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A STUDY ON THE CARDIO - METABOLIC RISK FACTORS IN VIETNAMESE FEMALES WITH LONG -TERM VEGAN DIET

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TABLE OF CONTENTS

TABLES

LIST OF ABBREVIATION

AUC	Area under the curve
ROC	Receiver operating characteristic
DM	Diabetes mellitus
NIDDM	Non-insulin-dependent diabetes mellitus
MS	Metabolic syndrome
CMS	Cardio metabolic syndrome
CVD	Cardiovascular disease
ASCVD	Atherosclerotic cardiovascular disease
IAA	Intra-abdominal adiposity
FFAs	Free fatty acids
BMI	Body mass index
WC	Waist circumference
ABP	Arterial blood pressure
SBP	Systolic plood pressure
DBP	Diastolic blood pressure
ISH	International Society of Hypertension
hsCRP	High-sensitivity C-reactive protein.
IMTc	Intima-media thickness of carotid artery
CCA	Common carotid artery
ESC	European Society of Hypertension
ESH	European Cardiovascular Society
HbA1c	Hemoglobin A1c
FBG	Fasting blood glucose
TC	Total cholesterol
LDL.C	Low-density lipoprotein (LDL) cholesterol
HDL.C	High-density lipoprotein (HDL) cholesterol
STC	Serum total cholesterol
TG	Triglycerides
IR	Insulin resistance indices

FI	Fasting insulin
WHR	Waist-to-hip ratio
HOMA-IR	Homeostatic model assessment – insulin resistance
SD	Standard deviation
SDS-PAGE	Sodium dodecyl sulfate-polyacrylamide gel electrophoresis
WB	Western blot
WHO	World Health Organisation
NHANES	National Health and Nutrition Examination Survey
NCDs	Non communicable diseases
WHF	The World Heart Federation
IHD	Ischemic heart disease
PWV	Pulse wave velocity
FMD	Flow-mediated dilation

ABSTRACT

A study of the cardio- metabolic risk factors in Vietnamese females with vegan diet.

Background

Numerous studies have shown that vegan diet has beneficial effects on the prevention of cardiovascular diseases. However, the effects of vegan diet on cardio-metabolic risk factors and the association between duration of vegan diet and those risk factors, are still unclear.

Objectives

The present study aims to investigate the prevalence and influence of duration of vegan diet on cardio- metabolic risk factors.

Materials and Methods

144 Buddhist nuns aged 20-75 years with duration of vegan diet ranged 10-70 years, were screened for cardio-metabolic risk factors. They were compared with 68 age-matched women 22-84 years of age on non-vegan diet.

Cardio-metabolic risk factors were assessed, including BMI, WC, blood pressure, fasting glucose, HbA1c, fasting insulin, HOMA-IR, plasma concentration of TC, LDL.C, HDL.C, TG, non-HDL.C, TC/HDL.C, LDL.C/HDL.C, TG/HDL.C, hsCRP, IMT of carotid artery and ischemic heart disease detected by ECG.

Results

1. Cardiovascular disease risk factors of female in vegan group

There was no significant difference in the mean BMI between vegan and control group (21.9 ± 3.1 vs 21.09 ± 2.50, $p > 0.05$). The prevalence of overweight (BMI ≥ 23) in vegan group was significantly higher than in control group (34.7% vs 10.3%, $p < 0.05$).

There was significant difference in the mean WC between vegan and control group (81.2 ±13.0 vs 74.18 ± 7.14cm, $p < 0.05$). The prevalence of android obesity (WC ≥ 80 cm) in vegan group was higher than in control group (53.5% vs 20.6%, $p < 0.05$).

The prevalence of hyper ABP (SBP and/or DBP) in vegan group was higher than in control group (26.45% vs 11.8 %, $p < 0.05$). The average SBP in vegan group was higher than that in control group (120.9±19.50 vs 115.59 ± 17.22 mmHg, $p < 0.05$)

The prevalence of ABP ≥ 130/85 mmHg (metabolic syndrome) in Vegan group was higher than in control group (34.03 % vs 26.47 %, $p < 0.05$).

The average fasting glucose in Vegan group was higher than in control group (5.00 ±1.4 vs 4.67 ± 0.98 mmol/l, $p<0.05$). The prevalence of hyperglycemia (based on fasting glucose) in Vegan group was higher than in control group (13.2% vs 10.3%, $p < 0.05$).

There were significant differences in HbA1c levels between two groups. The average HbA1c in Vegan group was higher than in control group (5.9 ±0.9 vs 4.3 ± 0.90 %, $p < 0.05$).

The prevalence of hyperglycemia (based on HbA1c) in Vegan group was higher than in control group (45.1% vs 13.2%, $p < 0.05$); prediabetes was 34% in Vegan group and 10.3% in control group.

The average fasting insulinemia in Vegan group was higher than that in control group (6.9 ± 4.3 vs 5.55 ± 2.13 µU/ml, $p < 0.05$). The proportion of fasting insulin ≥ 12 µU/ml in Vegan group was 7.6%.

The average HOMA-IR index in Vegan group was higher than in control group (1.67±1.62 vs 1.16 ± 0.55, $p < 0.05$). The proportion of HOMA-IR ≥ 2.6 in Vegan group was higher than control group (9.7% vs 1.5%, $p < 0.05$).

The mean TC in vegan group was significantly lower than in control group (4.8±1.11 vs 5.31±1.32 mmol/l, $p < 0.05$). The proportion of TG (≥ 1.7 mmol/l) in Vegan group was significantly lower than in control group (43.8% vs 63.2%, $p < 0.05$). The proportion of LDL.C (≥ 3.4 mmol/L) in Vegan group was significantly lower than in control group (20.1% vs 41.1. $p < 0.05$).

The average HDL.C in Vegan group was significantly lower than in control group (1.2 ± 0.2 vs 1.35 ± 0.39 mmol/l, $p < 0.05$). The proportion of HDL-C (< 1.3 mmol/L) in Vegan group was significantly higher than in control group (60.4 % vs 45.59%, $p < 0.05$).

The mean non-HDL.C in Vegan group was significantly lower than in the control group (3.6 ± 1.00 vs 3.97 ± 1.20 mmol/l, $p < 0.05$). The proportion of non-HDL.C (≥ 3.4 mmol/L) in Vegan group was significantly lower than in control group (50.7% vs 67.65 % $p < 0.05$).

The average IMTc in Vegan group was thinner than in control group (0.64 ± 0.39 mm vs 0.73 ± 0.11 mm, $p < 0.05$).

The prevalence of MS (+) in Vegan group was significantly higher than in controls (31.35% vs 2.9%, $p < 0.001$).

2. The prediction of age appeared the cardio-metabolic risk factors in study groups.

Benefits of Vegan diet with respect to the prevalence of cardio-metabolic risk factors were studied by using the ROC curves for predicting the age cut-off points between Vegan group and control group to; BP (58 vs 52 years), TC (61 vs 44 years), LDL.C (62 vs 44 years), non-HDL.C (46 vs 35 years), LDL.C/HDL.C (46 vs 39 years), CIMT (61 vs 56 years), respectively. Vegan diet seems to be disadvantageous towards prediabetes (43 vs 49 years), HOMA-IR (44 vs 68 years), TG (43 vs 53 years), hsCRP (50 vs 57 years) and MS (44 vs 68 years).

3. The relationship between duration of vegan diet and the cardio-metabolic risk factors with predicted values in Vegan females.

BMI was 20 yrs, WC was 30 yrs, SPB was 40 yrs, Hyper SBP and / SDP was 41 yrs, IMTc was 40 yrs, IHD (+) was 28 yrs, CRP was 49 yrs.

Prediabetes was 18 yrs and diabetes was 42 yrs, IR was 22 yrs.

Dyslipidemia: TC was 29 yrs, TC was 27 yrs, decrease HDL.C was 27 yrs, increase LDL.C was 44 yrs and atheroclerosis was 18 yrs.

MS (+) was 30 yrs.

There were correlations between duration of vegan diet and cardio- metabolic risk factors including BMI ($r = 0.374$), WC ($r = 0.411$), SBP ($r = 0.539$), FG ($r = 0.312$), HbA1c ($r = 0.403$), lipid profile ($r = 0.307$ - 0.525), hsCRP ($r = 0.486$) and IMTc ($r = 0.463$), in which the duration of vegan diet was considered as an independent risk factor for hyperglycemia.

Conclusions: A decrease in multiple cardio-metabolic risk factors such as BP, TG, LDL.C, non-HDL.C, LDL.C/HDL.C and cIMT… was associated with vegetarian diet in female subjects. However, a long-term Vegan diet could increase metabolic syndrome (obesity, hyperglycemia, hypertension, insulin resistance, decreased HDL) in this population. These problems required an urgent need for greater public awareness on risk factors that correlated with the duration of vegan diet.

1. INTRODUCTION

1.1. HISTORY OF THE METABOLIC SYNDROME

According to a group of researchers [11]:

- In 1920s - Kylin first described the clustering of hypertension, hyperglycemia. Nicolae Paulescu, speaking about obesity and diabetes, said "most frequently, the obese people become glycosuria as if the two affections (obesity and fat diabetes) represent two consequent phases of the same pathological process" [4].

- In 1927, Maranon, in Spain, explicitly described the fact that the arterial hypertension is a pre-diabetical stage and this concept is similarly applied to obesity [15].

- In 1947,Vague also drew the attention to upper body adiposity (android or male-type obesity) as a metabolic abnormality commonly associated with type 2 diabetes and cardiovascular diseases [16] [17].

- In 1965, Yalow and Berson developed insulin assay and correlated insulin levels and glucose lowering effects in resistant and non-resistant individuals [21].

- In 1965, Vogaro et al., and then Haller et al in 1977 the frequent simultaneous presence of obesity, hypertension, diabetes and hyperlipidemia in association with atherosclerosis [11].

- Ten years later, in 1988. Reaven suggested that insulin resistance was a fundamental "disorder" associated with a set of metabolic abnormalities which not only increased the risk of type 2 diabetes but also contributed to the development of cardiovascular disease before the appearance of hyperglycemia [18-19]. He emphasized that insulin resistance was at the centre of a cluster of metabolic abnormalities, which include hypertriglyceridemia, low LDL.C level, increased glycemia, and elevated BP [13]. A later key conceptual advance was the recognition of the central role of abdominal obesity [20] in the diagnosis of the metabolic syndrome, and its introduction as a clinically easy-measurable entity.

1.1.1. Definition of metabolic syndrome and cardio metabolic syndrome

Metabolic syndrome was called by other names such as: Syndrome X, Cardiometabolic Syndrome, Cardiovascular Dysmetabolic Syndrome, Insulin-Resistance Syndrome, Metabolic Syndrome, Beer Belly Syndrome, and Reaven's Syndrome.

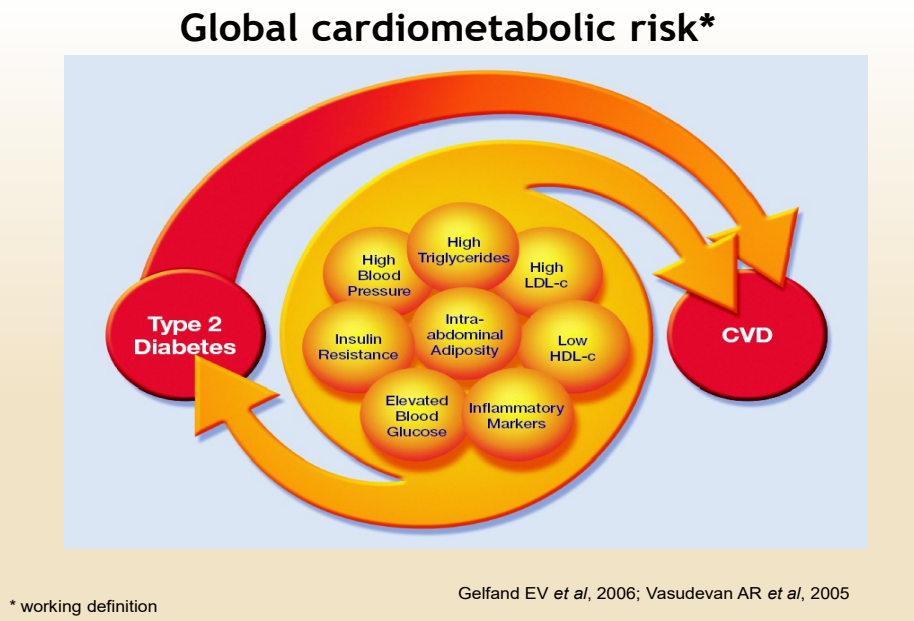
1.1.1.1.Metabolic syndrome (MetS)

Metabolic syndrome is a name for a group of risk factors and combination of medical disorders that can increase your chance of developing heart disease, diabetes, and stroke. These risk factors include: Elevated blood pressure, Impaired glucose tolerance, Insulin resistance, Abdominal obesity, elevated triglyceride levels and low LDL.Cs. Each of the associated conditions has an independent effect, but clustering together they become synergistic, making the risk of developing cardiovascular disease (CVD) greater. This article reviews the evidence that demonstrates that individuals with the MetS are at increased risk for CVD incidence and mortality and discusses these debated issues [23].

1.1.1.2.Cardiometabolic syndrome

Cardiometabolic syndrome (CMS), also known as insulin resistance syndrome or metabolic syndrome X, a combination of metabolic disorders or risk factors that essentially includes a combination of diabetes mellitus, systemic arterial hypertension, central obesity and hyperlipidemia. Common to these diseases of metabolism is associated development of atherosclerotic cardiovascular disease (ASCVD). Studies have shown a strong link between CMS and increased prevalence of peripheral vascular diseases, coronary artery disease and myocardial infarctions as well as cerebro-vascular arterial diseases and stroke [5,22].

Fig 1.1.Global Cardiometabolic risks



We have understood for decades the roles of 'classical' risk factors - elevated LDL.Cl, hypertension, elevated blood glucose and smoking in the pathogenesis of cardiovascular disease. Abdominal obesity is associated with multiple cardiometabolic risk factors such as atherogenic elevated blood glucose (hypertriglyceridaemia and low HDL.C), elevated blood glucose and inflammation, which are major drivers of cardiovascular disease and type 2 diabetes. In addition, atherosclerosis is increasingly regarded as an inflammatory condition.

Evaluation criteria of metabolic syndrome according to IDF 2006 (International Diabetes Federation) [85].

Three or more of the following:

1. Abdominal obesity: waist > 40" for men, >35" for women
   (Asia: WC male ≥ 90 cm and female ≥ 80 cm)
2. High triglycerides: >150 mg/dL (1.7 mmol/l)
3. Low HLD.C:

< 40 mg/dL male (1.03 mmol/l), < 50 mg/dL women (1.29 mmol/l)

4. High blood pressure: >130 systolic or > 85 diastolic (mmHg)
5. High fasting plasma glucose: >100 mg/dL (5.6 mmol/l)

Risk factor for cardiovascular disease and glucose intolerance

Malik and colleagues demonstrated that the cardio metabolic risk factors associated with metabolic syndrome increase the CVD mortality rate. Relative to an individual with no metabolic syndrome risk factors, having 1 to 2 risk factors increased a patient's hazard ratio by more than 70%. Persons with metabolic syndrome (having ≥ 3 of the 5 risk factors) were found to have a hazard ratio of 2.71. The ratio increased with the onset of type 2 diabetes, CVD, and was greatest in persons with existing CVD and T2DM [1].

1.2. GLOBAL CARDIOVASCULAR RISK FACTORS AND MORTALITY

CVD are an emerging public health problem in developing countries that CVD has been an important health issue in developed countries for some decades, while in developing countries it has often not been seen as a major problem compared with communicable diseases and malnutrition [29]. The CVD epidemic is decreasing as a result of major efforts to identify risk factors and implement interventions [30]. Meanwhile, in many developing countries, CVD and related

risk factors are emerging as increasingly important public health problems [31-39]. CVD is the term used by the scientific community to embrace not just conditions of the heart (coronary artery, valvular, muscular, and congenital disease), but also hypertension and conditions involving the cerebral, carotid and peripheral circulation [40].

1.2.1. The prevalence of CVD in United States

Heart disease has been the leading cause of death in the United States for the past 80 years and is a major cause of disability.

- In 1995: the leading cause of death in US women was heart disease, which has been the leading cause of death for the past 50 years [24].

- In 1998: estimated direct and indirect costs of heart disease were $95.6 billion, and 53.3 million adults had elevated LDL-C and warrant intervention (1994 NHANES data); 22.3 million qualified for drug therapy and 5.5 million received therapy [25].

- In 2005: cardiovascular heart disease (CHD) was the single largest killer of men and women (Monthly Vital Statistics Report: MV). Each year 1.1 million people have myocardial infarction (MI); 370.000 die of MI, 250.000 die within 1 hr. By age 60, every 5^{th} man and 17^{th} woman develops CHD [26].

1.2.2. Cardiovascular disease epidemiology in Asia

CVD is the leading cause of death in the world and half of the cases of CVD are estimated to occur in Asia. Compared with Western countries, most Asian countries, except for Japan, South Korea, Singapore and Thailand, have higher age-adjusted mortality from CVD. Hypertension and smoking are the most notable risk factors for stroke and coronary artery disease, whereas dyslipidemia and DM are risk factors for IHD and ischemic stroke [27].

1.2.3. In Viet Nam

The probability of dying between ages 30 and 70 years from the 4 main NCDs is 17%. Adult risk factors included raised blood pressure (2008) affecting 20.5% females in total 23.1%, and obesity (2008) 2.1% females in total 1.7%.

The World Health Organization (WHO) defines CVD as disorders of the heart and blood vessels, including hypertension, heart failure, stroke, myocardial infarction, coronary artery disease and atherosclerosis.

The World Heart Federation (WHF) forecast that up to 20 percent of Vietnam's population will suffer heath problems caused by cardiovascular diseases and hypertension by 2017. In addition to this, a recently conducted study [42] found that the prevalence of overweight and obesity in adults is 6.4% in Ho Chi Minh City.

1.3. THE PREVALANCE OF DIABETES AND MORTALITY

1.3.1. In United States

By the year 2025, it is estimated that nearly 22 million adults in the United States will have diabetes. The most common form - type 2 diabetes - accounts for 90% to 95% of all diagnosed cases, whereas type 1 diabetes accounts for 5% to 10% of all diagnosed cases. In some studies, in nearly 40% of women who had gestational diabetes, diabetes later developed [43].

1.3.2. In the South – East Asia

Close to one-fifth of all adults with diabetes in the world live in the South-East Asia Region. Current estimates indicate that 8.3% of the adult population, or 71.4 million people, have diabetes in 2011. 61.3 million of whom are in India. The number of people with diabetes in India, Bangladesh and Sri Lanka makes up 99% of the total for the region

1.3.3. The prevalence of mortality in Asia

The region has the second highest number of deaths attributable to diabetes of any of the seven IDF. 16 regions with 1 million deaths in 2011. This represents 14.5% of all deaths for the region among adults. More than half (55%) of these deaths occur in people under the age of 60 and almost a third (27%) under the age of 50. India is the largest contributor to regional mortality with 983.000 deaths attributable to diabetes [44].

1.4. THE CARDIO-METABOLIC RISK FACTORS

1.4.1. Overweight and Obesity

All of us love to have a well-built bodies, or at least not to be obese, and we have right to think like that, because obesity is not just a cosmetic concern, it is also a risk for some health problems, such as heart disease, diabetes and the high blood pressure and others. That is, one of the most common problems related to lifestyle today is being overweight. Obesity and overweight are serious problems that pose a huge and growing financial burden on national resources.

1.4.1.1. Definition of Overweight and Obesity by WHO [50]

✍Overweight and obesity are defined as abnormal or excessive fat accumulation in the fat tissues (adipose tissue) of body that presents a risk to health.

✍Body weight depends on the balance between food intake and utilization of food in the body [54]. Obesity may result when food intake exceeds the utilization of energy.

✍**BMI:** the most commonly used measure for overweight and obesity is BMI - a simple index to classify overweight and obesity in adults. The range that is considered "normal" or healthy weight depends upon a person's height. It is natural for taller people to weigh more. BMI stands for Body Mass Index. It is a number that is calculated based on both the height and weight to determine if the weight is high or low compared with what you would expect for that height. BMI is an indicator of body fatness, and is used as a screening tool for weight issues.

It is defined as the weight in kilograms divided by the square of the height in meters (kg/m^2).

BMI = Weight (kg) / [Height sq. (m^2)]

1.4.1.2. Differences between overweight and obesity

The term overweight is generally used to indicate the excess weight while obese refers to excess fat. Being overweight means having more body weight than is considered normal or healthy for one‘s age or build. On the other hand, Obesity is the condition of being obese, i. e., excess amount of body fat. While an overweight person will carry excess weight, he may or may not have excess accumulation of fat.

1.4.1.3. Causes of overweight and obesity

Our daily bodies activities need energy come from food we eat and more exercise and activities burn more calories that we get from food. And not just the activities need to burn calories also many metabolic reactions in the body need, such as to warm up in cold weather and to sweat in hot days. But when our food calories amount exceeds the body need, they will be stored in the body as fatty. The major causes of obesity are excessive food energy intake and lack of physical activity. A limited number of cases are due primarily to genetics, medical reasons, or psychiatric illness [52]. In contrast, increasing rates of obesity at a societal level are felt to be due to an easily accessible and palatable diet [53].

