการบริโภคอาหารที่มีน้ำตาลและไขมันสูง มีการรับประทานผักผลไม้และผลิตภัณฑ์นมลดน้อยลง รวมทั้งมีพฤติกรรมการออกกำลังกายน้อยลงใช้เวลาไปกับการดูโทรทัศน์และเล่นเกมส์คอมพิวเตอร์เป็นส่วนใหญ่ จากการสำรวจเด็กไทยทั่วประเทศใน ปี พ.ศ. 2544 แสดงให้เห็นว่า เด็กไทยใช้เวลาถึงหนึ่งในห้าของเวลาว่างที่นอกเหนือจากการนอน การเรียนและการทำกิจวัตรประจำวันในการดูโทรทัศน์ นอกจากเป็นดัชนีทางอ้อมของการไม่เคลื่อนไหวออกกำลังกายแล้ว การดูโทรทัศน์ยังสัมพันธ์กับพฤติกรรมการบริโภคของขบเคี้ยวที่อุดมด้วยแป้ง และไขมัน ส่งผลให้เด็กไทยอ้วนในที่สุด

เนื่องจากในปัจจุบันนี้อัตราการเกิดโรคอ้วน ไขมันสูงในเลือด เบาหวาน ความดันโลหิตสูง เพิ่มมากขึ้นในกลุ่มคนวัยทำงานขึ้นไป ทำให้เป็นอุปสรรคต่อประสิทธิภาพในการทำงาน และนำมาซึ่งสุขภาพที่ไม่สมบูรณ์เมื่อเข้าสู่วัยสูงอายุโอกาสที่จะเสี่ยงต่อการเกิดโรคหัวใจและหลอดเลือดเพิ่มสูงขึ้น หรืออาจเกิดขึ้นได้ก่อนวัยอันควร โรคเรื้อรังที่สัมพันธ์กับอาหาร ดังกล่าวมานี้ สามารถป้องกันได้ด้วยโภชนบำบัดหรือใช้โภชนบำบัดควบคู่ไปกับการรักษาด้านอื่นๆเพื่อลดและงดการใช้ยาให้มากที่สุด เพื่อคุณภาพชีวิตที่ดีและเพื่อลดค่าใช้จ่ายในการรักษาพยาบาลทั้งของส่วนตัว หรือขององค์กรต่างๆรวมถึงระดับประเทศได้ด้วย

วัตถุประสงค์ของโครงการ

1. เพื่อประเมินภาวะโภชนาการของนักเรียนระดับมัธยมศึกษาโรงเรียนจุฬาภรณราชวิทยาลัย เชียงราย
2. เพื่อศึกษาหาความสัมพันธ์ระหว่างภาวะโภชนาการ พัฒนาการทางด้านสติปัญญาและประสิทธิผลการเรียนของนักเรียนระดับมัธยมศึกษาโรงเรียนจุฬาภรณราชวิทยาลัย เชียงราย
3. เพื่อประเมินประสิทธิภาพการให้โภชนบำบัดในนักเรียนระดับมัธยมศึกษาโรงเรียนจุฬาภรณราชวิทยาลัย เชียงราย ต่อการลดปัจจัยเสี่ยงของโรคหัวใจและหลอดเลือด

รายละเอียดที่จะปฏิบัติต่อผู้เข้าร่วมการวิจัย

ผู้วิจัยแจ้งวัตถุประสงค์และรายละเอียดของโครงการวิจัยแก่ครู นักเรียน และผู้ปกครองของโรงเรียนจุฬาภรณราชวิทยาลัยชั้นมัธยมศึกษาปีที่1-6 รับทราบ โดยนักเรียนและผู้ปกครองที่เต็มใจเข้าร่วมโครงการวิจัยมีการเซ็นยินยอมใน Informed Consent Form

1. เก็บรวบรวมข้อมูลด้วยแบบสอบถามต่างๆ

1.1. แบบสอบถามข้อมูลพื้นฐานทั่วไป

1.2. แบบประเมินข้อมูลสถานภาพทางเศรษฐกิจและสังคม

1.3 แบบประเมินข้อมูลด้านสุขภาพ

1.4 แบบประเมินข้อมูลบริโภคนิสัย

2. การประเมินภาวะโภชนาการ ด้วยมาตราการ ดังต่อไปนี้

2.1 การวัดสัดส่วนร่างกาย

2.2 การประเมินด้านชีวเคมีในเลือด ซึ่งได้จากผลการตรวจสุขภาพประจำปี เมื่อเริ่มต้นปีการศึกษา

2.3 การประเมินข้อมูลการบริโภคอาหาร โดยใช้แบบบันทึกอาหาร 24 ชม.