The causes of obesity is a combination of stated factors that work together to store more fat in our bodies and these factors include:

1. Inactivity: without activity you do not burn as much calories.

2. Diets: some bad eating habits like high calories diet epically in the night, or skipping breakfast healthy and replace it by junk fast food, all of that increase the body fat.

3. Pregnancy at a later age

4. Insufficient sleep: this cause disturbances in the body hormones and increase the appetite.

5. Increase in the use of medications that can cause weight gain (e.g., a typical antipsychotics)

6. Endocrine disruptors (environmental pollutants that interfere with lipid metabolism),

7. Proportional increases in ethnic and age groups that tend to be heavier

8. Genetics, environmental and social, as well as several other factors can all contribute to obesity and family lifestyle.

9. Proportional increases in ethnic and age groups that tend to be heavier: could occur at any age, and when we get age we lose more amount of muscles built. More amount of muscles gives higher rate of metabolism and calories burning. When we lose them we will reduce the calories burning and tend to fill the body with fat. And there is a decrease in energy expenditure, particularly in the 50- to 65-year-old age group. In those 65 years of age and older, hormonal changes that occur during aging may cause the accumulation of fat. Aging is associated with a decrease in growth hormone secretions, reduced responsiveness to thyroid.

1.4.1.4. The prevalence of overweight and obesity in some countries

- In USA:

Urbanization and economic development have led to a nutritional transition characterized by a shift to diet of higher energy content and reduction of physical activities, resulting in changes individual body composition [46]. Over 1.6 billon adults worldwide are overweight, of which 400 million are obese with higher rates among women than in men. Obesity also increases with age at least up to 50 or 60 years [48]. The World Health

Organization (WHO) projects that more than 700 million adults will be obese by 2015. The prevalence of overweight and obesity is rapidly increasing in developing as well as industrialised countries [47].

- In Asia:

Prevalence rates of overweight and obesity in Asia Pacific countries are rising, compared to Australia, UK, New Zealand and USA, 2008. For example, between 1980 and 2013.China's overweight and obesity prevalence in adults rose from 11.3% to 27.9% and in individuals below age 20 from 5.7 % to 18.8 % [51].

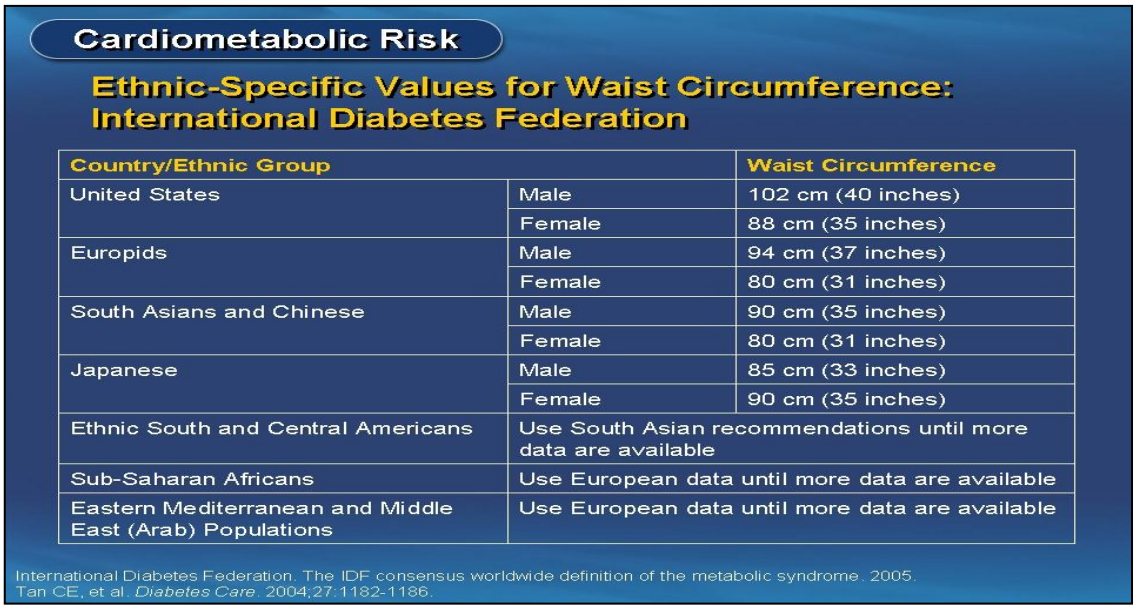
1.4.2. Waist circumference (Central obesity)

WHO Expert Consultation on WC and WHR was held in Geneva, Switzerland on 8–11 December 2008 and chose WC to be used as an indicator of abdominal obesity and is associated with the cardiovascular diseases and type 2 diabetes [76a].

1.4.2.1. WC is Pathophysiology of Metabolic Syndrome

Abdominal obesity and MS: contribution to Global Cardio metabolic Risk factors. In central obesity excess macronutrients are ingested and energy is always in over-supply. Not only are lipids unable to be accommodated and oxidised in a timely manner in the body's cells, but glucose uptake is also compromised. The pancreatic β-cells increase the tonic insulin production to increase the transport of glucose into cells as glycogen storage molecules in the liver.

Fig 1.2.Values for waist circumference



Country/Ethnic Group		Waist Circumference
United States	Male	102 cm (40 inches)
	Female	88 cm (35 inches)
Europids	Male	94 cm (37 inches)
	Female	80 cm (31 inches)
South Asians and Chinese	Male	90 cm (35 inches)
	Female	80 cm (31 inches)
Japanese	Male	85 cm (33 inches)
	Female	90 cm (35 inches)
Ethnic South and Central Americans	Use South Asian recommendations until more data are available	
Sub-Saharan Africans	Use European data until more data are available	
Eastern Mediterranean and Middle East (Arab) Populations	Use European data until more data are available	

Excess intra-abdominal adipose (IAA) typically is accompanied by elevated levels of CRP and FFAs, as well as decreased levels of adiponectin. 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. There is substantial evidence of sex and age variations in WC and WHR and some evidence for ethnic differences. It also highlighted the need for other indicators to complement the measurement of BMI, to identify individuals at increased risk of obesity-related morbidity due to accumulation of abdominal fat [75]. WHR (i.e. the waist circumference divided by the hip circumference) was suggested as an additional measure of body fat distribution. The ratio can be measured more precisely than skin folds, and it provides an index of both subcutaneous and IAA [73]. A way to measure fat distribution is the circumference of the waist [2]. WC is unrelated to height and provides a simple and practical method of identifying overweight people who are at increased risk of obesity-related conditions. If waist circumference is greater than 94-102 cm for men and 80-88 cm for women, it means they have excess abdominal fat, which puts them at greater risk of health problems, even if their BMI is about right [64].

1.4.2.2. Relationships between IAA and increased cardio metabolic risk

IAA is a major contributor to increased cardio metabolic risk facors. The classical CVD risk and waist markers of the MetS are very useful concepts which have made clinicians and researchers aware of the importance of central obesity. The prevalence of insulin resistance in obese with abdominal fat accumulation was higher ($p < 0.05$) compared to obese with global fat (52.6 vs 28.6 %), respectively [63].

1.4.3. Insulin resistance and type 2 diabetes

1.4.3.1. Definitions of Diabetes and Impaired Fasting Glucose

Diabetes is defined as group of diseases characterized by high blood glucose concentrations resulting from defects in insulin secretion, insulin action, or both. It can be defined as an impaired response to the physiological effects of insulin, including those on glucose, lipid, and protein metabolism, and the effects on vascular endothelial function [77].

Diabetes Type 2 Pathophysiology

■ Results from a combination of insulin resistance and β-cell failure

Insulin resistance: decreased tissue sensitivity or responsiveness to insulin

Endogenous insulin levels may be normal, depressed, or elevated, but inadequate to overcome insulin resistance

Diabetes Type 2 Risk Factors

Family history of diabetes, Older age, Obesity, particularly intra-abdominal obesity, Physical inactivity, Prior history of gestational diabetes, Impaired glucose homeostasis, Race or ethnicity

Prediabetes (Impaired Glucose Homeostasis) [82]

■ Impaired fasting glucose (IFG)

Fasting plasma glucose (FPG) above normal (>100 mg/dl and < 126 mg/dl)

■ Impaired glucose tolerance (IGT)

Plasma glucose elevated after 75 g glucose load (>140 and < 200 mg/dl)

• New ADA definition (1998) defines fasting blood sugar of > 126 mg/dl as diabetes, casual blood glucose > 200 mg/dl. Impaired fasting glucose is 110-125 mg/dl

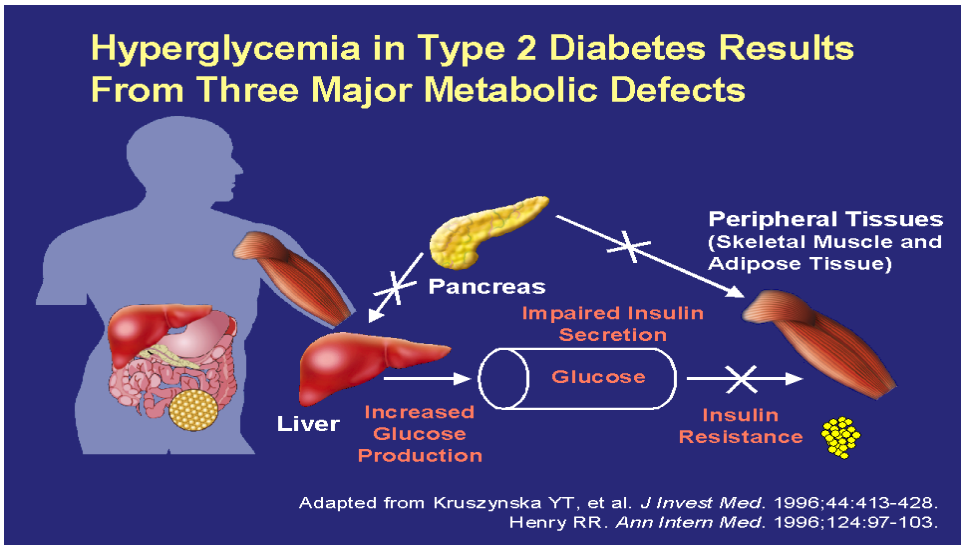
• Diabetic control generally defined as HbA1c < 8%.

• BP recommended < 130/80 mmHg, LDL.C goal < 100 mg/dl

1.4.3.2. Hyperglycemia in type 2

The macronutrients are composed of (1) CHO subgroups, starches and sugars (2) lipids (fats), and (3) protein; of which the latter is not usually ingested primarily for energy.

Fig 1.3: Hyperglycemia mechanism in type 2



Three major metabolic defects contribute to hyperglycemia in patients with type 2 diabetes: increased hepatic glucose production, impaired pancreatic insulin secretion, and peripheral tissue insulin resistance.

After eating a meal or ingesting glucose, insulin is secreted, hepatic glucose output is suppressed, and insulin-dependent glucose uptake by peripheral tissues is stimulated. In type 2 diabetes, insulin resistance and impaired insulin secretion inhibit normal suppression of hepatic glucose output. As a consequence, the liver continues to release glucose into the circulation.

This finding supports the idea of Stern and [62] which reported that central obesity has been associated with hyperinsulinemia and it has been suggested that the over production of insulin may act as an energy conserving mechanism under conditions of periodic famine and low energy intake.

The health consequences of obesity and overweight are many and varied, ranging from an increased risk of premature death to several non-fatal but debilitating and psychological complaints that can have an adverse effect on quality of life [55].

Women who are obese are more than 12 times more likely to develop Type 2 diabetes than women of healthy weight. The risk of Type 2 diabetes increases with BMI, especially in those with a family history of diabetes, and decreases with weight loss [56].

There is an age-related increase in total body fat and visceral adiposity until age 65 that is often accompanied by diabetes or impaired glucose intolerance (Wilson et al, 2007). In the Framingham Study 30-40% of people over 65 were found to have diabetes or glucose intolerance.

1.4.3.3. Insulin resistance

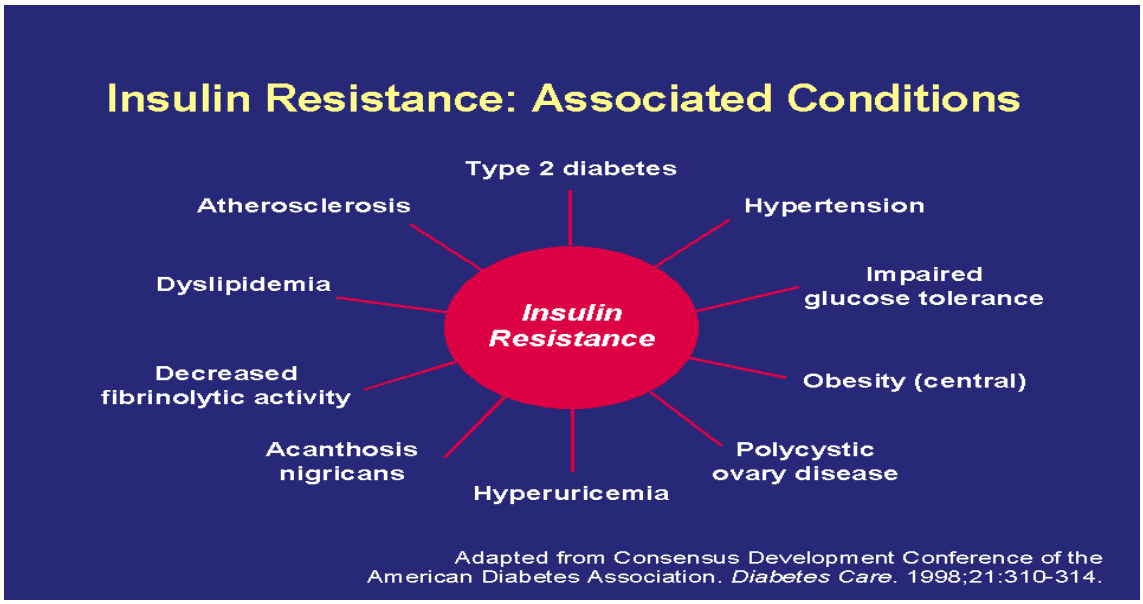
Insulin is a hormone made by your pancreas. It allows your cells to use glucose (sugar) for energy. People with insulin resistance have cells that don’t use insulin effectively. This means the cells have trouble absorbing glucose, which causes a buildup of sugar in the blood. If your blood glucose levels are higher than normal, but not high enough to be considered type 2 diabetes, you have a condition called prediabetes. Insulin resistance may also damage your blood vessels without you realizing it. This can increase your risk of heart disease and stroke. Insulin resistance is a primary defect in type 2 diabetes. As reported in a recent study by Haffner and colleagues, 92% of patients with type 2 diabetes have insulin resistance. Overweight and Obesity are known Risk Factors For Major Diseases.

1.4.3.4. Relationship between WC and IR

In addition to type 2 diabetes, IR is associated with the development of a broad spectrum of clinical conditions. These include hypertension, atherosclerosis, dyslipidemia, decreased fibrinolytic activity, impaired glucose tolerance, acanthosis nigricans, hyperuricemia, polycystic ovary disease, and obesity. The high prevalence of IR among women mainly those aged 40 - 49 years as shown in this study can be explained by the role of central obesity, a high percentage of fat and the strong sedentary lifestyle of women in Cameroon. Central obesity is associated with insulin resistance and elevated levels of FFAs. As illustrated, FFAs can reduce insulin-mediated glucose disposal under experimental conditions. This enzyme catalyzes the removal of lipids from LDL and HDL, which makes them smaller and more dense. In turn, these effects lead to hypertriglyceridemia, production of small, dense LDL particles, and reduced HDL_2-cholesterol levels. This dyslipidemic pattern, which has been termed the atherogenic lipoprotein phenotype, is also characteristic of that found in type 2 diabetes [79]

Excess IAA increases overall cardio metabolic risk partially through alterations in the secretion of a series of biologically active molecules (adipokines). These include increased secretion of free fatty acids which can induce insulin resistance in muscle and ß-cell toxicity in the pancreas, inflammatory mediators, such as TNF, IL-6.resistin and PAI-1. and decreased secretion of the cardioprotective adipokine, leptin that contribute to insulin resistance [49].

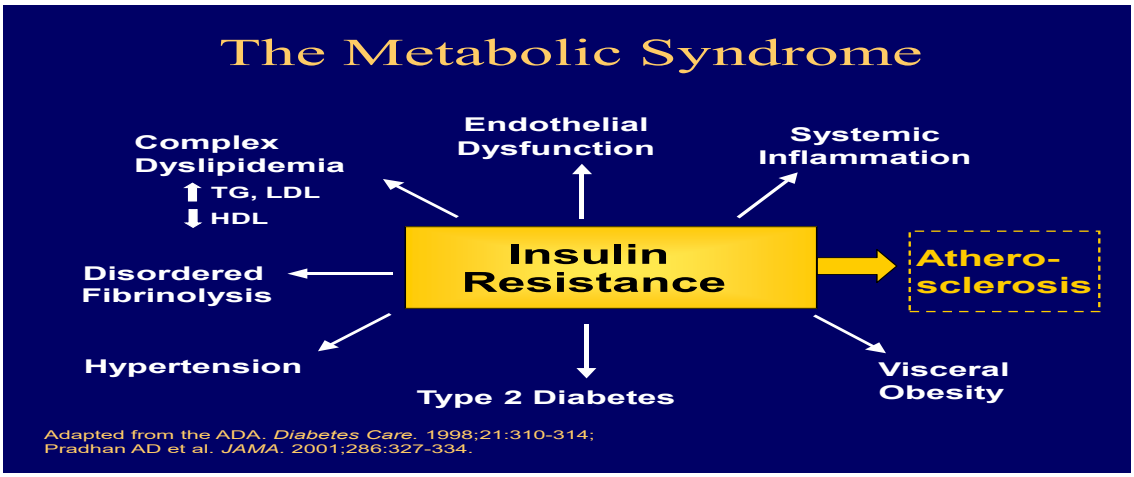
Fig 1.4.Associated conditions to Insulin resistance



Obesity predisposes an individual to a number of cardiovascular risk factors, including hypertension and elevated blood cholesterol. In women, obesity is the third most powerful predictor of CVD after age and blood pressure [57].

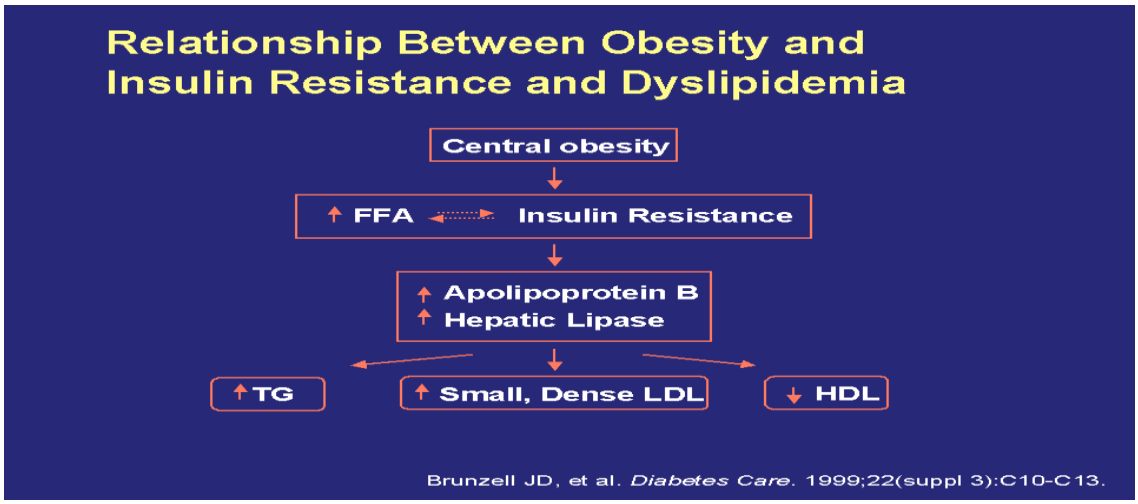
In addition to type 2 diabetes, insulin resistance is associated with the development of a broad spectrum of clinical conditions. These include hypertension, atherosclerosis, dyslipidemia, decreased fibrinolytic activity, impaired glucose tolerance, acanthosis nigricans, hyperuricemia, polycystic ovary disease, and obesity [80].

Fig 1.5.Atherosclerosis Mechanism



Insulin resistance is a precursor to a variety of metabolic abnormalities, including systemic inflammation, visceral obesity, and type 2 diabetes. Insulin resistance is also a risk factor for cardiovascular abnormalities, including hypertension, dyslipidemia (increased triglycerides and LDL and decreased HDL), disordered fibrinolysis, and endothelial dysfunction. All of these aberrations contribute to the atherosclerotic process [81].

Fig 1.6.Relation between obesity and IR and Dyslipidemia



1.4.4. High cholesterol and triglycerides

The relevance of plasma triglyceride levels as a CHD risk marker has been debated for decades [87] although some recent studies have suggested that no fasting triglycerides concentrations may be a useful marker of risk [88].

Obese individuals are more likely to have elevated blood triglycerides (blood fats), low LDL.C ("bad cholesterol") and decreased high HDL.C (“good cholesterol”). A 10 kg weight loss can produce a 15% decrease in LDL cholesterol levels and an 8% increase in HDL cholesterol [58].

1.4.4.1. Elevated FFA levels: play a significant role in the cause of IR and β-cell dysfunction. 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, hypertriglyceridemia and low HDL-cholesterol have been shown to be associated with low plasma adiponectin concentrations. All of these components help to explain why excess abdominal adiposity is considered to be a great threat to cardiovascular and metabolic health. A proxy marker for which is waist circumference (waist), has been shown to increase risk for CVD. Hypertension or raised systolic and diastolic blood pressure (S/DBP), serum dyslipidemia, namely decreased high density lipoprotein cholesterol (HDL.C) and raised triglyceride (TG), and impaired fasting plasma glucose (FPG) or FPG in the type II diabetes mellitus (TIIDM) range, are conditions which commonly occur together.

1.4.4.2. Dysregulation of Lipid and Glucose Metabolism

The abundance of stored fat is required for survival during nutritionally deprived states such as starvation. However, very efficient fat storage results in

the excessive storage of fat, eventually resulting in obesity (Speigelman et al., 2001; Ravussin et al., 1989; Seeley et al., 2003). The release of these excessive free fatty acids then incites lipotoxicity, as lipids and their metabolites create oxidant stress to the endoplasmic reticulum and mitochondria. This affects adipose as well as nonadipose tissue, accounting for its pathophysiology in many organs, such as the liver and pancreas, and in the metabolic syndrome [59].

The FFAs released from excessively stored triacylglycerol deposits also inhibit lipogenesis, preventing adequate clearance of serum triacylglycerol levels that contribute to hypertriglyceridemia. Release of FFAs by endothelial lipoprotein lipase from increased serum triglycerides within elevated β lipoproteins causes lipotoxicity that results in insulin-receptor dysfunction. The consequent insulin-resistant state creates hyperglycemia with compensated hepatic gluconeogenesis. The latter increases hepatic glucose production, further accentuating the hyperglycemia caused by insulin resistance. Free fatty acids also decrease utilization of insulin-stimulated muscle glucose, contributing further to hyperglycemia (Pan et al., 1997; Boden et al., 1994). Lipotoxicity from excessive free fatty acids also decreases secretion of pancreatic β-cell insulin, which eventually results in β-cell exhaustion (Unger et al., 1995).

1.4.4.3. Atherosclerosis

As lipids are transported in the blood as lipoproteins, among them, serum HDL is responsible for reverse Transportation, specifically for carrying cholesterol from tissues back to the liver [2] and thus, acts as an anti-atherosclerotic factor. On the other hand, LDL, the chief pathogenic factor for atherosclerosis, drives cholesterol to the peripheral tissues. Since vegetable diets contain less saturated fat and cholesterol, and greater amounts of dietary fiber, their consumptions help to lower the level of serum cholesterol. Results of our study suggest that vegetable-based diets lower both atherogenic lipoproteins as LDLcholesterol and non-atherogenic lipoproteins as HDL lipoprotein, with potentials to reduce the risk of developing microvascular diseases. Vegetarians consume whole grains, soybeans, and nuts [3], all of which have significant cardio-protective effects, and reduce overall incidence of stroke, as well as risk of deaths from stroke and ischemic heart disease [7]. Elevated serum atherogenic lipoproteins and their higher ratios due to various vasoprotective lipoproteins are primary risk factors for atherosclerotic

changes with increased risk of micro vascular diseases [8]. Higher TC, LDL.C and TG, and higher ratio of LDL: HDL and lower serum HDL.C increase the risk of coronary heart disease, and are considered major risk factors beside smoking and hypertension [9].

1.4.5. C-reactive protein (CRP)

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. CRP are considered to be predictive of cardiovascular disease and insulin resistance.

The progressive pro-inflammatory state resulting from increased obesity that promotes IR also perpetuates atherogenesis throughout its development, from early endothelial fatty streaks to late-plaque formation, rupture, and thrombosis. Endothelial modulators such as vasoactive endothelial growth factor (Ferrara et al., 1997), angiotensinogen, renin, and angiotensin II are secreted by white fat cells, in particular by perivascular fat tissues that contribute to vasomotor dysfunction and cause hypertension and endothelial injury. This activity causes atheroma cap thinning and plaque rupture that precipitates release of the tissue factor, also promoting intravascular thrombosis**.**

1.4.6. Cardiovascular disease, obesity and hypertension risk factors

Cardiovascular disease (CVD) includes coronary heart disease (CHD), stroke and peripheral vascular disease. These diseases account for a large proportion (up to one third) of deaths in men and women in most industrialised countries and their incidence is increasing in developing countries.

Hypertension or high blood pressure. Hypertension can lead to premature atherosclerosis, coronary artery disease, heart attacks, abnormally large hearts and strokes. Obesity may blunt certain actions of insulin that open blood vessels and may cause structural changes in the kidney and abnormal handling of sodium.

Obesity-related hypertension also is commonly associated with other elements

of the metabolic syndrome (in the aggregate often shown to be a cardiovascular risk factor), such as insulin resistance and glucose intolerance. The hypertension effect of blood lipid levels not effectively mitigated by drugs can contribute to a higher mortality rate from CHD. Furthermore, obesity as a significant risk factor for diabetes also increases cardiovascular risk through diabetes.

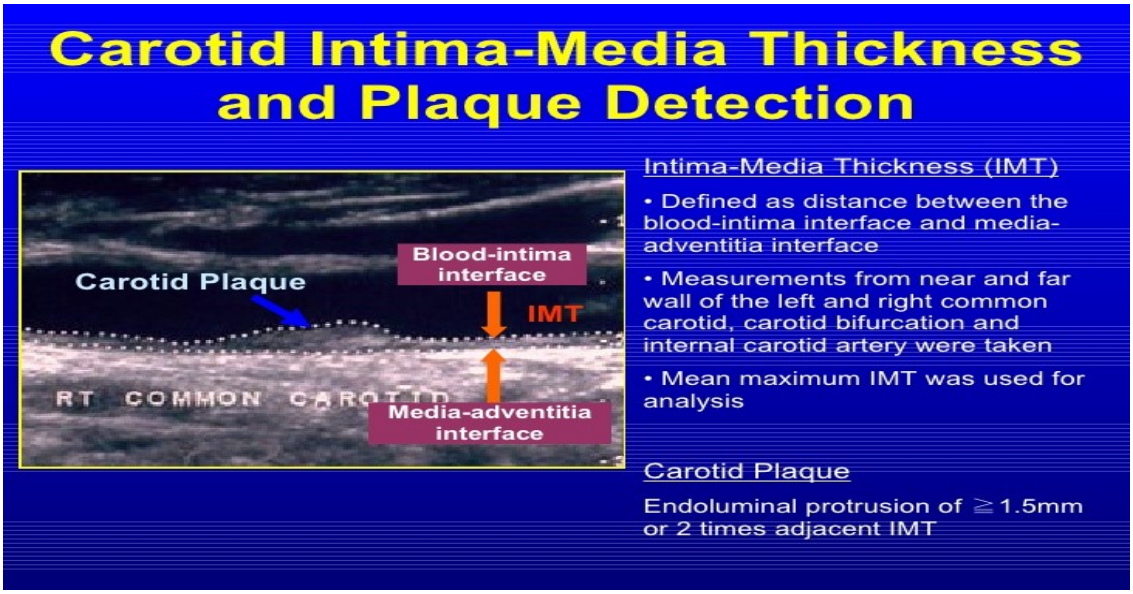
The prevalence of hypertension in overweight individuals is nearly three times higher than in non-overweight adults and the risk in overweight individuals aged 20-44 years of hypertension is nearly six times greater than in no overweight adults.

1.5. ROLE OF ULTRASOUND ECHOGRAPHY IN DETECTION OF ATHEROSCLEROSIS

Ultrasound is widely used to evaluate atherosclerosis, for the assessment the risk of cardiovascular disease in healthy persons and in persons with cardiovascular risk factors. [72] Three markers of vascular disease may help to a better evaluation of vascular dysfunction in type 2 DM and IMTc, arterial stiffness, assessed by PWV, and endothelial function, evaluated through the brachial artery (FMD). [86,51,61] Among these parameters, IMTc is considered a marker of structural vessel wall properties, and arterial stiffness reflects functional wall properties. Endothelial dysfunction is a systemic process who appear in the coronary circulation as in the systemic circulation. IMTc and brachial artery FMD are affected in diabetes mellitus, and they are risk marker of atherosclerotic cardiovascular disease. IMTc incresed in patients with type 2 DM and other independent risk factors, such as: age, hyperlipidaemia, and duration of DM. The patients with DM have shown increased arterial stiffness, with reductions in FMD which has already been reported to be inversely and strongly related to the extent of hyperglycemia [86].

In the early stage of atherosclerosis, the functional parameters, as FMD are helpful in the assessment of cardiovascular risk to the patients with cardiovascular risk factors [41]. The increased IMTc and the altered FMD are related with the presence and the degree of coronary atherosclerosis [71].

Fig 1.7.Carotid intima media thickness and plaque detection



1.6. VEGAN DIET

1.6.1. Introduction of vegetarian diets

Nowadays, the movement vegetarian diet is very popular not only in Viet Nam but also over the world because there are health benefits such as better for heart, decrease obesity and hypertension, anticancer diseases, lower cholesterol levels, diabetes. A diet high in saturated fats (e. g. cheese) and trans fats (often used in cakes, cookies and fast food) leads to high levels of cholesterol.

Excess insulin is the second problem. Insulin is a major hormone in the body, and is released in high levels anytime you ingest what would be considered a “simple” carbohydrate which would include, but not be limited to: fruit juice, white bread, most “wheat” bread (basically white bread with a little extra fiber), white rice, baked white potato, bagels, croissants, pretzels, graham crackers, vanilla wafers, waffles, corn chips, cornflakes, cake, jelly beans, sugary drinks, Gatorade, beer, and anything that has high fructose corn syrup on the nutritional label. Two actions occur when the insulin levels are spiked. First, the body’s fat burning process is shut down so that the sugar that has just been ingested can be immediately used for energy. Then, insulin takes all that sugar and puts it into your muscles. Well, not quite! Actually, most of us, except those random Ironman triathletes and 8000-calories-per-day exercisers, walk around with fairly full energy stores in the muscles. As soon as the muscles energy stores are full, the excess sugars are converted to fat and, just like the fatty acids released from the liver, stored as adipose tissue on our waistline.

1.6.3. Classification of vegetarian diet

Vegetarian is a broad term, used to describe a person who refrains from eating any form of meat, poultry or seafood. There are different kinds of vegetarian diets but we divided into two main groups:

Vegetarian diet (no meat or fish or any product made using any part of any animal, including fish and sea-creatures, but products derived from live animals are acceptable so dairy products such as milk, cream, cheese and eggs are included in the diet). This type of vegetarian diet is also called ovo-lacto-vegetarian - because eggs and milk products are acceptable.

Vegan diet: (no meat or fish or any product made using any part of any animal, including fish and sea-creatures, and also excluding any and all products derived from animals - so dairy products such as milk, cream, cheese and eggs are not eaten and other products produced by animals e. g. honey - because that is made by bees - are also unacceptable.)

1.6.4. Health concerns

Some studies have shown that there is not a large margin of difference between the health of vegán and non-vegetarians. In fact, certain studies have shown that vegan or vegetarians tend to be healthier than non-vegetarians, with lower levels of obesity, lower cholesterol levels, and a reduced risk of heart disease. These findings are attributed to the consumption of larger amounts of vegetables, whole grains, nuts and fruits, which substitute animal meat.

Table 1.1: Intakes of Protein, Fat, Carbohydrates, Cholesterol, and Fiber

Nutrient	No vegetarian	Lacto-ovo vegetarian	Vegan
Fat (% total calories)	34-38	30-36	28-33
Cholesterol (total grams)	300-500	150-300	0
Carbohydrate (% total calories)	< 50	50-55	50-65

Dietary fiber (total grams)/day	10-12	20-35	25-50
Protein (% total calories)	14-18	12-14	10-12
Animal protein (% total calories)	60-70	40-60	0

✍Total fat not too varied though non-vegetarians consume more saturated fat

Fiber consumption higher in vegetarians. The recommended daily amount of fiber is 25 grams for women and 38 grams for men

✍Vegan diet: consumed a mount of high carbohydrate. Some chronic diseases can be affected by a vegetarian diet such as obesity, heart diseases, cancer…

1.6.4.1. Health Benefits of Vegetarian Diet: obesity is a chronic disease and treatment requires long-term lifestyle changes body defends itself against weight loss. Thyroid hormone concentrations (BMR) drop during weight loss and make it more difficult to lose weight and activity of lipoprotein lipase increases making it more efficient at taking up fat for storage. Aim to prevention of obesity is easier than curingbalance energy in (take) with energy out (put), focus on improving food habits and focus on increased physical activities. So many people choose vegan diet or vegetarian diet. Because they bring benefits health. It can decrease Cardiovascular Hypertension, Cancer, Diabetes, Obesity, Kidney disease/ renal stones, Gallstones, Diverticular disease.

Cardiovascular:

✍Death from ischemic heart disease lower in vegetarians

✍Heart disease lowest in vegans

✍Lacto-ovo and vegans lower mean blood cholesterol

✍Vegetarian diets not low fat but lower in saturated fat, higher fiber, higher consumption of soy protein, higher intakes of antioxidants

Hypertension:

✍Lower blood pressure (systolic and diastolic),

✍Lower rates of hypertension.

✍Possible collective effect of beneficial compounds from plant foods.

Cancer:

✍Vegetarians have higher fiber intake; higher intake of phytochemicals and iso-flavones that have anticancer effects.

1.6.2. Vegan diet situation in Viet Nam

Vegetarian diet is one of the popular diet in Vietnam in particular and the European countries with Buddhist beliefs in general. There are several types of vegetarian diet while a vegan diet is one of them. This is a strict vegetarian diet consisting of foods of plant origin, does not contain lipid, protid of animals, dairy products eggs [65]. Their food consists of whole plant: tofu, vegetables, sprouts, fruits, cereals. Thus energy by bringing vegetarian diet mainly sugars and plant derived proteins. For many years, the world has had many works as Patricia K Johnston, Ricardo Trespidi, Harman SK, Mezzano, EllaH. Haddad, Milton G. Crane, Lisa Ann Rauma, Krajcovicova studies on vegetarian diet in short recorded some good results [66-69]. Especially, in the summit of the WDF (World Diabetes

Foundation) in Hanoi [70] announced in India with a vegetarian diet that is common in people with diabetes in the country leads the world with 31.7 million (2000) plans to increase 79.4 million (2030).

In Viet Nam, most of people often choose vegan diet and especially the Buddhist nuns are living at the pagodas. They like vegan diet because of their religious reasons than keeping their benefits health. However, with the long-term diet depending on the manner and the duration of vegan diet also have undesired effects in the process of health protection. Indeed on these objects if the vegan diet can cause the opposite effect to dyslipidemia is hypertriglyceridemia, the increase in this substance is the source of insulin resistance and CVD. Before previous two views about vegetarian, so I need to continue studying. Subjects previously studied only in a short time vegetarian diet. There has been extensive research into the nutritional adequacy of vegetarian diets, but less is known about the long-term health of vegetarians and vegans.

SOME RESEARCH VEGETARIANS

Although more recent studies of different diets. It is recognized in surplus or deficit are nutrients that affect your health, but do not have a study on how a research project about the vegetarian diet a complete disaster

- Research and body mass index:

Some studies have recognized this index in vegetarians than non vegetarians, while Harman SK [71], Alix E [78] found that a BMI between two groups no crucial differences.

- The study of blood pressure:

Some studies recognized vegetarians effectively reduce blood pressure, reduce cholesterol. According to SK Harman's systolic blood pressure did not differ vegetarians than non-vegetarians, but diastolic blood pressure of vegetarians is higher than that of non-vegetarians

-Pham Thi Lich (1995) in Ho Chi Minh City to study some indicators Lipids on vegetarian Buddhists in 5 years showed a lowering of plasma lipid components of these objects.

2. RESEARCH OBJECTIVES

The term “Cardio-metabolic Syndrome” is used to indicate a clinical entity of substantial heterogeneity, represented by the co-occurrence of hypertension, impaired glucose tolerance, atherogenic dyslipidemia, central fat accumulation, insulin resistance, as well as prothrombotic and inflammatory states [114]. This multiple metabolic and cardiovascular disorders clusters together in the same individual more often than might be expected by chance, leading to an increased probability of suffering from cardiovascular disease and type 2 DM [115, 116, 118,119,120,121].

Abdominal obesity is associated with multiple cardiometabolic risk factors such as hypertriglyceridaemia, low HDL.C, elevated blood glucose and inflammation, which are major drivers of cardiovascular disease and type 2 diabetes [114,115,116]. This number is set to increase rapidly, fuelled by the increase in obesity and diabetes epidemics [124]. The pathogenesis of the metabolic syndrome is complex and so far incompletely understood but the interaction of obesity, sedentary lifestyle, dietary, environmental and genetic factors are known to contribute to its development [111,112, 113]. One important justification cited for the utility of the syndrome is that it changed medical perspective from a single-risk factor to the multiple-risk factors paradigm [122,123]. The new IDF definition focuses on abdominal obesity rather than insulin resistance. 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. t has been suggested that elevated FFAs. Adiponectin has been shown to be reduced in adults with obesity and type 2 diabetes.

Many people choose vegetarian diets to reduce risk factors. In the last year of my Ph.D. project, I tried to understand if long term vegan diet, that is a popular diet in Viet Nam, could contribute in preventing cardiovascular diseases and diabetes mellitus. The previous studies improved that vegetarian diets were benefit healths and can prevent CVD risk factors. However, an article published in Food Technology in October 2012 explained that plant-based diets either

minimize or completely eliminate people's genetic propensity to developing chronic diseases, such as diabetes type 2. cardiovascular disease, and cancer. This paper reviews data on the effects of dietary carbohydrates on body fatness. Especially, participants in my studywere vegans. They do not consume any foods of animal origin, not even by-products such as eggs, dairy products and honey because of a part of the reason is a belief in religion. They think that whole grains, vegetables, fruits, and legumes contain no cholesterol and are low in fat, especially saturated fats and also high in fiber and other nutrients will not obesity. There are several plant based foods that are good sources of protein, such as beans, peanuts, and soys. But if vegan diet with a long term vegan diet that they were benefit healths or not? Does the composition of the diet as related to carbohydrates affect the like hood of passive over-consumption and long-term weight change? Therefore, our study has been carried out to predict the risk factor of cardiometabolic syndrome on vegan diet with following objectives.

2.1. To assess the cardio-metabolic risk factors in the Vietnamese females with long- term vegan diet and the non-vegan females.

2.2. To evaluate the relationship of age with the cardio-metabolic risk factors and to predict the age appearing the cardio-metabolic risk factors through cut-off points by a ROC curve.

2.3. To define the correlation of vegan duration with the cardio-metabolic risk factors and risk prediction through cut-off points by a ROC curve.

2.4. To identify plasma biomarkers useful for elucidating the biochemical mechanisms underlying the strong associations between diabetes and atherosclerosis, by differential proteomic analysis of plasma samples from diabetic and non-diabetic atherosclerotic patients.

3. MATERIALS AND METHODS

3.1. MATERIALS

3.1.1. Study sites

✍This was a cross-sectional and prospective cohort study and was conducted from May 2014 to November 2016.at following settings:

- Hue University of Medicine and Pharmacy, Viet Nam
- Department of Biomedical Sciences – University of Sassari, Italy.
- The pagodas in Hue province, Viet Nam.
- Central laboratory in Hue Centre General Hospital.

3.1.2. Study population

✍All of these participants are living in Hue. In that, vegan group are the Buddhist nuns living in some pagodas in Hue province, north center Viet nam. Hue is also an important center of Buddhism.

✍All individuals were provided information and signed informed consent on study procedure.

3.2. METHODS

3.2.1. Sample collection

✍Cohort, cross sectional, and case-control studies are collectively referred to as observational studies. Cohort studies are used to study incidence, causes, and prognosis.

✍Cross sectional studies are used to determine prevalence. They are relatively quick and easy but do not permit distinction between cause and effect. Case controlled studies compare groups retrospectively.

✍They seek to identify possible predictors of outcome and are useful for studying rare diseases or outcomes.

✍ A total of 212 volunteers were divided into two groups:

♣**Vegan group (pure vegetarians):** 144 vegans were for more than 10 years (Min:10 years diet and Max: 70 years diet). The age was from 20-75 years old (mean: **48.19±17.3 yrs).**

♣**Control group:** 68 non vegetarians were chosen randomly. The age was 22 – 84 years old (mean: **49.91 ± 17.45 yrs)**.

3.2.2. Inclusion and exclusion criteria

The investigators must specify inclusion and exclusion criteria for participation in the study.