2.4 ประเมินพัฒนาการทางด้านสติปัญญาด้วยวิธี Progressive Matrices

2.5 ประเมินประสิทธิผลการเรียนของนักเรียนจากผลการเรียนของนักเรียน

2.6 คัดเลือกนักเรียนที่มีภาวะอ้วน โคเลสเตอรอลในเลือดสูง ไตรกลีเซอร์ไรด์ในเลือดสูง และ ระดับน้ำตาลในเลือดสูง เข้าร่วมโครงการโภชนบำบัดตามความสมัครใจและผู้ปกครองยินยอมให้เข้าร่วมโครงการ

2.7 ขั้นตอนการให้โภชนบำบัดประกอบด้วย

2.7.1 ให้โภชนศึกษา

2.7.2 บันทึกอาหาร 24 ชม. ที่รับประทานทุกวัน

2.7.3 การให้โภชนบำบัดที่เหมาะสมสำหรับปัญหาในเด็กแต่ละคน

2.7.4 กระตุ้นให้ออกกำลังกาย

2.7.5 ติดตามการให้โภชนบำบัดทุก 4 สัปดาห์ จำนวน 6 ครั้ง (6 เดือน) และปรับการให้ โภชนบำบัด ที่เหมาะสมกับการเปลี่ยนแปลงแต่ละบุคคล

2.8 มาตรการที่ใช้ในการศึกษา และระยะเวลาที่ประเมินผล มีดังนี้

2.8.1 การประเมินสัดส่วนร่างกาย ที่สัปดาห์ 0, 4, 8, 12, 16, 20, 24

2.8.2 การประเมินอาหารที่รับประทาน ที่สัปดาห์ 0, 4, 8, 12, 16, 20, 24

2.8.3 Serum TC, LDL, HDL, TG, plasma glucose ที่สัปดาห์ 0, 24

ประโยชน์ที่จะเกิดแก่ผู้เข้าร่วมโครงการ

1. ทราบอัตราการเกิดโรคเรื้อรังที่สัมพันธ์กับอาหาร ได้แก่ โรคอ้วน ไขมันในเลือดสูง เบาหวาน ในเด็กนักเรียนวัย 12-18 ปี

2. ลดอัตราการเกิด และ ความรุนแรงของโรคดังกล่าวในเด็กนักเรียนฯ ด้วยโภชนบำบัด

3. ได้แบบแผนที่มีประสิทธิภาพของการให้โครงการโภชนบำบัด สำหรับการสอนและการให้ คำแนะนำข้อมูลเกี่ยวกับวิธีการปรับปรุงปัจจัยเสี่ยงของโรคหัวใจและหลอดเลือดในเด็กนักเรียน

4. เด็กวัยเรียนมีสุขภาพที่ดีได้ด้วยโภชนบำบัดที่ประหยัด และได้ผลระยะยาว ซึ่งนำไปสู่การลด อัตราการเกิดโรคเรื้อรังที่สัมพันธ์กับอาหารในผู้ใหญ่ในอนาคต

5. นักเรียนสามารถนำความรู้ที่ได้รับตลอดโครงการไปดูแลครอบครัวและสังคมใกล้ตัวได้

6. เพื่อใช้เป็นแนวทางในการส่งเสริมภาวะโภชนาการที่ดีเพื่อเพิ่มประสิทธิผลในการเรียนของ นักเรียน

ผลข้างเคียงที่อาจเกิดแก่ผู้เข้าร่วมโครงการ

1. อาจเกิดความวิตกกังวล อาการเจ็บปวด ฟกช้ำ จากการเจาะเลือด โดยการเจาะเลือดทำโดยพยาบาลผู้เชี่ยวชาญการเจาะเลือด โดยการกระทำที่นุ่มนวล ระมัดระวัง และมีการแนะนำให้กดบริเวณแผลเป็นเวลา 5นาที หลังเจาะเลือดเสร็จ เพื่อป้องกันอาการฟกช้ำ ส่วนเข็มเจาะเลือดจะใช้ครั้งเดียวเฉพาะบุคคลแล้วทิ้ง จึงไม่มีความเสี่ยงต่อการติดเชื้อ และดำเนินการด้วยความระมัดระวัง