- Must be checked clinical symptoms carefully before participated in studying.
- No signs or symptoms of opportunistic infections to remove the influence of specific confounding variables.
- Non smoking and no use stimulant and drugs.
- Past medical history and family history: blood sugar disorders, diabetes, obesity, hypertension, heart diseases which were surveyed through structured interview questionnaires.
- They were excluded if they self-reported to have clinician-diagnosed diseases that related to study.

3.2.3. Slide preparation

✍Contact the Unified Buddhist of Vietnam, Thua Thien Hue province for permission to conduct and support research projects.

✍ Send invitations and letters of recommendation to the nuns at the pagoda in Hue City, the location and time of appointment to conduct research.

✍Establish the protocol: the questionnaire included sections on illness, diet, physical activity, demographics, age, the duration of vegan diet, arterial blood pressue, height and weight ect.

✍Clinical examination.

✍ Total lipid profiles survey done by a random selection.

✍Surveys in the relevant risk factors such as gender, age, hyperglycemia, hypertension, body mass index (BMI), waist circumference (WC), CRP, IMTc, lipid profiles, Atherogenic indices, glucose, insulin resistance index.

3.3. STUDY PARAMETERS

✍Preparing subjects:

These subjects are contacted before the procedure and given instructions before conducting study.

Trained staff performed all anthropometric measurements and at the same meeting. Before starting the evaluation, they should remove all metal accessories and wear light clothing. They should empty the bladder and avoid the practice of rigorous physical activity in the previous 12 hours and consumption of alcohol in the 24 hours prior to the assessment of achievement.

Study parameters and methods:

1. Age: based on age of the calendar (at least 22 years old)

2. Duration of vegan diet: at least 10 years

3. BMI (Body Mass Index): is a physical measurement used to assess an individual's total amount of body fat. A BMI measurement is a statistical measurement using a person's height and weight to determine their "healthy" body weight and identify health risks such as heart disease.

♣ **Body weight:** in kg, was measured with an electronic Filizola scale of the platform type with a maximum capacity of 300 kg and precision of 0.1 kg.

♣ **Height:** was measured with a stadiometer with 0.1 cm precision.

BMI was calculated as weight (kg) divided by height (m) squared:

$$\mathrm{BMI} = \frac{\text{weight (kg)}}{\text{height}^2(\mathrm{m}^2)}$$

4. WC (Waist circumference)

♣ **Waist circumference:** The inspection and evaluation of the distribution of body fat is important because it shows that the risk of dangerous diseases such as obesity, cardiovascular disease, hypertension, diabetes. WC is the simplest and most common way to measure "abdominal obesity"- the extra fat found around the middle that is an important factor in health, even independent of BMI.

♣ Waist measurement helps to assess risk by measuring the amount of fat carried around your middle. It can be used along with measuring your body mass index (BMI). Together, these tools give an indication of your risk linked with excess body fat.

♣ The circumferences were performed using a metal measuring tape, Sanny, accurate to 0.1cm and maximum length of 2m.

♣ **Waist circumference (WC):** was performed midway between the inferior margin of the last rib and the crest of the ilium in a horizontal plane. If most of your fat is around your waist rather than at your hips, you're at a higher risk for heart disease and type 2 diabetes. It's the circumference of the abdomen, measured at the natural waist (in between the lowest rib and the top of the hip bone), the umbilicus (belly button), or at the narrowest point of the midsection and breathe out normally [110].

♣ **Hip circumference (HC):** was performed in the region of largest circumference between the waist and the thigh.

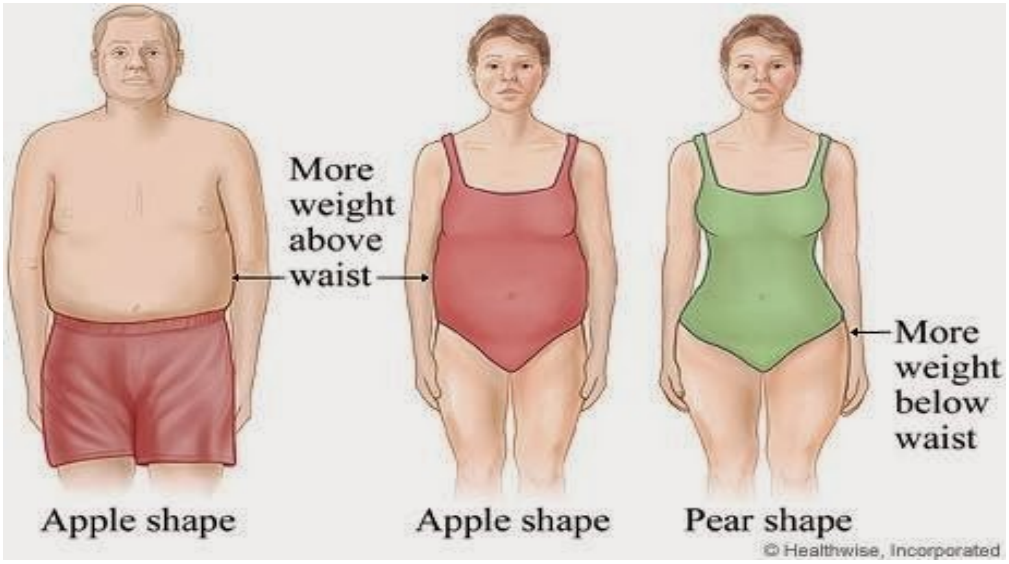
♣ **Thigh circumference (TC):** was performed in the end of the right gluteus. Thigh circumference (TC) was performed in the end of the right gluteus [88].

♣ **Waist-to-Hip Ratio (WHR):** like the waist circumference, WHR is also used to measure abdominal obesity. It's calculated by measuring the waist and the hip (at the widest diameter of the buttocks), and then dividing the waist measurement by the hip measurement [98,100].

Waist Circumference (WC)

WHR is calculated following: WHR (cm)= ---. ----------. ----------

Thigh circumference (TC)



Based on these two WHO reports, the recommendations often attributed to WHO are shown in table 1 although those sex - specific cut - off points cited in the report of the WHO Expert Consultation on Obesity (2000b) were an example only and not WHO recommendations.

Table 3.1. World Health Organization cut-off points and risk of metabolic complications Indicator Cut-off points Risk of metabolic complications [93]

Indicator	**Cut off points**		**Risk of metabolic complications**
	Male	**Female**	
Waist circumference	> 94cm	> 80cm	Increased
Waist circumference	≥ 102cm	> 88cm	Substantially increased
Waist – hip ratio	≥ 0.9cm	≥ 0.85cm	Substantially increased

Table 3.2. Waist –to-Hip Ratio (WHR) for males and females

Waist-to-Hip Ratio (WHR) Norms				
Gender	Excellent	Good	Average	At Risk
Males	<0.85	0.85–0.89	0.90–0.95	≥0.95
Females	<0.75	0.75–0.79	0.80–0.86	≥0.86

Table 3.3. Assess obesity based on BMI with standard of WHO for the Asians countries following [92]

Classification	**BMI (kg/m2)**
Underweight	< 18.5
Normal	18.5 – 22.9
Overweight	23
Pre – obesity	23 – 24.9
Obesity level 1	25 – 29.9
Obesity level 2	30
Obesity level 3	40

Table 3.4. International Diabetes Federation criteria for ethnic or country-specific values for WC [87]

Country or ethnic group	**Sex**	**Waist circumference (cm)**
Europid	Men Women	94 80
South Asian	Men Women	90 80
Chinese	Men Women	90 80

✍**Overweight and Obesity by BMI ≥ 23 and Waist Circumference ≥ 80 (cm) associated cardiovascular disease risk factors.**

5. Arterial Blood Pressure (SBP and DBP):

Blood Pressure (BP) is the pressure of circulating blood on the walls of blood vessels. BP is usually expressed in terms of the systolic (maximum during one heart beat) pressure over diastolic (minimum in between two heart beats) pressure and is measured in millimeters of mercury (mmHg).

✍**Preparing subjects:**

- Don't drink coffee or smoke cigarettes for 30 minutes before.
- Before test sit for five minutes with back supported and feet flat on the ground. Test your arm on a table even with your heart.
- Wear short sleeves so your arm is exposed.
- Rest quietly for 5 minutes beforehand
- Sit with your feet flat on the floor, back and arm supported, and arm at heart level
- Apply cuff on a bare arm
- Measure BP twice in the morning.
- Keep BP readings in a log
- Do Not smoke or drink caffeine 30 minutes before
- Do not speak during monitoring

Blood pressure is measured with an instrument called a sphygmomanometer. First, a cuff is placed around your arm and inflated with a pump until the circulation is cut off. A small valve slowly deflates the cuff, and the doctor measuring blood pressure uses a stethoscope, placed over your arm, to listen for the sound of blood pulsing through the arteries. That first sound of rushing blood refers to SBP; once the sound fades, the second number indicates the diastolic pressure, the blood pressure of your heart at rest refer to DBP. At least two measurements should be made and the average recorded.

Table 3.5. The WHO/ISH and American heart association of classification ABP [89-91]

Category	Systolic, mmHg	Diastolic, mmHg
Hypotension	< 90	< 60
Desired	90–119	60–79
Prehypertension	120–139	80–89
Stage 1 hypertension	140–159	90–99
Stage 2 hypertension	160–179	100–109
Hypertensive urgency	≥ 180	≥ 110
Isolated systolic hypertension	≥ 160	< 90

✍Prehypertension is **not** a disease category rather a designation for individuals at high risk of developing HTN. **SBP >120 mmHg and < 139mmHg** and/or **DBP >80 mmHg and < 89 mmHg**. Systolic BP is more important cardiovascular risk factor after age 50.Diastolic BP is more important before age 50.

Both numbers in a blood pressure reading are important. But after the age of 60, the systolic reading is even more significant. Isolated systolic hypertension is a condition in which the diastolic pressure is normal (less than 90 mm Hg) but systolic pressure is high (greater than 140 mm Hg). This is a common type of high blood pressure among people older than 60.

6. IMTc (Intima Media Thickness of carotid artery): a New Tool for Diagnosis and Treatment of Cardiovascular Risk.

An article from the e-journal of the ESC Council for Cardiology Practice

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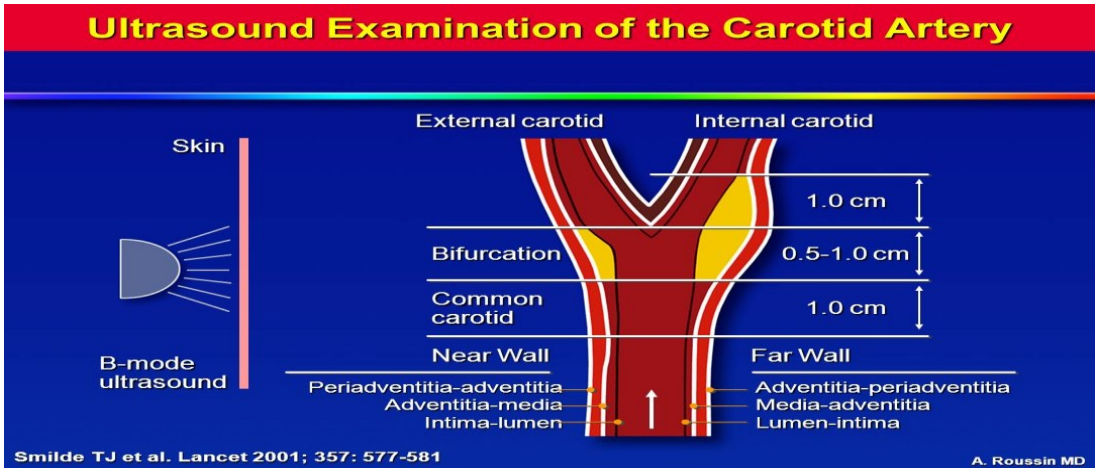
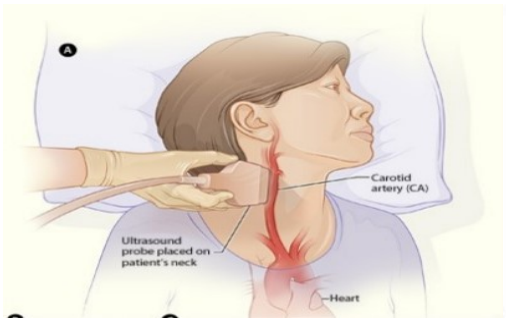
✍ IMTc is a surrogate marker of atherosclerosis and imparts prognostic information independent of traditional cardiovascular risk factors. Quantitative assessment of IMT using semiautomated border detection software is a new and easy technique that has been previously shown to be accurate, effective, and reproducible. The study is aimed to define the upper limit of carotid IMT at the common carotid artery (CCA) and its bifurcation among a healthy population in the United Kingdom.

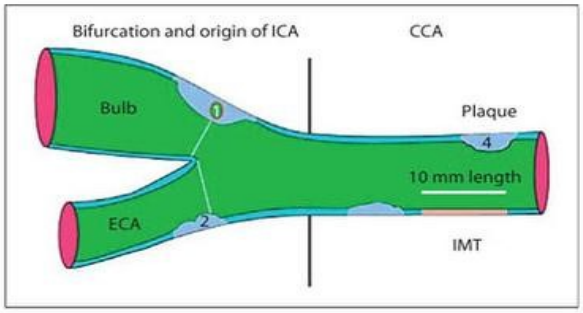
✍Carotid ultrasound is a very safe, available and reliable method for evaluation of carotid arteries that provides information about common and internal carotid IMT, presence of plaque, plaque volume, lumen narrowing, and

sheer stress. This may help us detect coronary artery disease in the early stages of disease and predict the risk of a future stroke or cardiovascular event [98].

Fig 3.1. Ultrasound examination of the carotid artery







Equipment settings

High-resolution B-mode system (B-mode imaging is preferred over M-mode imaging), equipped with a linear array transducer >7.5MHz with minimal compression (< 10:1) and footprint of at least 3 cm; Focus depth (30-40 mm), frame rate (>15-25 Hz) and gain settings adjusted optimally to facilitate edge detection; Clear 3-lead electrocardiographic signal; Use of a zoom function is discouraged (most of the studies relating IMT to cardiovascular events have not used zoomed images);

Position for scanning

Patient lie down in supine or semi supine position, head hyperextended and rotated 45^0 away from side being examined higher frequency linear transducers ≥ 7.5MHz.

How to measure

CIMT is measured between the intimal-luminal and the medial-adventitial interfaces of the carotid artery wall represented as a double-line density on an

ultrasound image (Figure 1). IMTc measurement at a distance of at least 5 mm below the distal end of CCA (IMT could also be measured at the carotid bifurcation and internal carotid artery bulb, but the values should be given separately);The accuracy of the common carotid artery (CCA) far wall IMT measurement was validated against histological specimens [8] as representing the true biological thickness of the vessel wall, whereas the near-wall IMT measurement was shown to have a systematic measurement error because of the echogenicity of the adventitial layer masking the adventitial-medial boundary [95, 96] as well as being affected by gain settings.

Normal versus and abnormal values

Normal IMT values and reference ranges are age- and sex-dependent – there is a significant steady increase in IMT with advancing age in all carotid segments and significantly higher IMT values in men than in women.

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European Society of Hypertension / European Cardiovascular Society (ESC / ESH) in 2013 [103]: IMTc ≥ 0.9 mm: thick IMT unusual, is a sign of the occurrence of asymptomatic agencies and >1.2mm as being high risk. There is general agreement that the presence of obvious plaque indicates high risk at any age [101]. Thus, if you exceed the average progression by age, then you likely have plaque and are at risk. Normal ≥ 0.9mm is thick and ≥ 1.5 mm is used to define the presence of a plaque. IMT may be a potential useful marker for coronary atherosclerosis, as well as an indicator for its progression or regression, on the condition that the carotid atherosclerosis reflects coronary atherosclerosis [102].

7. Blood glucose

Glucose is the primary energy source for the body's cells and the only energy source for the brain and nervous system. A steady supply must be available for use, and a relatively constant level of glucose must be maintained in the blood. A few different protocols may be used to evaluate the glucose level in the blood. Normally, blood glucose rises slightly after a meal and insulin is released by the pancreas into the blood in response, with the amount corresponding to the size and content of the meal. If the balance is disrupted and the glucose level in the blood rises, then the body tries to restore the balance, both by increasing insulin production and by

eliminating excess glucose in the urine. There are a few different conditions that may disrupt the balance between glucose and the pancreatic hormones, resulting in high or low blood glucose. The most common cause is diabetes. Diabetes is a group of disorders associated with insufficient insulin production and/or a resistance to the effects of insulin. Those who are not able to produce any or enough insulin (and typically have diabetes autoantibodies) are diagnosed as having type 1 diabetes. Those who are resistant to insulin and may or may not be able to produce sufficient quantities of it may have prediabetes or type 2 diabetes.

♣ PATIENT PREPARATION FOR BLOOD TESTS:

Patients should be explained clearly and psychologically prepared to cooperate.

Patient should fast for 8 hours before blood collection. Fasting should be no food or drink except for water. A blood sample is obtained by inserting a needle into a vein in the arm.

There are different kinds of blood tests that can diagnose hyperglycemia.

●**Random blood glucose:** this test reflects the blood sugar level at a given point in time. Normal values are generally between 70 and 125 mg/dL, as discussed earlier.

●**Fasting blood glucose:** this is a measurement of blood sugar level taken in the early morning prior to eating or drinking anything since the night before. Normal fasting blood glucose levels are less than 100 mg/dL. Levels above 100 mg/dL up to 125 mg/dL suggest prediabetes, while levels of 126 mg/dL or above are diagnostic of diabetes.

●**Glycohemoglobin A1c:** is a measurement of glucose that is bound to red blood cells and provides an indication about blood sugar levels over the past 2 to 3 months.

In my study, i used HbA1c (Hemoglobin A1c) and Fasting glucose to determine hyperglycermia**.**

♣ Blood Collection and Plasma Preparation for fasting glucose test?

A blood sample is obtained by inserting a needle into a vein in the arm. A digital readout on the device lets the person know the blood glucose level in real time.

FBG test measures the level of glucose in the blood after fasting for at least 8 hours. Fasting blood samples were collected from 212 patients in lithium heparin anticoagulants containing Vacutainer tubes and stable blood for 8 hours at 15-25^0

until analysis. Then, plasma was separated from each blood sample tube by centrifugation at 2. 000 x g for 10 minutes and analyzed for blood glucose level by automatic analyzer, Cobas 6000 automated chemistry analyzer (Roche Diagnosistics Ltd. Switzerland). Machine has been installed glucose screening program with room temperature from 26 to 28°C under the air condition control. The long-term storage temperature should be at least −80 °C [104].

♣What does the test result mean?

- Fasting Blood Glucose

High levels of glucose most frequently indicate diabetes, but many other diseases and conditions can also cause elevated blood glucose.

In a person with signs and symptoms of diabetes or hyperglycemia, a non-fasting glucose level (random blood sample) that is equal to or greater than 200 mg/dL (11.1 mmol/l) indicates diabetes.

Table 3.6. The following information summarizes the meaning of other test results [104] [106]

GLUCOSE LEVEL		INDICATION
From 70 to 99 mg/dL	3.9 to 5.5 mmol/l	Normal fasting glucose
From 100 to 125 mg/dL	5.6 to 6.9 mmol/l	Prediabetes
126 mg/dL and above on more than one testing occasion	7.0 mmol/l and above on more than one testing occasion	Diabetes

- Quantitative measurement of HbA1c by an immuno-turbidimetric assay:

Hemoglobin is the substance inside red blood cells that carries oxygen to the cells of the body. Glucose (a type of sugar) molecules in the blood normally become stuck to hemoglobin molecules - this means the hemoglobin has become glycosylated (also referred to as hemoglobin A1c, or HbA1c). As a person's blood sugar becomes higher, more of the person's hemoglobin becomes glycosylated. The glucose remains attached to the hemoglobin for the life of the red blood cell, or about 2 to 3 months.

This can help determine how well a person's diabetes is being controlled over time. Determination of hemoglobin A1c (HbA1c) is one of the most important monitoring procedures for long-term control of DM. Several analytical methods

have been developed for the measurement of glycohemoglobin (GHb). In this study, a new turbidimetric immunoassay for HbA1c was evaluated that was performed on AU4000 clinical chemistry analyzer.

• Preparation of blood samples

Blood samples were collected in EDTA-containing tubes. Whole blood (1 ml) was washed three times with 8 mL of saline solution and centrifuged for 10 min at 15. 000 rpm at room temperature. Whole blood stable for 2 weeks at 2 - 8ºC: 7 days at 25 ° C

•Methodology

The concentrations of both HbA1c and total Hemoglobin are determined. The HbA1c/total Hemoglobin ratio is expressed as percentage HbA1c (%HbA1c). The assay for percent HbA1c, involves the use of four reagents: Total Hemoglobin reagent, HbA1c R1 antibody reagent, HbA1c R2 agglutinator reagent, and Hemoglobin Denaturant. Total Hemoglobin is measured via the conversion of all hemoglobin derivatives into alkaline hematin in the alkaline solution of a non-ionic detergent. HbA1c is measured in a latex agglutination inhibition assay. The presence of HbA1c in the sample results in a decrease in the rate of agglutination of the HbA1c R1 and the agglutinator in the HbA1 reagent R2.The increase in absorbance is, therefore, inversely proportional to the concentration of HbA1c in the sample. The increase in the absorbance is measured at 700nm. System Information For AU400/400e /480

HbA1c Results

The following are the results when HbA1C is being used to diagnose diabetes [105]

Normal (no diabetes): HbA1c < 5.7%

Pre-diabetes: 5.7 to 6.4 %,

Diabetes: ≥ 6.5%

8. Assessment of insulin resistance

HOMA – IR: The prospective association between insulin levels and risk of cardiovascular disease (CVD) is controversial. The objective of the present study was to investigate the relationship of the homeostasis model assessment of insulin resistance (HOMA-IR), as well as insulin levels, with risk of nonfatal. HOMA-IR in Relation to the Incidence of CVD. HOMA model is used to yield an estimate of insulin sensitivity and β-cell function from fasting plasma insulin and glucose concentrations.

HOMA is a method for assessing β-cell function and insulin resistance (IR) from basal (fasting) glucose and insulin or C-peptide concentrations. It has been reported in >500 publications, 20 times more frequently for the estimation of IR than β-cell function [99].

Decreases in β-cell function were modeled by changing the β-cell response to plasma glucose concentrations. The HOMA model compares favorably with other models and has the advantage of requiring only a single plasma sample assayed for insulin and glucose.

The values for a patient can be calculated from the fasting concentrations of insulin (FI) and fasting plasma glucose (FPG) using the following formula:

HOMA-IR = [FI (μU/ml) × FPG (mmol/l)]/ 22.5

Abnormal HOMA-IR ≥ 2.6

9. hsCRP: A high-sensitivity C-reactive protein

hs-CRP test may be used to help evaluate an individual for risk of (CVD). It may be used in combination with a lipid profile or with other cardiac risk markers to provide added information about heart disease risk. CRP is a protein that increases in the blood with inflammation. Studies have suggested that a persistent low level of inflammation plays a major role in atherosclerosis, the narrowing of blood vessels due to build-up of cholesterol and other lipids, which is often associated with CVD. The hs-CRP test accurately measures low levels of C-reactive protein to identify low but persistent levels of inflammation and thus helps predict a person's risk of developing CVD.

Preparation of blood samples

A blood sample is obtained by inserting a needle into a vein in the arm.

Blood samples were collected in EDTA with 3 mL of saline solution and centrifuged for 10 min at 15. 000 rpm at room temperature. Whole blood stable for 2 months at 2 - 8ºC: 7 days at 25 ° C

Methodology Immunoturbidimetric assay:

CRP was quantified by measuring turbidity immunotherapy (immunoturbidimetric assay). CRP in the sample precipitated with latex particles coated with monoclonal antibodies CRP reagent, generated immune complexes causing antigen-antibody reaction solution turbidity. CRP concentration in the sample is proportional to the turbidity caused by immune complexes antigen-antibody generated.

Measurement engineering limited: < 1mg/l and abnormal : ≥ 3mg/l

10. Bilan lipid: A complete cholesterol test is also called a lipid panel or lipid profile. You can use it to measure the amount of "good" and "bad" cholesterol and triglycerides, a type of fat, in your blood. Cholesterol is a soft, fat that your body needs to function properly. However, too much cholesterol can lead to: •heart disease•stroke•atherosclerosis, a clogging or hardening of your arteries.

Storage and sample stability. Serum can be stored at -20°C in a non-self defrosting freezer for up to 4 weeks. For longer storage (> 4 weeks) they should be maintained at -80°C or lower. Total cholesterol, triglyceride and HDL-cholesterol are stable for at least one year at-80 oC or lower.

A complete cholesterol test measures four types of lipids, or fats, in your blood:

• **TC:** This is the total amount of cholesterol in your blood.

• **LDL.C:** This is referred to as "bad" cholesterol. Too much of it raises your risk of heart attack, stroke, and atherosclerosis.

• **HDL.C:** This is referred to as "good" cholesterol because it helps remove LDL cholesterol from your blood.

• **TG:** When you eat, your body converts the calories it doesn't need into triglycerides, which are stored in your fat cells.

●**Non- HDL.C : TC – HDL.C = LDL.C + VLDL.C**

According to ATP III cholesterol goals higher non HDL and LDL goal of 30 mg / dL. Non-HDL cholesterol is considered as the second treatment targets to limit the atherogenic power of the combination of the Remnant lipoproteins in patients with hypertriglyceridemia [108,16].

To check your cholesterol levels

You should avoid eating or drinking anything other than water for nine to 12 hours before your test.

Table 3.7. ATP III Classification of total lipid profiles (2001) [107].

Ingredients	Concentration mg/dl (mmol/l)	Risk assessment
TC	< 200mg/dL (5. 2mmol/l)	Desirable
	200-239 mg/dL (5. 2-6.2mmol/l)	Borderline high
	> 240mg/dL (6.2 mmol/l)	High
HDL.C	< 40 mg/dL (1mmol/l)	Low
	> 60 mg/dL (1. 6mmol/l)	High
LDL.C	< 100 mg/dL (2. 6mmol/l)	Optimal
	100-129mg/dL (2. 6-3.4mmol/l)	Near optimal
	130-159 mg/dL (3.4-4.2 mmol/l)	Borderline high
	160-189 mg/dL (4.2-5 mmol/l)	High
	> 190 mg/dL (5mmol/l)	Very high
TG	< 150 mg/dL (1. 7mmol/l) 150-199mg/dL (1. 7-2. 3mmol/l) 200 - 499mg/dL (2. 3-5. 7mmol/l) > 500mg/dL (5. 7 mmol/l)	Normal Borderline high High Very high

1.3. Atherogenic indices: TC/HDL.C, TG/HDL.C and LDL.C/HDL.C

TC/HDL.C ≥ 4 , TG/HDL.C ≥ 2.4 , LDL.C/HDL.C ≥ 2.3

3.4. DATA ANALYSIS

Statistical analysis was performed using Microsoft Excel 2012 and Medcalc software version 10.4.8.0 and SPSS 16.0 for Windows (SPSS Inc. Chicago. IL. USA).

Comparisons of proportions between two rates were calculated by Chi-squared tests.

Comparisons of two mean were calculated by Independent sample T – test for evaluation case control-study.

Multivariate regression analysis independent predictor

Comparisons of two mean of following up sera antibody titers were calculated by Kruskal – Wallis test because of the small number of patients.

Use R solf ware to analysis ROC curve and cut-off points

ROC analyses were used to evaluate sensitivity and specificity of case control- study.

ROC analyses were also used to evaluate the relation between the following up prognosis by age, duration of vegan diet with risk factors (eg BMI, bilan lipid, ….)

The determination of the cut-off points was based on the values that maximized simultaneously both sensitivity and specificity

Levene's test for equality of variances, ANOVA test for evaluation the relationship, Student-Newman-Keuls test for all pairwise comparisons.

All reported confidence intervals were two-sided 95% confidence intervals and P - values < 0.05 were regarded as statistically significant.

4. RESULTS IN STUDY

4.1. THE PREVALENCE OF THE CARDIO -METABOLIC RISK FACTORS IN STUDY GROUPS

4.1.1. General characteristics of study groups

Table 4.1.1.1. Age of study groups

Age (yrs)	Vegan group	Control group	P value
< 40	51(35.4 %)	24 (35.3%)	>0.05
40-59	40(27.8%)	24 (35.3%)	>0.05
≥ 60	53(36.8%)	20 (29.4%)	>0.05
Mean	48.19±17.3	49.91 ± 17.45	>0.05
Min-Max	20-75	22-84	

The mean ages was not significantly between two groups (48.19 ± 17.3 yrs vs 49.91 ± 17.45 yrs, p> 0.05)

Table 4.1.1.2. Duration of vegan diet

Duration of vegetarian diet (Yrs)	< 15 yrs	15-30 yrs	>30 yrs
N (%)	37(25.7%)	49(34.4%)	58(40.3%)
Mean	27.8±15.9 yrs		
Min-Max	10-70 yrs		

The average duration of vegan diet was 27.8±15.9 yrs

Duration of vegan diet < 15 years was 25.7% and >30 years 40.3%

4.1.2. CARDIO- METABOLIC RISK FACTORS OF STUDY GROUPS

4.1.2.1. BMI

Table 4.1.2.1. BMI of study groups

BMI	Vegan group (n=144)	Control group (n=68)	P
< 18.5	17(11.8%)	7 (10.3%)	>0.05
18.5- 22.9	77(53.5%)	54 (79.4%)	< 0.05
≥ 23	50(34.7%)	7 (10.3%)	< 0.05
Mean	21.9 ± 3.1	21.09 ± 2.50	>0.05
Min –max	13.34-32.37	16.6-31.32	

There were not significant differences in the average BMI between vegan group and control group (21.9 ± 3.1 vs 21.09 ± 2.50, p > 0.05)

The prevalence of overweight (BMI ≥ 23) in vegan group was significantly

higher than in control group (34.7% vs 10.3%, p < 0.05)

4.1.2.2. Waist Circumference (WC)

Table 4.1.2.2. WC of study groups

Value	Vegan Group (N=144)	Control group (N=68)	P value
< 80 cm	67(46.5%)	54 (79.4%)	< 0.05
≥ 80 cm	77(53.5%)	14 (20.6%)	< 0.05
Mean	81.2±13.0	74.18 ± 7.14	< 0.05
Min-max	58-113	60-89	

The prevalence of android obesity (WC ≥ 80cm) in vegan group was significantly higher than in control group (53.5% vs 20.6%, p < 0.05). There was significantly different in the mean WC between two groups (81.2±13.0 vs 74.18 ± 7.14 cm, p < 0.05)

4.1.2.3. Arterial Blood Pressure (ABP)

Table 4.1.2.3. Blood Pressure of study groups

Blood Pressure MmHg	Vegan group (n=144)	Control group (n=68)	P value
≥ 140 and/or ≥ 90 mmHg	38 (26.4%)	8 (11. 8%)	< 0.05
≥ 140/< 90 mmHg	28 (19.4%)	8 (11. 8%)	> 0.05
≥ 130/85 mmHg (MS)	49 (34.03%)	18 (26.47%)	< 0.05
Mean SBP	120.9±19.50	115.59 ± 17.22	< 0.05
Mean DBP	71.82±10.20	71.25 ± 10.66	> 0.05

The prevalence of hypertension (SBP and/or DBP) in the vegan group was higher than in control group (26.4% vs 11.8 %, p < 0.05)

The average of SBP in vegan group was higher than in control group (120.9 ±19.50 vs 115.59 ± 17.22 mmHg, p < 0.05)

The prevalence of hyper SBP in vegan group was not significantly higher than in control group (19.4% vs 11.8 %, p > 0.05).

The mean of DBP in vegan group was not significantly higher than in control group (71.82±10.20 vs 71.25 ± 10.66, p > 0.05)

The prevalence of ABP ≥ 130/85 mmHg (Metabolic Syndrome) in vegan group was higher than in control group (34.03 % vs 26.47 %, p < 0.05)

4.1.2.4. Intima Media Thickness of Carotid Artery (IMTc)

Table 4.1.2.4. IMTc of study groups

IMTc	< 0.9 mm	≥ 0.9 mm	X ± SD
Vegan group	119 (82.6%)	25 (17.4%)	0.64 ± 0.39 mm
Control group	59(86.8%)	9 (13.2%)	0.73 ± 0.11 mm
P	> 0.05		< 0.05

There were not significant differences in IMTc ≥ 0.9 mm between vegan group and control group (17.4 %vs 13.2 %, p>0.05)

The average IMTc in vegan group was thinner than in control group (0.64± 0.39 mm vs 0.73 ± 0.11 mm, p < 0.05).

4.1.2.5. hs CRP

Table 4.1.2.5. hsCRP of study groups

hsCRP (mg/l)	< 1	1-2.9	≥ 3	Mean
Vegan	84(58.3%)	36(25.0%)	24(16.7%)	1.99±3.08
Control group	38(55.9%)	17(25.0%)	13(19.1%)	1.41±1.62
P	> 0.05			> 0.05

The proportion of hsCRP ≥ 3 mg/l in vegan group was not significantly lower than in control group (16.7% vs 19.1 %, p >0.05).

There were not significant differences in the mean hsCRP between two groups (1.99 ±3.08 vs 1.41±1.62 mg/l, p > 0.05)

4.1.2.6. Ischemic heart disease (IHD) detected by ECG

Table 4.1.2.6. Ischemic heart disease of vegan group detected by ECG

Ischemic heart disease	(+)	(-)
Vegan group	17 (11.8%)	127 (88.2%)
Control group	15 (22.0 %)	53 78.0%)
P	>0.05	

Ischemic heart disease detected by ECG in vegan group was not significantly lower than in control group (11.8 vs 22%, p > 0.05)

4.1.2.7. Glycemia

Table 4.1.2.7.1. Fasting glucose of study groups

Fasting glucose	Vegan group	Control group	P
< 5.6 mmol/l	125(86.8%)	61 (89.7%)	>0.05
5.6 - 6.9 mmol/l	8 (5. 6%)	5 (7.4%)	>0.05
≥ 7 mmol/l	11(7.6%)	2 (2.9 %)	< 0.05
Mean	5.00±1.4	4.67 ± 0.98	< 0.05

The prevalence of hyperglycemia (based on fasting glucose) in vegan group was higher than in control group (13.2% vs 10.3%).

The average FG in vegan group was higher than in control group (5.00 ±1.4 vs 4.67 ± 0.98 mmol/l, $p < 0.05$).

Table 4.1.2.7.2. HbA1c of study groups

HbA1c	Vegan group	Control group	P
< 5.7%	79(54.9%)	59 (86.8%)	< 0.05
5.7 - 6.4%	49 (34%)	7 (10.3%)	< 0.05
≥ 6.5%	16 (11.1%)	2 (2.9%)	< 0.05
Mean %	5.9 ± 0.9	4.60 ± 0.80	< 0.05

The prevalence of hyperglycemia (based on HbA1c) in vegan group was higher than in control group (45.1% vs 13.2%, $p < 0.05$) in which prediabetes was 34% in vegan group and 10.3% in control group.

There was a significant difference in HbA1c levels between two groups. The average HbA1c in vegan group was higher than in control group (5.9 ±0.9 vs 4.3 ± 0.90 %, $p < 0.05$).

4.1.2.8. Insulin resistance

Table 4.1.2.8.1. Fasting Insulin of study groups

Fasting Insulin (µU/ml)	Vegan group	control group	P
≥ 12	11(7.6%)	0	< 0.05
< 12	133 (92.4%)	68 (100%)	< 0.05
Mean	6.9 ± 4.3	5.55 ± 2.13	< 0.05
Min – max	1.5-30.4	1.2-11.4	

The proportion of FI ≥ 12 µU/ml in vegan group was 7.6% but no case of control group. The average FI in vegan group was higher than in control group (6.9 ± 4.3 vs5.55 ± 2.13 µU/ml, $p > 0.05$).

Table 4.1.2.8.2. HOMA-IR of study groups

HOMA-IR	Vegan group	Control group	P
≥ 2. 6	14 (9.7%)	1 (1.5%)	< 0.05
< 2. 6	130 (90.3%)	67 (98.5%)	< 0.05
Mean	1. 67±1. 62	1.16 ± 0.55	< 0.05
Min-Max	0.29-11.84	0.23-3.90	

The proportion of HOMA-IR≥ 2. 6 in vegan group was higher than in control group (9.7% vs 1.5%, p < 0.05)

The average HOMA-IR index in vegan group was higher than in control group (1.67±1.62 vs 1.16 ± 0.55, p < 0.05)

4.1.2.9. Lipid profile

Table 4.1.2.9. Total lipid profile of study groups

Total Lipid	Value (mmol/l)	Vegangroup (n=144)		Control group (n=68)		P value
		N	%	n	%	
TC	≥ 5.2	46	31.9	35	51.47	< 0.05
	< 5.2	98	68.1	33	48.53	
	Mean	4.8±1.11		5.31 ±1.32		< 0.05
TG	≥ 1.7	63	43.8	43	63.24	< 0.05
	< 1.7	81	56.2	25	36.76	
	Mean	1.9 ± 1.2		2.14 ± 1.07		>0.05
LDL.C	≥ 3.4	29	20.1	28	41.18	< 0.05
	< 3.4	115	79.9	40	58.82	
	Mean	28 ± 0.9		3.00 ± 1.03		>0.05
HDL.C	< 1.3	87	60.4	31	45.59	< 0.05
	≥ 1.3	57	39.6	37	54.41	
	Mean	1.2 ± 0.2		1.35 ± 0.39		< 0.05
Non-HDL.C	≥ 3.4	73	50.7	46	67.65	< 0.05
	< 3.4	71	49.3	22	32.35	
Mean	3.60 ± 1.00			3.97 ± 1.20		< 0.05

Proportion of TC (≥ 5. 2mmol/l) in vegan group was significantly lower than in control group (31. 9% vs 51. 47%, p < 0.05)

The mean TC in vegan group was significantly lower than in control group (4.8±1. 11 vs 5. 31 ±1. 32 mmol/l, p =0.035)

Proportion of TG (≥ 1. 7 mmol/l) in vegan group was significantly lower than in control group (43.8% vs 63.2%, p < 0.05), but the aveage TG in vegan group was not significantly lower than in control group (1. 9 ± 1. 2 vs 2. 14 ± 1. 07mmol/l, p>0.05)

Proportion of LDL.C (≥ 3.4 mmol/l) in vegan group was significantly lower than in control group (20.1% vs 41. 1%, p < 0.05), but the mean LDL.C in vegan group was not significantly lower than in the control group (2. 8 ± 0.9 vs 3.00 ± 1. 03 mmol/l, p > 0.05)

Proportion of HDL.C (< 1. 3 mmol/l) in the vegan group was significantly higher than in control group (60.4 % vs 45.59%, p < 0.05) and the average HDL.C in vegan group was significantly lower than in control group (1.2 ± 0.2 vs 1.35 ± 0.39 mmol/l, p < 0.05)

Proportion of non-HDL.C (≥ 3.4 mmol/l) in vegan group was significantly lower than in control group (50.7% vs 67.65 %, p < 0.05)

The mean non.HDL.C in vegan group was significantly lower than in control group (3.60 ± 1. 00 vs 3.97 ± 1. 20 mmol/l, p < 0.05)

4.1.2.10. Atherogenic indices

Table 4.1.2.10. Atherogenic index

Atherogenic index	Value	Vegan group		Control group		P value
		N	%	N	%	
TC/HDL.C	≥ 4	67	46.5	32	47.06	> 0.05
	< 4	77	53.5	36	52. 94	
Mean	3.9±0.9			4.14 ± 1.23		< 0.05
TG/HDL.C	≥ 2.4	26	18.1	11	16.18	>0.05
	< 2.4	118	81.9	57	83.82	
Mean	1.6 ± 1.3			1.68 ± 0.97		>0.05
LDL.C/HDL.C	≥ 2.3	65	45.1	34	50	> 0.05
	< 2.3	79	54.9	34	50	
Mean	2.3±0.7			2.39 ± 1.02		> 0.05

TC/HDL (≥ 4) in vegan group was not significantly lower than in control group (46.5 % vs 47%, p > 0.05) and the mean TC/HDL in vegan group was not significantly lower than in control group (3.9±0.9 vs 4.14 ± 1. 23, p > 0.05)

TG/HDL in vegan group was not significantly higher than in control group

(18.1% vs 16.18%, p > 0.05) and the average TG/HDL in vegan group was not significantly lower than in control group (1. 6 ± 1. 3 vs 1.68± 0.97, p> 0.05)

LDL.C/HDL ≥ 2.3 in vegan group was not significantly lower than in control group (45.1% vs 50%, p>0.05) and the average LDL.C/HDL in vegan group was not significantly lower than in control group (2.3±0.7vs 2.39 ±1,02, p > 0.05)

4.1.2.11. Metabolic Syndrome

Table 4.1.2.11. The prevalence of MS in study groups

MS	Vegan group %	Control group %	p
MS (+)	45 (31.35%)	2 (2.9%)	< 0.001
MS (-)	99 (68.8%)	66 (97.1%)	< 0.001

Prevalence of MS (+) in vegan group was significantly higher than in control group (31. 35% vs 2. 9%, p < 0.001).