2. ภาวะหน้ามืดหรือหมดสติเนื่องจากระดับน้ำตาลในเลือดต่ำ (Hypoglycemia)โดยผู้วิจัยจะสังเกตและเฝ้าดูอาการของผู้เข้าร่วมโครงการวิจัยอย่างใกล้ชิด แนะนำผู้เข้าร่วมโครงการวิจัยว่าถ้ามีอาการ เหงื่อออก มือเท้าสั่น รู้สึกหิวจัด อ่อนเพลีย หน้ามืดคล้ายจะเป็นลม หรือมีอาการผิดปกติใดๆ ให้รีบบอกผู้วิจัย และผู้วิจัยเตรียมน้ำหวานสำหรับอาสาสมัครที่มีอาการดังกล่าว

การเก็บข้อมูลเป็นความลับ

ข้อมูลส่วนบุคคลของผู้เข้าร่วมโครงการทุกคน ผู้ทำการวิจัยจะเก็บเป็นความลับ จะไม่นำมาเปิดเผย ถ้าไม่ได้รับอนุญาตจากเจ้าของข้อมูล

ลงนาม.....หัวหน้าโครงการ

(รศ.ดร. ปรียา ลีฬหกุล)

วันที่ 8 ตุลาคม 2552

APPENDIX B

หนังสือยินยอมโดยได้รับการบอกกล่าวและเต็มใจ

(Informed Consent Form)

ชื่อโครงการ ภาวะโภชนาการของนักเรียนระดับมัธยมศึกษาโรงเรียนจุฬาภรณราชวิทยาลัย เชียงราย

ผู้ทำการวิจัย รศ.ดร. ปรียา ลีพหกุล

สำนักงานวิจัย คณะแพทยศาสตร์ โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล

*** ชื่อผู้เข้าร่วมการวิจัย**

อายุ **.....** เลขที่เวชระเบียน .....

คำยินยอมของผู้เข้าร่วมการวิจัย

ข้าพเจ้า นาย/นาง/นางสาว ..... ได้ทราบรายละเอียดของโครงการวิจัยตลอดจนประโยชน์ และข้อเสี่ยงที่จะเกิดขึ้นต่อข้าพเจ้าจากผู้วิจัยแล้วอย่างชัดเจนไม่มีสิ่งใดปิดบังซ่อนเร้นและยินยอมให้ทำการวิจัยในโครงการที่มีชื่อข้างต้น และข้าพเจ้ารู้ว่าถ้ามีปัญหาหรือข้อสงสัยเกิดขึ้นข้าพเจ้าสามารถสอบถามผู้วิจัยได้ และข้าพเจ้าสามารถไม่เข้าร่วมโครงการวิจัยนี้เมื่อใดก็ได้ โดยไม่มีผลกระทบต่อการรักษาที่ข้าพเจ้าพึงได้รับ นอกจากนี้ผู้วิจัยจะเก็บข้อมูลเฉพาะเกี่ยวกับตัวข้าพเจ้าเป็นความลับและจะเปิดเผยได้เฉพาะในรูปที่เป็นสรุปผลการวิจัย การเปิดเผยข้อมูลเกี่ยวกับตัวข้าพเจ้าต่อหน่วยงานต่างๆที่เกี่ยวข้อง กระทำได้เฉพาะกรณีจำเป็นด้วยเหตุผลทางวิชาการเท่านั้น

ลงชื่อ ..... (ผู้เข้าร่วมการวิจัย)

..... (พยาน)

..... (พยาน)

วันที่ .....

คำอธิบายของผู้วิจัย

ข้าพเจ้าได้อธิบายรายละเอียดของโครงการ ตลอดจนประโยชน์ของการวิจัย รวมทั้งข้อเสี่ยงที่อาจจะเกิดขึ้นแก่ผู้เข้าร่วมการวิจัยทราบแล้วอย่างชัดเจน โดยไม่มีสิ่งใดปิดบังซ่อนเร้น

ลงชื่อ ..... (ผู้วิจัย)

วันที่ .....

หนังสือยินยอมโดยได้รับการบอกกล่าวและเต็มใจ

สำหรับผู้เข้าร่วมการวิจัยที่ไม่สามารถแสดงความยินยอมได้ด้วยตนเอง

ชื่อโครงการ ภาวะโภชนาการของนักเรียนระดับมัธยมศึกษาโรงเรียนจุฬาภรณราชวิทยาลัย เชียงราย

ผู้ทำการวิจัย รศ.ดร. ปรียา ลีพหกุล

สำนักงานวิจัย คณะแพทยศาสตร์ โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล

*** ชื่อผู้เข้าร่วมการวิจัย**

อายุ **.....** เลขที่เวชระเบียน.....