4.2. THE RELATIONSHIP BETWEEN AGE AND THE CARDIO-METABOLIC RISK FACTORS WITH PREDICTED VALUES BY ROC CURVE IN STUDY GROUPS

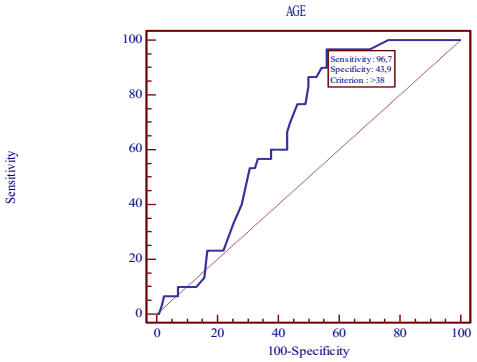
4.2.1. BMI

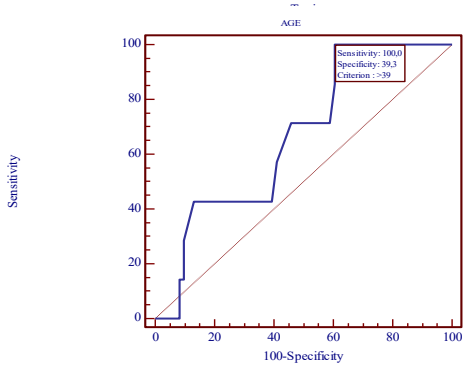
Table 4.2.1. The relationship between BMI and age in study groups

Age	< 40 yrs	41- 59 yrs	≥ 60 yrs	p
Vegan group	(n=51) 20.48±2.22	(n=40) 22.57±3.17	(n=53) 22.84±3.35	< 0.001
Control group	(n=24) 20.65 ± 1.71	(n=24) 20.92 ± 2.29	(n=20) 21.85 ± 3.37	>0.05

There were statistically significant differences in the mean of BMI in vegan group (p < 0.001) but were not presented in control group (p >0.05).

Graph 4.1. Cut-off values of BMI ≥ 23 analysis by ROC curve





Variables	Group	Criterion	AUC	Sensitivity	CI	Specificity	CI
BMI ≥ 23	vegan	38	0.669	96.7	82.8-99.9	43.9	34.6-53.5
	control	39	0.666	100	59-100	39.3	27.1-52.7

There was not significant difference in age cut-off values between two groups (38 vs 39 yrs)

4.2.2. Waist Circumference (WC)

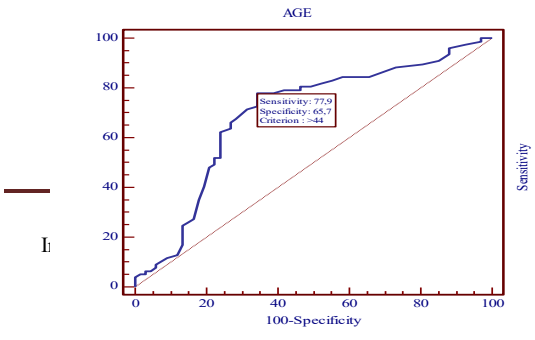
Table 4.2.2. The relationship between WC and age in study groups

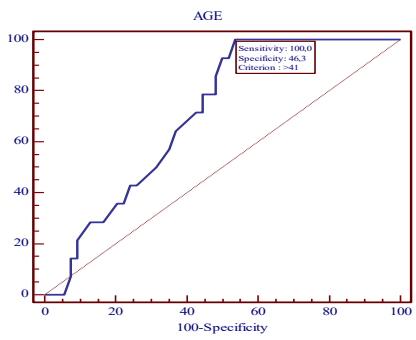
Age	< 40 yrs	41- 59 yrs	≥ 60 yrs	p
Vegan group	(n=51) 75.20±8.26	(n=40) 80.74±12.27	(n=53) 87.30±14.55	< 0.001
Control group	(n=24) 68.50 ± 3.74	(n=24) 78.68 ± 5.26	(n=20) 75.65 ± 7.82	< 0.01

There were statistically significant differences in the mean of WC between two goups (p < 0.001)

Variables	Group	Criterion	AUC	Sensitivity	CI	Specificity	CI
WC ≥ 80	Vegan	44	0.694	**77.9**	67-86.6	65.7	53.1-76.8
	Control	41	0.708	100	76.8-100	46.3	32.6 - 60.4

Graph 4.2. Cut-off values of WC ≥ 80 analysis by ROC curve for vegan group and control group





Age ROC curve for WC ≥ 80cm in vegan group was higher than in control group (44 vs 41 yrs).

4.2.3. Arterial Blood Pressure (ABP)

Table 4.2.3.1. The relationship between SBP and age in study groups

Age	< 40 yrs	41- 59 yrs	≥ 60 yrs	p
Vegan group	108.24± 14.86	117.67 ± 13.24	135.57 ± 17.77	< 0.001
Control group	102.92±6.90	119.79±17.03	125.75±17.42	< 0.0001

There were statistically significant differences in the mean of SBP with different age groups in study groups (p < 0.001)

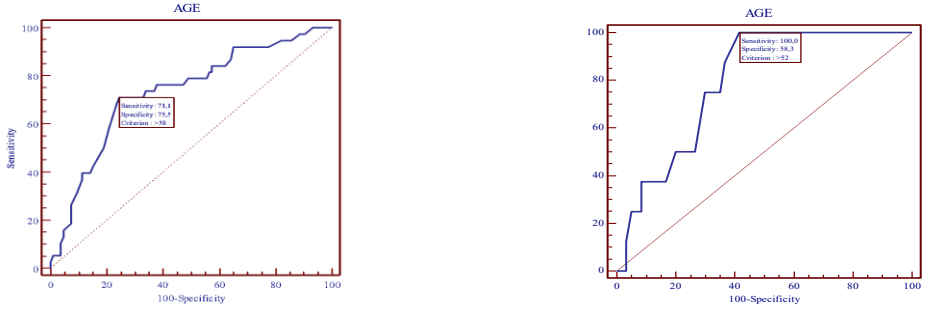
Variables	Group	Criterion	AUC	Sensitivity	CI	Specificity	CI
Hyper SBP	Vegan	60	0.816	82.1	63.1-93.9	75.9	67-83.3
	Control	52	0.793	100.0	63.1-100	58.3	44.9-70.9
Hyper SBP and/or DBP (≥ 140/90)	Vegan	58	0.732	71.1	54.1-84.6	75.5	66.2-83.3
	Control	52	0.793	100	63.1-100	58.3	44.9-70.9

Table 4.2.3.2. The relationship between DBP and age in study groups

Age	< 40 yrs	41- 59 yrs	≥ 60 yrs	p
Vegan group	67.71± 9.75	73.33± 8.97	74.60 ± 10.69	< 0.001
Control group	63.75 ± 6.29	74.58 ± 10.73	76.25 ± 10.11	< 0.0001

There were statisticantly differences in the mean DBP with different age groups in study groups (p < 0.001)

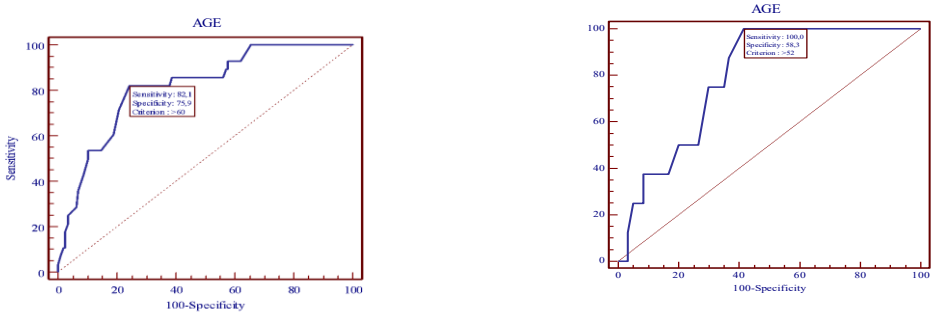
Graph 4.3. Cut-off values of Hyper Blood Pressure (SBP and/or DBP) analysis by ROC curve for vegan group and control



Age cut-off values for Hyper BP (SBP and/or DBP) in vegan group was

older than in control group (58 vs 52 yrs)

Graph 4.4. Cut-off values of Hyper SBP analysis by ROC curve for vegan group and control



Age cut-off values for Hyper SBP in vegan group was older than in control group (60 vs 52 yrs)

4.2.4. Intima Media Thickness of Carotid Artery (IMTc)

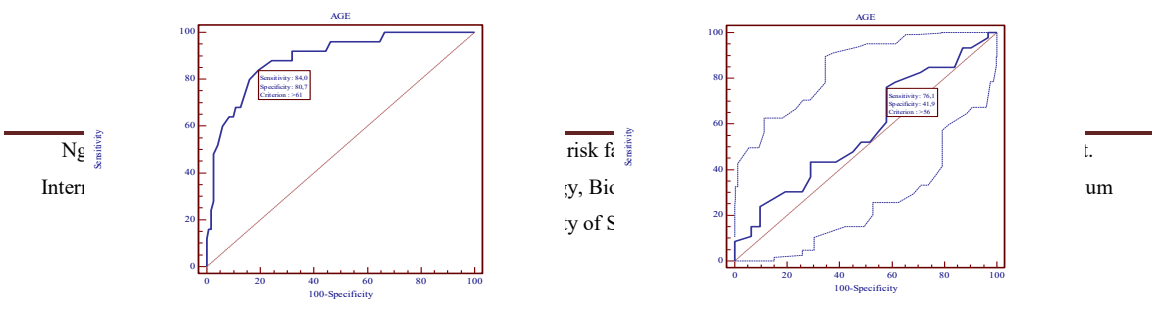
Table 4.2.4. The relationship between age and IMTc in study groups

Age	< 40 yrs	41- 59 yrs	≥ 60 yrs	P value
Vegan group (N=144)	0.42±0.12	0.54±0.14	0.92±0.51	< 0.05
Control group (N=68)	0.45 ± 0.31	0.65 ± 0.23	0.98 ± 0.75	< 0.05

There were statistically significant differences in the mean of IMTc with different age groups ($p < 0.01$) in study groups.

Variables	Group	Criterion	AUC	Sensitivity	CI	Specificity	CI
IMTc ≥ 0.9 mm	Vegan	61	0.89	84	63.9-95.5	82.7	72.4-87.3
	Control	56	0.574	76.1	61.2-87.4	41.9	24.5-60.9

Graph 4.5. Cut-off values of IMTc analysis by ROC curve for two groups



Age cut-off values for IMTc (≥ 0.9mm) in vegan group was older than in control group (61 vs 56 yrs)

4.2.5. hs CRP

Table 4.2.5. The relationship between hsCRP and age in study groups

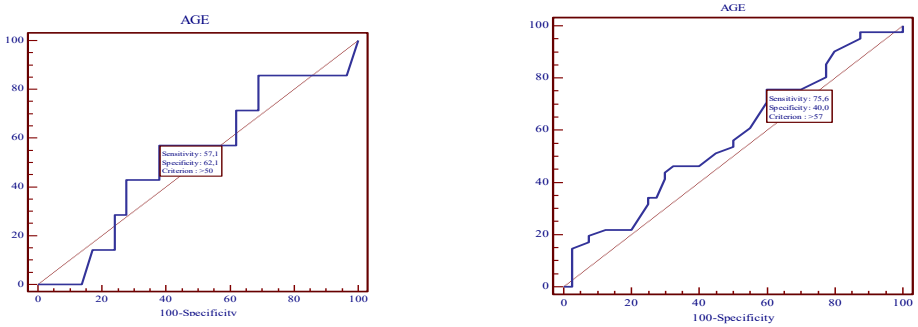
hsCRP mg/l	< 40 yrs	41- 59 yrs	≥ 60 yrs	P
Vegan group	0.78±2.07	1.69±4.41	3.06±4.28	p < 0.05
Control group	1.14±1.42	2.19±2.35	1.46±1.49	p>0.05

There were significantly differences in the mean of hsCRP with different age groups (p < 0.05) in vegan group but they were not presented in control group (p > 0.05)

Variables	Group	Criterion	AUC	Sensitivity	CI	Specificity	CI
hsCRP ≥ 3 (mg)	vegan	49	0.756	87.5	67.6-97.3	60.0	50.7-68.8
	control	57	0.573	75.6	59.7-87.6	40.0	24.9-56.7

hsCRP as inflammatory factors, was a risk factor for heart metabolism, in study found no significant difference between two groups.

Graph 4.6. Cut-off values of hsCRP analysis by ROC curve for vegan group and control



4.2.6. Ischemic heart disease (IHD)

Table 4.2.6. The relationship between age and IHD (ECG+) in study groups

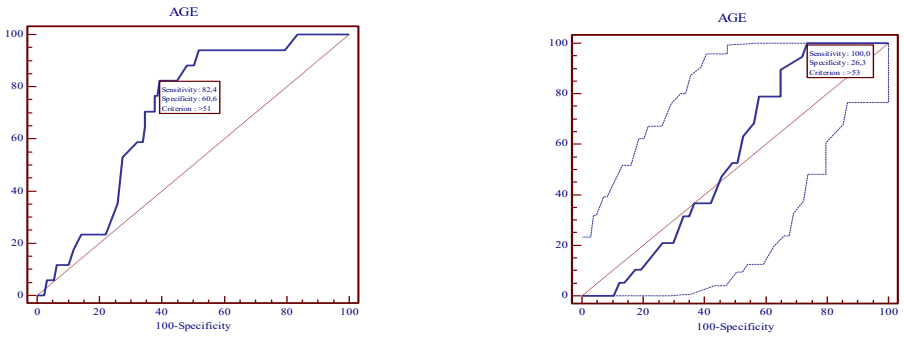
Age ECG (+)	< 40 yrs	41- 59 yrs	≥ 60 yrs	p

Vegan group	1 (1.9%)	6 (15%)	10 (18.6%)	< 0.05
Control group	2 (8.3%)	6 (25%)	7 (35 %)	< 0.05

There were significantly differences in the prevalence of IHD (ECG +) with age ($p < 0.05$) in study groups.

Variables	Group	Criterion	AUC	Sensitivity	CI	Specificity	CI
IHD (+)	Vegan	51	0.697	82.4	56.6 - 96.2	60.6	51.6 - 69.2
	Control	53	0.553	100.0	82.4 - 100.0	26.3	15.5 - 39.7

Graph 4.7. Cut-off values of IHD (+) analysis by ROC curve for vegan group and control group



Age for ECG (+) in vegan group was younger than in control group (51 vs 53 yrs)

4.2.7. Glycemia

Table 4.2.7.1. The relationship between age and fasting glucose in study groups

Age	< 40	41- 59 yrs	≥ 60 yrs	p
Vegan group (n=144)	4.46±0.37	4.86±0.73	5.76±1.95	< 0.001
Control group (n=68)	4.73 ± 1.34	4.52 ± 0.59	4.81 ± 0.87	>0.05

There were statistically significant differences in the mean of FG with different age groups in vegan group ($p < 0.001$) but were not presented in control group ($p>0.05$).

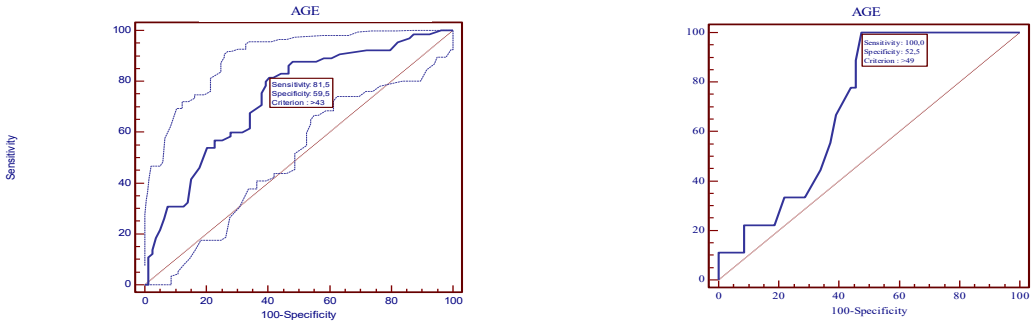
Table 4.2.7.2. The relationship between HbA1c and age in study groups

Age Risk factors	< 40 yrs	41- 59 yrs	≥ 60 yrs	P value
Vegan group (n=144)	5.48±0.28	5.76±0.45	6.33±1.34	< 0.001
Control group (n=68)	4.35± 1.23	4.15 ± 0.54	4.42 ± 0.80	> 0.05

There were statistically significant differences in the mean of HbA1c with different age groups in vegan group ($p < 0.001$) but in control group were no significant changes ($p > 0.05$)

Variables	Group	Criterion	AUC	Sensitivity	CI	Specificity	CI
HbA1c ≥ 5.7% Prediabetes	Vegan	43	0.735	81.5	70-90	59.5	47.9-70.4
	Control	49	0.702	100	66.4-100	52.5	39.1-65.7
HbA1c ≥ 6.5% Diabetes	Vegan	62	0.802	68.8	41.3-89	78.1	70-84.9
	Control	66	0.902	100	15.8-100	78.8	67-87.9

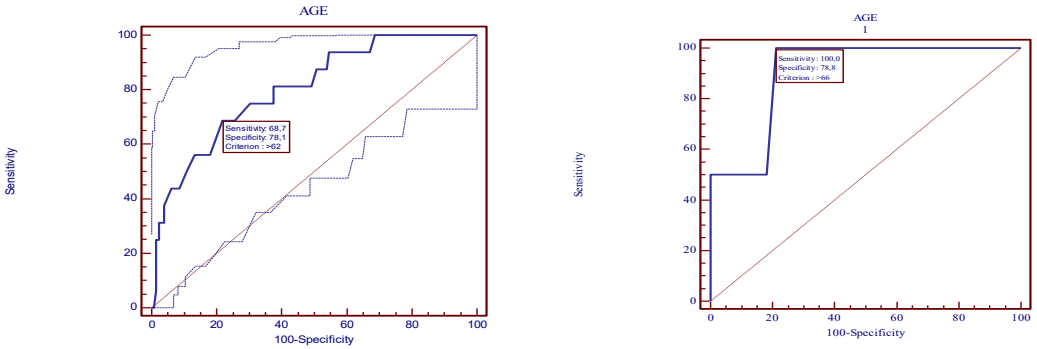
Graph 4.8. Cut-off values of HbA1c ≥ 5.7% analysis by ROC curve for vegan group and control group



Age cut-off for HbA1C ≥ 5. 7% (prediabetes) in vegan group was younger than in control group (43 vs 49 yrs)

Hyperglycemia on vegans were higher and earlier than controls because of vegans with following diet with much carbohydrate and inactivity increased WC and TG.

Graph 4.9. Cut-off values of HbA1c ≥ 6.5% analysis by ROC curve for vegan group and control group



Age cut-off for HbA1C ≥ 6.5% (diabetes) in vegan group was younger than in control group (62 vs 66 yrs)

4.2.8. Insulin resistance

Table 4.2.8.1. The relationship between fasting insulin level and age in study groups

Age	< 40	40- 59 yrs	≥ 60 yrs	P value
Vegan group	5.89±2.73	6.50±4.92	8.31±4.72	< 0.05
Control group	5.9 ± 2.45	4.87 ± 1.28	5.96 ± 2.41	>0.05

There were significantly differences in the mean of FI levels with different age groups ($p < 0.05$) in vegans**.** There were not significantly differences in the mean of FI levels with different age groups in controls ($p>0.05$)

Variables	Group	cut off	AUC	Sensitivity	CI	Specificity	CI
Fasting insulin ≥ 12 µU/ml	Vegan	62	0.608	75.2	67-82.3	54.6	23.4-83.3

Graph 4.10. Cut-off values of insulin ≥ 12 µU/ml by ROC curve for vegan group

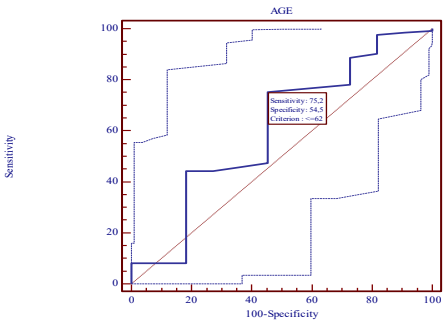


Table 4.2.8.2. The relationship between HOMA-IR and age in study groups

HOMA-IR	< 40	40- 59 yrs	≥ 60 yrs	P
Vegan group	1.17±0.52	1.47±1.37	2.31±2.20	< 0.001
Control group	1.27 ± 0.74	0.97 ± 0.29	1.26 ± 0.49	>0.05

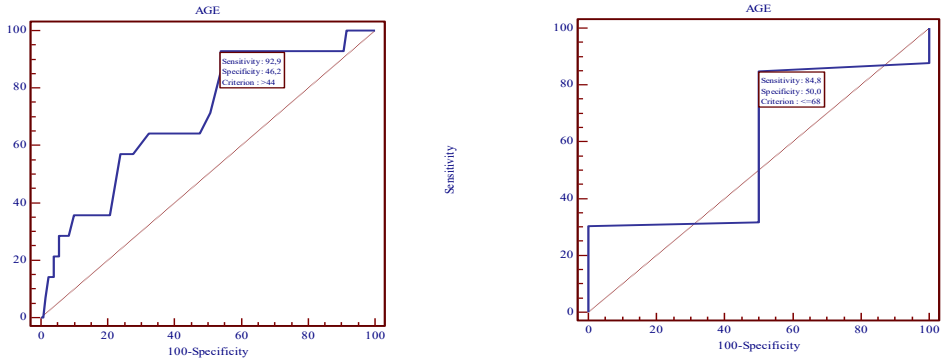
There were significantly differences in the mean of HOMA-IR in vegan group ($p < 0.001$).

There were not significantly differences in the mean of HOMA-IR in control group ($p > 0.05$).

Variables	Group	Criterion	AUC	Sensitivity	CI	Specificity	CI
HOMA-IR ≥ 2.6	Vegan	44	0.702	**92.9**	66.1-99.8	46.1	37.4-55.1
	Control	68	0.587	84.8	73.9-92.5	50.0	1.3-98.7

HOMA-IR index reflects increased glucose and related to secret insulin or insulin resistance. In vegans by using multiple CHO leaded to increase TG. TG caused insulin resistance.

Graph 4.11. Cut-off values of HOMA-IR ≥ 2.6 analysis by ROC curve for two groups



4.2.9. Total lipid profile

Table 4.2.9.1. The relationship between lipid profile and age in vegan group

Age / Risk factors	< 40 (n1=51)	41- 59 yrs (n2=40)	≥ 60 yrs (n3=53)	P
TC	4.25±0.90	4.84±1.04	5.31±1.02	< 0.001
TG	1.24±0.48	1.80±0.88	2.51±1.56	< 0.001
HDL.C	1.29±0.24	1.21±0.23	1.22±0.25	>0.05
LDL.C	2.39±0.68	2.84±0.87	3.06±0.86	< 0.001
Non- HDL.C	2.96±0.80	3.63±0.99	4.09±0.89	< 0.001

There were significantly differences in the mean of lipid profile (TC, TG, LDLC

and Non-HDL.C) with different age groups ($p < 0.001$) but were not with HDL.C ($p > 0.05$) in vegan group.

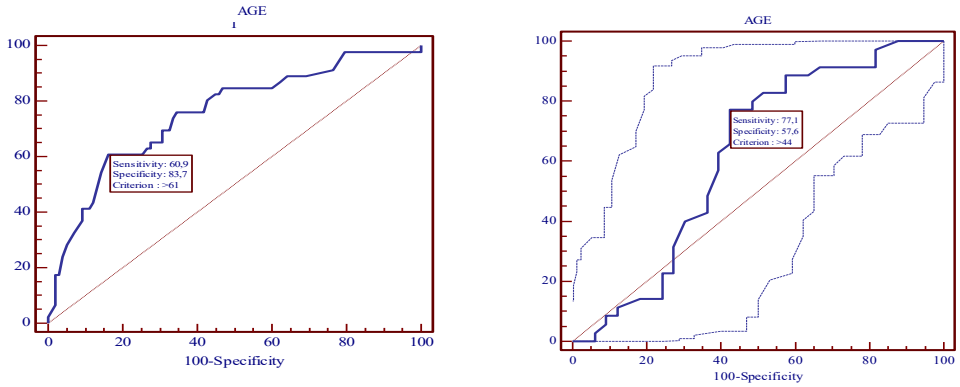
Table 4.2.9.2. The relationship between lipid profile and age in control group

Age Risk factors	< 40 (n1=24)	41- 59 yrs (n2=24)	≥ 60 yrs (n3=20)	P
TC	4.75 ±0.99	5.78 ± 1.28	5.43 ± 1.50	< 0.05
TG	1.75 ± 0.67	2.49 ± 1.43	2.17 ± 0.82	>0.05
HDL.C	1.34 ± 0.38	1.41 ± 0.36	1.29 ± 0.46	>0.05
LDL.C	2.60 ± 0.79	3.19 ± 1.00	3.20 ± 0.79	>0.05
Non. HDL.C	3.41 ± 0.89	4.38 ± 1.19	4.14 ± 1.33	>0.05

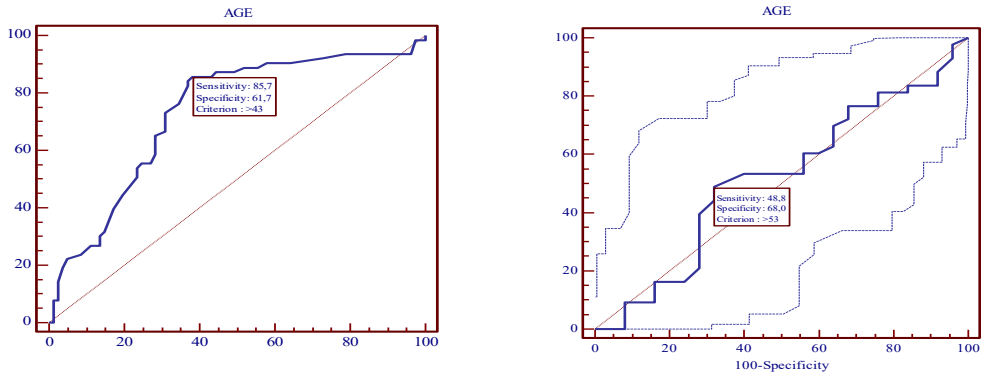
There were significantly differences in the mean of TC and LDL.C with different age groups ($p < 0.05$) but were not presented TG, HDL.C and LDL.C in control group.

Variables	Group	Criterion	AUC	Sensitivity	CI	Specificity	CI
TC ≥ 5.2	Vegan	61	0.769	60.9	45.4-74.9	77.1	74.8-90.8
	Control	44	0.621	83.7	59.9-89.6	57.6	39.2-74.5
TG ≥ 1.7	Vegan	43	0.732	85.7	74.6-93.3	62.7	50.3-72.3
	Control	53	0.518	48.8	33.3-64.5	68.0	46.5-85.1
HDL.C < 1.3	Vegan	67	0.502	24.6	14.1-37.8	85.1	75.8-91.8
	Control	67	0.503	29.0	14.2-48	89.2	74.6-97
LDL.C ≥ 3.4	Vegan	62	0.724	58.6	38.9-76.5	80.9	72.5-87.6
	Control	44	0.652	82.1	63.1-93.9	55	38.5-70.7
Non HDL ≥ 3.4	Vegan	46	0.758	69.1	56.9-79.5	78.08	66.9-86.9
	Control	35	0.652	84.8	71.1-93.7	50	28.2-71.8

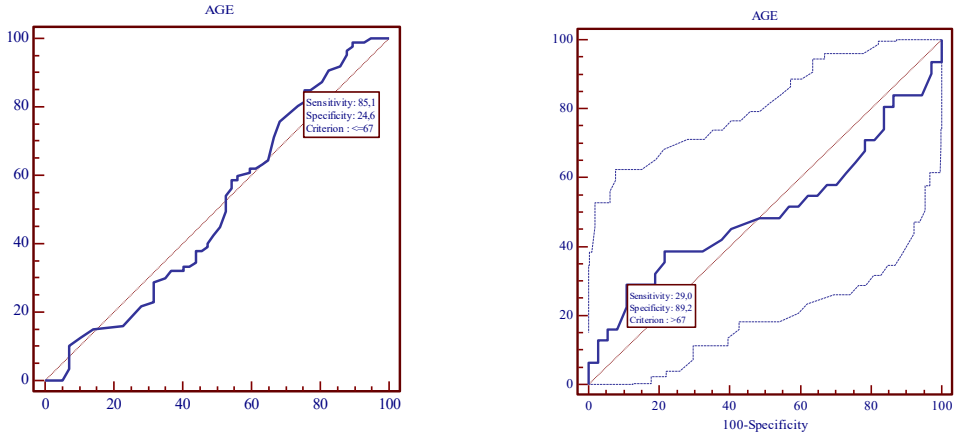
Graph 4.12. Cut-off values of TC ≥ 5.2 analysis by ROC curve for vegan group and control group



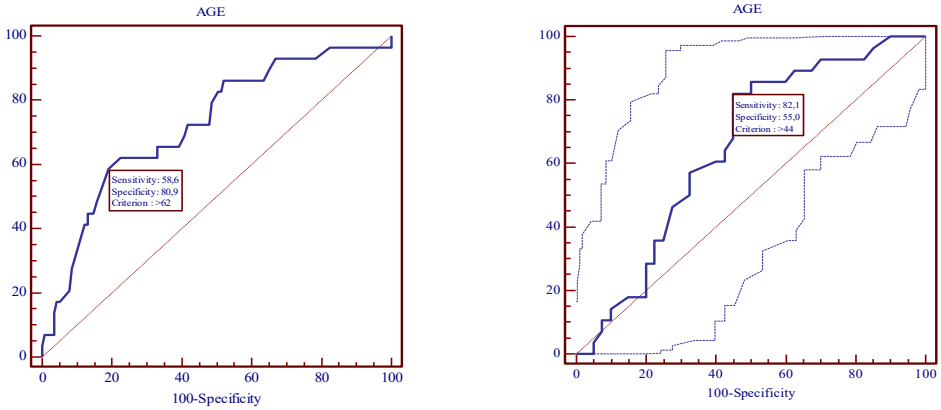
Graph 4.13. Cutoff values of TG ≥ 1.7 analysis by ROC curve for two groups



Graph 4.14. Cut-off value of HDL.C < 1.3 analysis by ROC curve for vegan group and control group



Graph 4.15. Cut-off values of LDL.C≥ 3.4 analysis by ROC curve for vegan group and control group



Graph 4.16. Cut-off values of non HDL.C ≥ 3.4 analysis by ROC curve for vegan group and control group

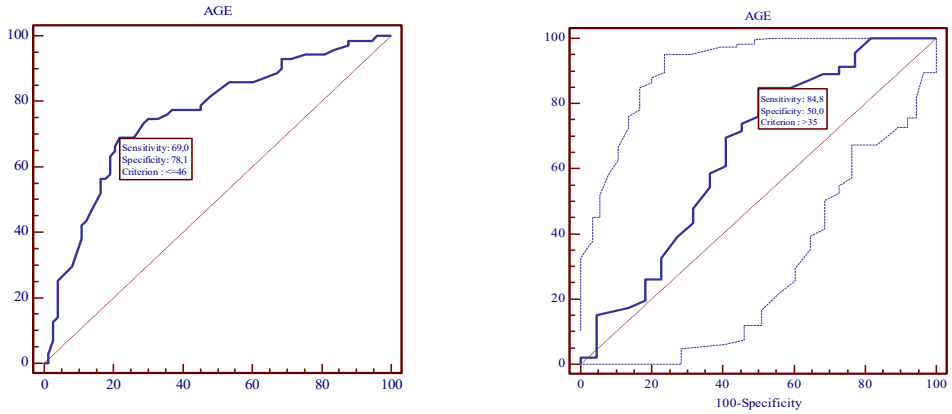


Table 4.2.9.3. The relationship between atherogenic indices and age in vegan group.

Age / Risk factors	< 40 (n1=51)	41- 59 yrs (n2=40)	≥ 60 yrs (n3=53)	p
TC/HDL.C	3.33±0.65	4.07±0.83	4.45±0.83	< 0.001
TG/HDL.C	1.00±0.47	1.57±0.83	2.25±1.83	< 0.001
LDL.C/HDL.C	1.87±0.51	2.38±0.68	2.54±0.62	< 0.001

There were significantly differences in the mean of atherogenic indices with different age groups ($p < 0.001$) in vegan group**.**

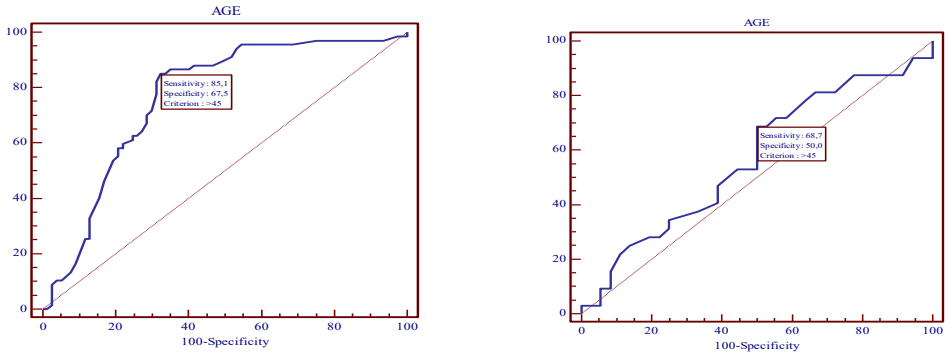
Table 4.2.9.4. The relationship between atherogenic indices and age in control group

Age / Risk factors	< 40 (n1=24)	41- 59 yrs (n2=24)	≥ 60 yrs (n3=20)	p
TC/HDL.C	3.72 ± 1.01	4.17 ± 1.71	4.48 ± 1.43	>0.05
TG/HDL.C	1.37 ± 0.61	1.90 ± 1.36	1.78 ± 0.67	>0.05
LDL.C/HDL.C	2.09 ± 0.87	2.38 ± 0.87	2.75 ± 1.26	< 0.05

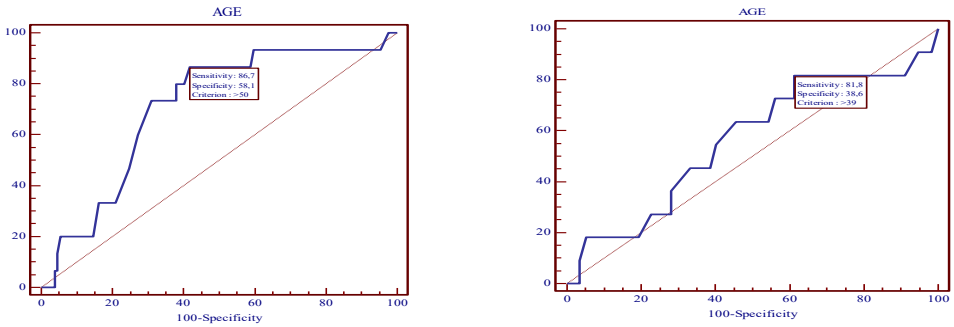
There were significantly differences in the mean of LDL.C/HDL.C with different age groups ($p < 0.05$) but were not presented in the control group.

Variables	Group	Criterion	AUC	Sensitivity	CI	Specificity	CI
TC/HDL ≥ 4	vegan	45	0.764	85.1	74.3-92.6	67.5	55.9-77.8
	control	45	0.569	68.8	50-83.9	50.0	32.9-67.1
TG/HDL ≥ 2.4	vegan	50	0.71	86.7	59.5-98.3	58.1	49.1-66.8
	control	39	0.565	81.8	48.2-97.7	38.6	26-52.4
LDL.C/HDL.C ≥ 2.3	vegan	46	0.709	76.3	64.8-86.5	63.3	51.7-73.9
	control	39	0.591	73.5	55.6-87.1	44.1	27.2-62.1

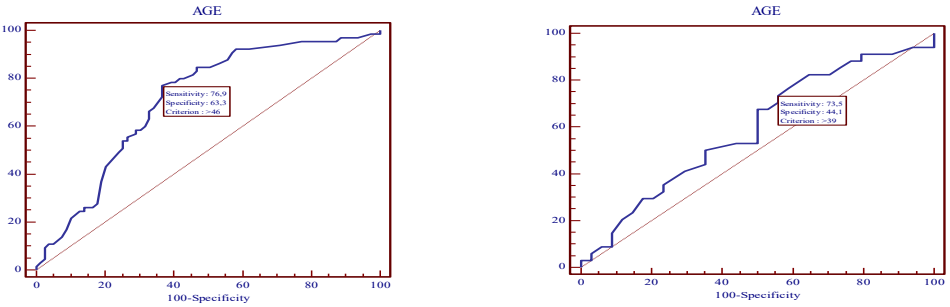
Graph 4.17. Cut-off values of non-TC/HDL.C ≥ 4 analysis by ROC curve for vegan group and control group



Graph 4.18. Cut-off values of TG/ HDL.C≥ 2.4 analysis by ROC curve for vegan group and control group



➢ Cut-off values of LDL.C/HDL.C ≥ 2.3 analysis by ROC curve for vegan group and control group



4.2.10. Metabolic Syndrome

Table 4.2.10.1. The proportion of MS in study groups

MS	Vegan group %	Control group %	P value
MS (+)	45 (31.35%)	2 (2.9%)	< 0.001
MS (-)	99 (68.8%)	66 (97.1%)	< 0.001

Proportion of MS (+) in vegan group was higher significantly than in control group (31. 35% vs 2. 9%, p < 0.001)

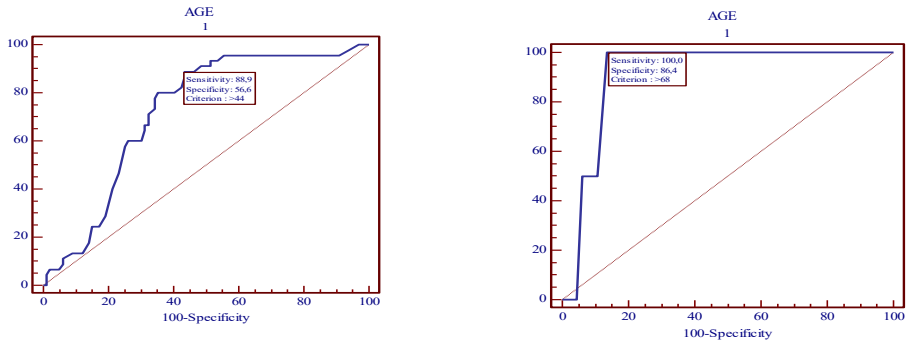
Table 4.2.10.1. Age of MS in study groups

MS	Vegan group	Control group	P
MS (+)	58.24 ± 13.03	72.00 ± 4.24	< 0.001
MS (-)	44.60 ± 17.37	49.24 ± 17.26	< 0.05

The mean age of vegan group with MS (+) was younger than in control group with MS (58.24 ± 13.03 vs 72. 00 ± 4.24, p < 0.001)

Variables	Group	Criterion	AUC	Sensitivity	CI	Specificity	CI
MS (+)	vegan	44	0.722	88.9	75.9 - 96.3	56.6	46.2-66.5
	control	68	0.913	100.0	15.8-100	86.4	75.7-93.6

Graph 4.20. Cut-off values of MS(+) analysis by ROC curve for two groups



Age cut-off values for MS (+) in vegan group was younger than in control group (44 vs 68 yrs)

Table 4.2.11. The proportion of cardio-metabolic risk factors in study groups

Number	Cardio-metabolic Risk factor	Vegan group (n=144)	Control group (n=68)	P value
1	BMI ≥ 23	50 (34.72%)	7 (10.29%)	< 0.05
2	WC≥ 80 cm	77 (53.47%)	14 (20.59%)	< 0.05
3	BP ≥ 130/85 mmHg	49 (34.03%)	18 (26.47%)	< 0.05
4	F Glucose ≥ 5.6mmol/L	19 (13.19%)	7 (10.3 %)	>0.05
5	HbA1c ≥ 5.7 %	65 (45.14%)	9 (13.24%)	< 0.05
6	Fasting Insulin ≥ 12µU/ml	11 (7.64%)	0	
7	HOMA-IR ≥ 2.6	14 (9.72%)	1 (1.5%)	< 0.05
8	TC ≥ 5.2 mmol/l	46 (31.9%)	35 (51.47%)	< 0.05
9	TG ≥ 1.7 mmol/l	63(43.75%)	43 (63.24%)	< 0.05
10	HDL.C < 1.3 mmol/l	87 (60.42%)	31 (45.59%)	< 0.05
11	LDL.C ≥ 3.4 mmol/l	29 (20.14%)	28 (41.18%)	< 0.05
12	Non. HDL ≥ 3.4 mmol/l	73 (50.69%)	46 (67.65%)	< 0.05
13	IMTc ≥ 0.9 mm	25 (17.36%)	9 (13.24%)	>0.05
14	hsCRP ≥ 3mg/l	24 (16.7%)	13 (19.1%)	> 0.05
15	IHD (+)	17(11.8%)	15 (22%)	>0.05
16	MS (IDF 2006)	45 (31.35%)	2 (2.9%)	< 0.001

There were several cardio-metabolic risk factors in subjects with vegan diet significantly higher than in control group, including BMI ≥ 23(34.72%), WC ≥ 80 cm (53.47%), HBP ≥ 130/85 mmHg (34.03%), HbA1c ≥ 5.7% (45.14%), HOMA-IR ≥ 2.6 (9.72%), HDL.C < 1.3 mmol/l (60.42%) and MS (+) (31.35%).

Otherwise there were some cardio-metabolic risk factors in subjects on vegan diet significantly lower than in control group, including TC ≥ 5.2 mmol/l (31.9%), TG ≥1.7 mmol/l (43.75%), LDL.C ≥ 3.4 mmol/l (20.14%) and non-HDL.C ≥ 3.4 mmol/l (50.69%).