คำยินยอมของผู้มีอำนาจกระทำการแทนผู้เข้าร่วมการวิจัย

ข้าพเจ้า นาย/นาง/นางสาว ..... ซึ่งเป็นผู้มีอำนาจกระทำการแทน นาย/นาง/นางสาว /ด.ช./ด.ญ. ..... ในฐานะ.....ได้ทราบรายละเอียดของโครงการวิจัยตลอดจนประโยชน์ และข้อเสี่ยงที่จะเกิดขึ้นต่อผู้เข้าร่วมการวิจัยจากผู้วิจัยแล้วอย่างชัดเจนไม่มีสิ่งใดปิดบังซ่อนเร้นและยินยอมให้ทำการวิจัยในโครงการที่มีชื่อข้างต้น และข้าพเจ้ารู้ว่าถ้ามีปัญหาหรือข้อสงสัยเกิดขึ้นข้าพเจ้าสามารถสอบถามผู้วิจัยได้ และข้าพเจ้าสามารถไม่ให้ผู้เข้าร่วมการวิจัยเข้าร่วมโครงการวิจัยนี้เมื่อใดก็ได้ โดยไม่มีผลกระทบต่อการรักษาที่ผู้เข้าร่วมการวิจัยได้รับ นอกจากนี้ผู้วิจัยจะเก็บข้อมูลเฉพาะเกี่ยวกับตัวผู้เข้าร่วมการวิจัยเป็นความลับและจะเปิดเผยได้เฉพาะในรูปที่เป็นสรุปผลการวิจัย การเปิดเผยข้อมูลเกี่ยวกับตัวผู้เข้าร่วมการวิจัยต่อหน่วยงานต่างๆที่เกี่ยวข้อง กระทำได้เฉพาะกรณีจำเป็นด้วยเหตุผลทางวิชาการเท่านั้น

ลงชื่อ ..... (ผู้มีอำนาจกระทำการแทน)

..... (พยาน)

..... (พยาน)

วันที่ .....

คำอธิบายของผู้วิจัย

ข้าพเจ้าได้อธิบายรายละเอียดของโครงการ ตลอดจนประโยชน์ของการวิจัย รวมทั้งข้อเสี่ยงที่อาจจะเกิดขึ้นแก่ผู้เข้าร่วมการวิจัยทราบแล้วอย่างชัดเจน โดยไม่มีสิ่งใดปิดบังซ่อนเร้น

ลงชื่อ ..... (ผู้วิจัย)

วันที่ .....

APPENDIX C

NUTRITION EDUCATION

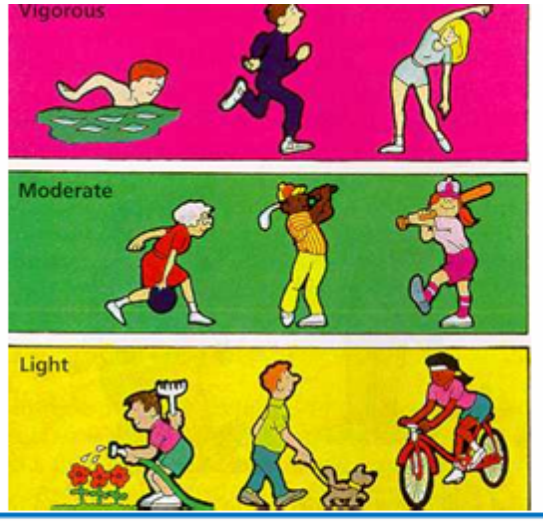
1. จดบันทึกอาหารขนมทุกอย่างที่กินเข้าปากตลอด 24 ชม.

ลงในสมุดบันทึกส่วนตัว

ตัวอย่าง วันที่ 30 พย. 52	เช้า	ข้าวต้มทะเล 3 ทัพพี
		นมจืดไทยเดนมาร์ค 250 มล. 1 กล่อง
	กลางวัน	ข้าวสวย 1 ทัพพี
		ผัดเผ็ดถั่วฝักยาวหมู 5 ช้อนโต๊ะ
		แกงจืดหัวไชเท้า 5 ช้อนโต๊ะ
		ซ่าหริ่ม 1 ถ้วย
	บ่าย	ขนมโคนัท 2 ชิ้น
	เย็น	ข้าวสวย ครึ่ง ทัพพี
		แกงส้มผักรวมปลา 5 ช้อนโต๊ะ
		ไก่ทอดไม่กินหนัง 1 น่อง
		ส้มเขียวหวาน 1 ผล

2. พยายามชั่งน้ำหนักทุกวัน สำหรับคนที่ต้องลดน้ำหนัก ลดไขมันในร่างกาย ตั้งใจลดให้ได้ วันละ 1 ขีด ด้วยการ

- ลดทุกอย่างที่กินลง เช่น กินข้าว 2 ทัพพี ลดเหลือ 1 ทัพพี ขนม 2 ชิ้น ลดเหลือ 1 ชิ้น
- น้ำแกงที่มัน ๆอาหารผัดที่มันมาก กินแต่ส่วนที่เป็นเนื้อ ๆ
- อาหารที่เป็นกะทิ กินแต่ส่วนที่เป็นเนื้อ ๆไม่กินน้ำแกงกะทิ
- ไม่กินหนังสัตว์ ไม่กินมันที่ติดมากับเนื้อสัตว์
- ไม่กินขนมหวาน กินผลไม้แทน
- กินเนื้อปลา เนื้อไก่ เต้าหู้ นมพร่องไขมัน เป็นหลัก



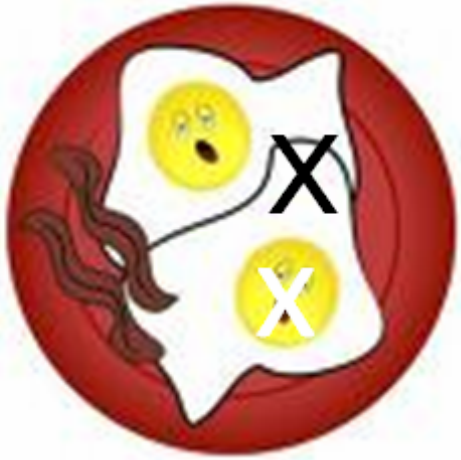
3. ออกกำลังกายทุกวัน และจดลงในสมุดบันทึกด้วยว่า
ออกกำลังกายอะไร นานเท่าใด

ตัวอย่าง 30 พย. 52 เวลา 18.00 เดินเร็ว 30 นาที
1 ธค. 52 เวลา 18.30 เล่นบาส 45 นาที

แนะนำให้ทุกคน
ทำทุกวันต่อเนื่องกันนาน 30 นาที ต่อวัน

4. สำหรับคนที่ไม่อ้วน แต่โคเลสเตอรอลสูงในเลือด ให้คุมอาหารแบบนี้

1. ไม่กินเครื่องในทุกชนิด ไข่แดง
2. กินเบเกอรี่น้อยลง เช่น เคยกินขนมปังทุกวัน ลดเหลือเป็นวัน เว้น วัน
3. ไม่กินหนังสัตว์ มันสัตว์
4. ไม่กินน้ำแกงกะทิ ขนมหวานที่มีกะทิ



5. สำหรับคนที่ไม่อ้วน แต่ไตรกลีเซอไรด์สูงในเลือด ให้คุมอาหารแบบนี้

1. ลดอาหารที่เป็นแป้ง ไขมัน กะทิ
   เช่น ลดข้าว จาก 2 ทัพพี เป็น 1 ทัพพี
   เคยกินหมู 3 ชั้น เปลี่ยนมากินหมูไม่ติดมัน
2. กินเบเกอรี่น้อยลง เช่น เคยกินขนมปังทุกวัน ลดเหลือเป็นวัน เว้น วัน
3. งดขนมหวานที่มีกะทิ

6. สำหรับคนที่น้ำตาลในเลือดสูง แต่ไม่อ้วน ให้กินอาหารแบบนี้
1. ลดขนมหวาน น้ำหวาน น้ำผลไม้ทุกชนิด
2. ลดอาหารที่เป็นแป้ง เช่น ข้าว ขนมปัง ก๋วยเตี๋ยวต่างๆ
3. เลือกกินแต่ผลไม้ที่ไม่หวานจัด เช่น แอปเปิ้ล ฝรั่ง ส้ม

BIOGRAPHY

NAME	Miss Sawitree Phio-ondee
DATE OF BIRTH	19 May 1981
PLACE OF BIRTH	Phitsanulok, Thailand
INSTITUTIONS ATTENDED	Chiangmai University, 1999-2003: Bachelor of Nursing Mahidol University, 2010 : Master of Science (Nutrition)
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