Table 4.2.12. Age cut-off values for cardio- metabolic risk factors in study groups

Number	Risk factor	Age (yrs)	
		Vegan group	Control group
1	BMI ≥ 23	38	39
2	WC ≥ 80 cm	44	41
3	BP ≥ 140/90 mmHg	58	52
4	HbA1c ≥ 5.7 %	43	49
5	Fasting Insulin ≥ 12µU/ml	62	
6	HOMA-IR ≥ 2.6	44	68
7	TC ≥ 5.2 mmol/l	61	44
8	TG ≥ 1.7 mmol/l	43	53
9	HDL.C < 1.3 mmol/l	67	67
10	LDL.C ≥ 3.4 mmol/l	62	44
11	Non.HDL ≥ 3.4 mmol/l	46	35
12	TC/HDL.C	45	45
13	TG/HDL.C	50	39
14	LDL.C/HDL.C	46	39
15	IMTc ≥ 0.9 mm	61	56
16	hsCRP ≥ 3mg/l	50	57
17	IHD (+)	51	53
18	MS (IDF 2006)	44	68

4.3. THE RELATIONSHIP BETWEEN DURATION VEGAN DIET AND THE CARDIO-METABOLIC RISK FACTORS WITH PREDICTED VALUES BY ROC CURVE IN VEGAN GROUP

4.3.1. BMI and WC

Table 4.3.1. The relationship between duration of vegan diet with BMI and WC

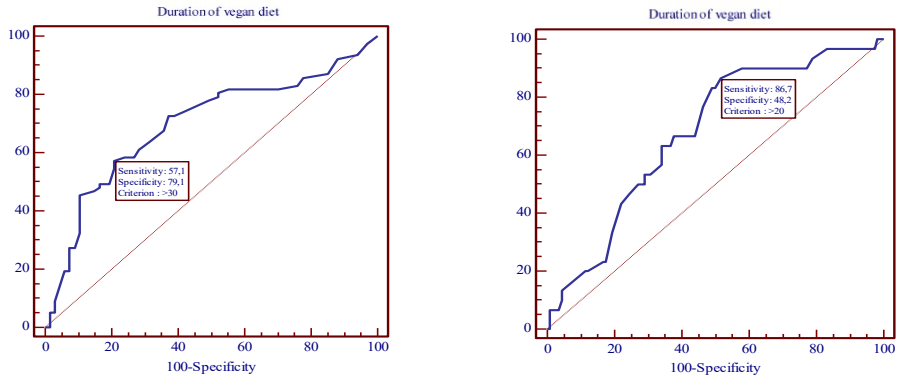
Duration of vegan diet	< 15 yrs n1=37	15-30 yrs n2=49	>30 yrs n3=58	P
BMI	20.52±2.53	21.29±2.75	23.37±3.19	< 0.001
WC	75.68±8.98	77.69±10.68	87.66±14.25	< 0.001

There were significantly differences between the duration of vegan diet and the mean BMI and WC ($p < 0.001$).

Variables	Criterion	AUC	Sensitivity	CI	Specificity	CI
BMI ≥ 23	20	0.667	86.7	69.3-96.2	48.3	38.8-57.8
WC ≥ 80	30	0.694	57.1	45.4-68.4	79.1	67.4-88.1

Graph 4.21. Cut-off values of BMI ≥ 23 and WC ≥ 80 analysis by ROC curve

WC ≥ 80 **BMI ≥ 23**



4.3.2. Duration of vegan diet and Arterial Blood Pressure

Table 4.3.2. The relationship between duration of vegan diet and blood pressure

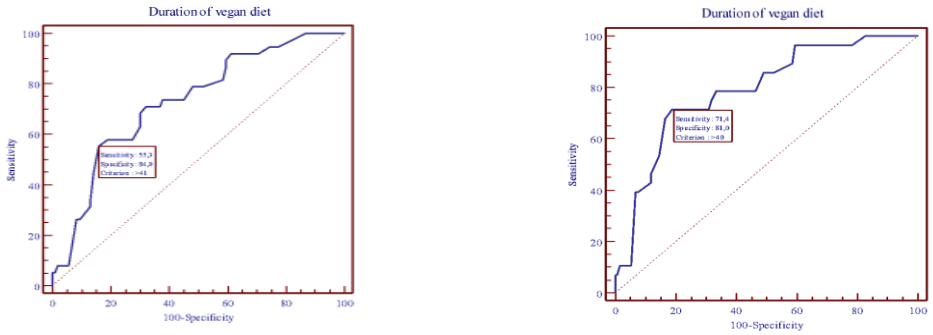
Duration of vegan diet	< 15 yrs n1=37	15-30 yrs n2=49	> 30 yrs n3=58	p
SBP (mmHg)	110.0± 13.74	115.47± 16.49	132.48 ± 19.11	< 0.001
DBP (mmHg)	68.30 ± 9.57	71.88 ± 9.51	73.98 ± 10.95	< 0.05

There were significantly differences between duration of vegan diet and the

average of SBP ($p < 0.001$) and DBP ($p < 0.05$)

Variables	Criterion	AUC	Sensitivity	CI	Specificity	CI
Hyper SBP	40	0.816	82.1	63.1-93.9	75.9	67.0-83.3
Hyper SBP and/or DBP (≥ 140/90)	41	0.729	55.3	38.3-71.4	84.0	75.6-90.4

Graph 4.22. Cut-off values of hyper BP (SBP and/ or DBP) and SBP analysis by ROC curve



4.3.3. Duration of vegan diet with hsCRP and IMTc

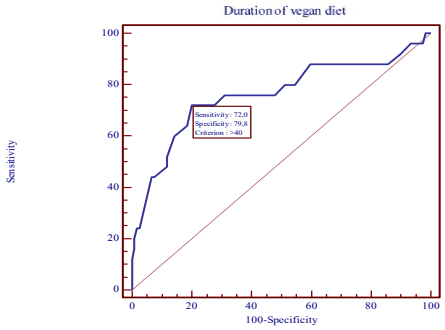
Table 4.3.3. Relationship between duration of vegan diet and hsCRP and IMTc

Duration of vegan diet	< 15 yrs	15-30 yrs	> 30 yrs	P
	n1=37	n2=49	n3=58	
hsCRP	0.82±1.93	0.96±1.63	3.32±5.30	< 0.001
IMTc	0.50±0.39	0.52±0.16	0.82±0.45	< 0.001
IHD	0(%)	3(6.1%)	14(24.1 %)	< 0.001

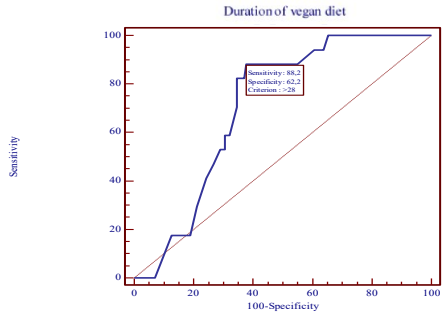
There were significant differences between duration of vegan diet with the mean hCRP, IMTc and IHD ($p < 0.001$).

Variables	Criterion	AUC	Sensitivity	CI	Specificity	CI
IMTc ≥ 0.9 (mm)	40	0.761	72. 0	50.6- 8.9	79.8	71.5-86.6
IHD (+)	28	0.708	88.2	63.6-98.5	62.2	53.2-70.7
hsCRP ≥ 3 (mg)	49	0.756	87.5	67.6 - 97.3	60.0	50.7-68.8

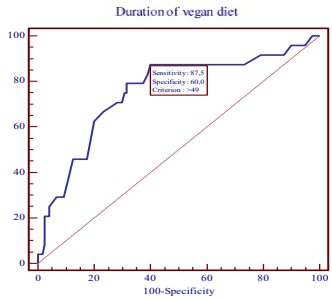
Graph 4.23. Cut-off values of IMTc ≥ 0.9 (mm) analysis by ROC curve



Graph 4.24. Cut-off values of IHD (+) analysis by ROC curve



Graph 4.25. Cut-off values of **hsCRP ≥ 3 (mg)** analysis by ROC curve



4.3.4. Duration of vegan diet and glycemia

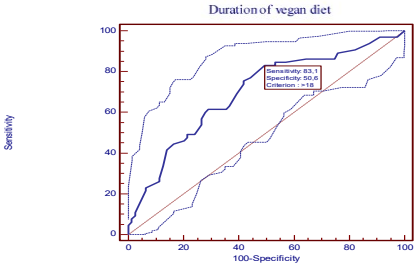
Table 4.3.4. Duration of vegetarian diet and CHO metabolism

Duration of vegan diet	**< 15 yrs**	**15-30 yrs**	**> 30 yrs**	**P value**
	n1=37	**n2=49**	**n3=58**	
Fasting Glucose (mmol/L)	4.71±0.64	4.73±0.64	5.54±1.78	< 0.05
HbA1c (%)	5.48±0.37	5.71±0.42	6.26±1.30	<0.001

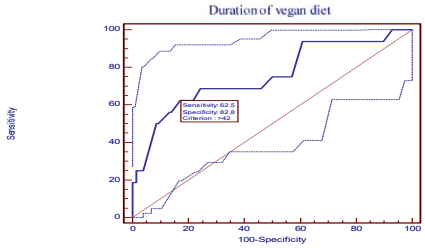
There were significant differences between duration of vegan diet with the average fasting glucose and HbA1c.

Variables	**Cretition**	**AUC**	**Sensitivity**	**CI**	**Specificity**	**CI**
HbA1c ≥ 5.7% Prediabetes	18	0.698	83.08	71.7-91.2	50.63	39.1-62.1
HbA1c ≥ 6.5% Diabetes	42	0.754	62.50	35.4-84.8	82.8	75.1-88.9

Graph 4.26. Cut-off values of HbA1c ≥ 5.7 % analysis by ROC curve



Graph 4.27. Cut-off values of HbA1c ≥ 6.5 % (diabetes) analysis by ROC curve



4.3.5. Duration of vegan diet with insulin resistance

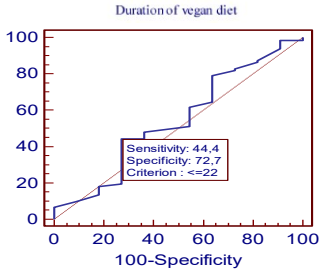
Table 4.3.5. The relationship between duration of vegan diet and insulin resistance

Duration of vegan	**< 15 yrs**	**15-30 yrs**	**> 30 yrs**	**p**
	n1=37	**n2=49**	**n3=58**	
Fasting Insulin	6.83±4.29	5.81±4.45	7.99±3.96	< 0.05
HOMA-IR	1.54±1.82	1.28±1.25	2.07±1.69	< 0.05

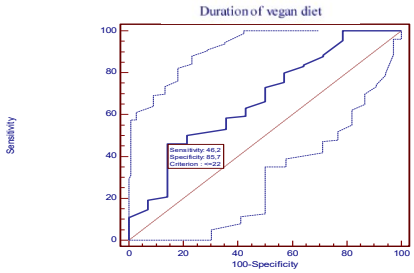
There were significant differences between duration of vegan diet with the mean fasting insulinemia and HOMA-IR ($p < 0.05$).

Variables	**Criterion**	**AUC**	**Sensitivity**	**CI**	**Specificity**	**CI**
Fasting insulin ≥ 12 µU/ml	22	0.545	44.36	35.8-53.2	72.73	39.0-94.0
HOMA-IR ≥ 2.6	22	0.702	46.15	37.4-55.1	85.71	57.2-98.2

Graph 4.28. Cut-off values of fasting insulin ≥ 12 µU/ml analysis by ROC curve



Graph 4.29. Cut-off value of HOMA-IR ≥ 2.6 analysis by ROC curve



4.3.6. Duration of vegan diet and total lipid profile

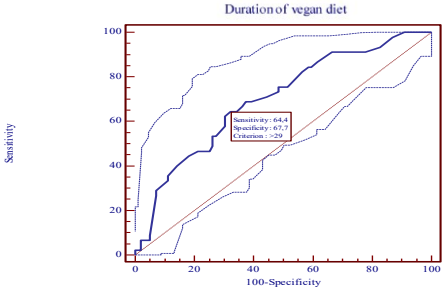
Table 4.3.6. The relationship between duration of vegan diet and total lipid

Duration of vegan	< 15 yrs	15-30 yrs	> 30 yrs	P value
	n1=37	n2=49	n3=58	
TC (mmol/l)	4.16±0.99	4.81±0.98	5.21±1.02	< 0.001
TG (mmol/l)	1.21±0.48	1.56±0.73	2.53±1.51	< 0.001
HDL.C (mmol/l)	1.28±0.21	1.29±0.28	1.18±0.23	< 0.05
LDL.C (mmol/l)	2.33±0.79	2.81±0.76	2.99±0.87	< 0.001
Non- HDL.C (mmol/l)	2.88±0.92	3.52±0.87	4.03±0.92	< 0.001

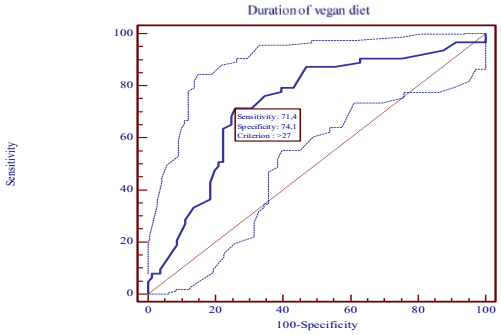
There were significant differences in the duration of vegan diet with the mean lipid profile and atherogenic indices ($p < 0.05$)

Variables	Criterion	AUC	Sensitivity	CI	Specificity	CI
TC ≥ 5.2	29	0.699	64.44	48-78.1	67.68	57.5-76.7
TG ≥ 1.7	27	0.729	71.43	58.7-82.1	74.07	63.1-83.2
HDL.C < 1.3	27	0.586	64.91	51.1-77.1	52.87	41.9-63.7
LDL.C ≥ 3.4	44	0.690	41.38	23.9-61.1	87.83	80.4-93.2
Non. HDL ≥ 3.4	26	0.709	65.75	53.7-76.5	71.83	59.9-81.9

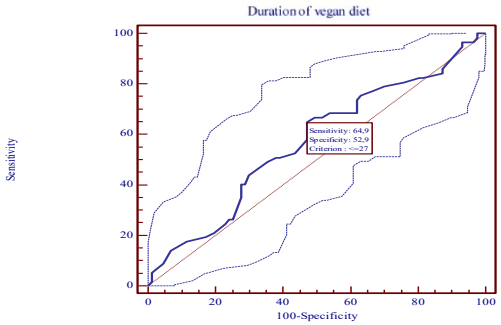
Graph 4.30 Cut-off value of TC ≥ 5.2 analysis by ROC curve



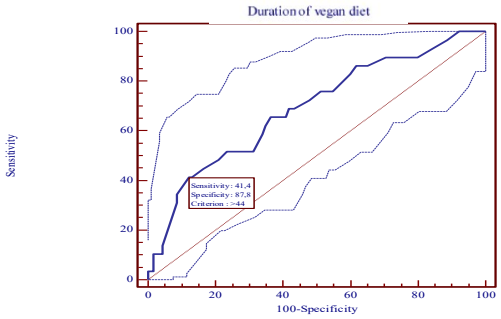
Graph 4.21. Cut-off value of TG ≥ 1.7analysis by ROC curve



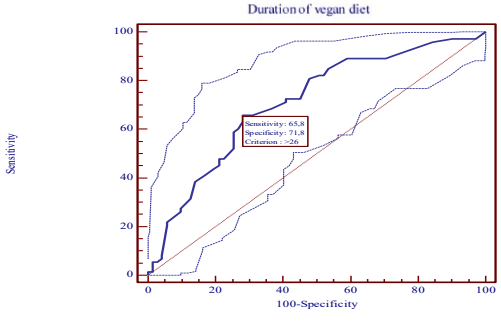
Graph 4.22. Cut-off values of HDL.C< 1.3 analysis by ROC curve



Graph 4.23. Cut- off values of LDL.C ≥ 3.4 analysis by ROC curve



Graph 4.24. Cut off values of non-HDL.C ≥ 3.4 analysis by ROC curve



4.3.7. Duration of vegan diet and atherogenic indices

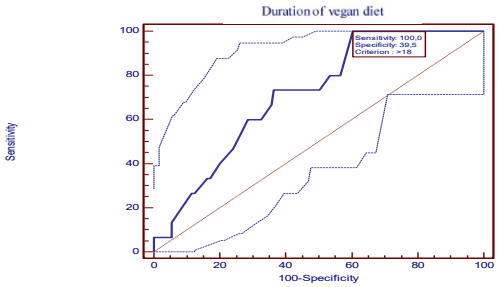
Table 4.3.7. The relationship between duration of vegan diet and atherogenic indices

Duration of vegan diet	< 15 yrs	15-30 yrs	> 30 yrs	P value
	n1=37	n2=49	n3=58	
TC/HDL.C	3.26±0.68	3.82±0.73	4.49±0.83	< 0.001
TG/HDL.C	0.96±0.41	1.30±0.73	2.30±1.75	< 0.001
LDL.C/HDL.C	1.82±0.56	2.23±0.55	2.57±0.66	< 0.001

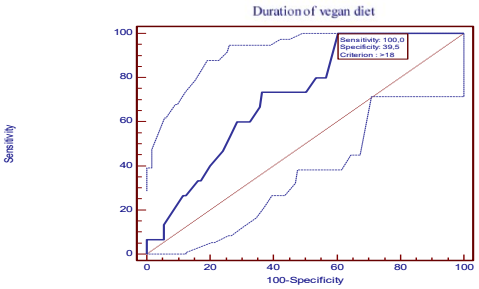
There were significant differences in the duration of vegan diet with the average lipid profile and atherogenic indices ($p < 0.001$)

Variables	Criterion	AUC	Sensitivity	CI	Specificity	CI
TC/HDL ≥ 4	18	0.784	89,55	79.7-95.7	57.4	45.4-68.4
TG/HDL ≥ 2.4	18	0.715	100.0	78.2-100.0	39.53	31.0-48.5
LDL.C/HDL.C ≥ 2.3	18	0.690	84.62	73.5-92.4	51.90	40.4-63.3

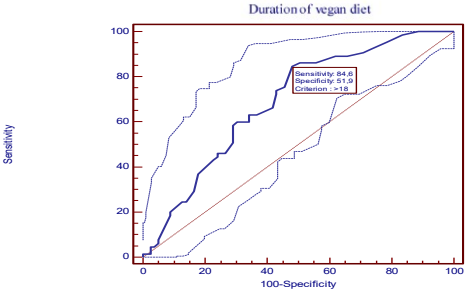
Graph 4.25. Cut-off value of TC/HDL.C ≥ 4 analysis by ROC curve



Graph 4.26. Cut- off values of TG/ HDL.C≥ 2.4 analysis by ROC curve



Graph 4.27. Cut-off values of LDL.C/HDL.C ≥ 2.3 analysis by ROC curve



4.3.8. Duration of vegan diet and Metabolic Syndrome

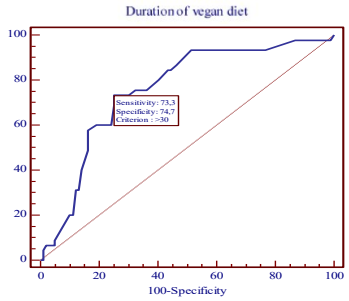
Table 4.3.8. Duration of vegan diet and MS

MS	Duration of vegan diet (yrs)	P
MS (+)	37.33 ± 13.63	< 0.001
MS (-)	23.53 ± 15.02	

The duration of vegan diet of MS (+) group was significantly higher than MS (-) group (37.33 ± 13.63 vs 23.53 ± 15.02 yrs, p < 0.001)

Variables	Criterion	AUC	Sensitivity	CI	Specificity	CI
MS(+)	30	0.756	73.33	58.1-85.4	74.75	65.0-82.9

Graph 4.28. Cut-off values of metabolic syndrome analysis by ROC curve

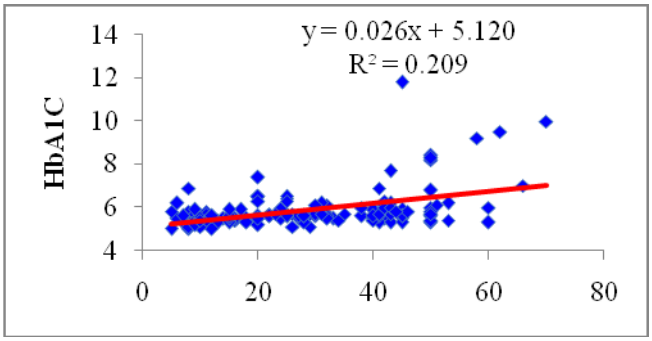


4.3.9. Correlation between duration of vegan diet and cardio-metabolic risk factors

Table 4.3.9. Correlation between duration of vegan diet and Cardio- metabolic risk factors

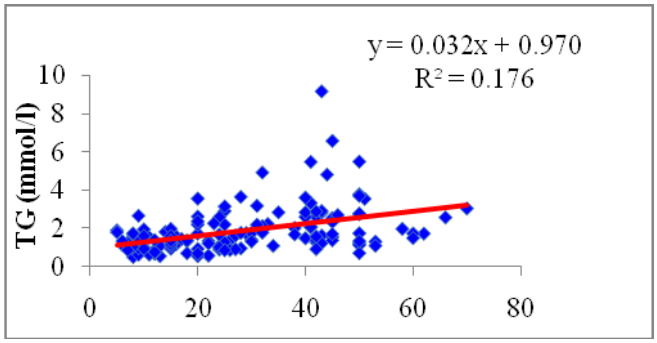
Vegan duration / CMRF	R	n	p
BMI	0.374	144	0.001
WC	0.411	144	0.001
SBP	0.539	144	0.0001
DBP	0.184	144	0.028
F Glucose	0.312	144	0.001
HbA1c	0.403	144	0.001
F Insulin	0.182	144	0.029
HOMA-IR	0.242	144	0.003
TC	0.377	144	0.001
TG	0.420	144	0.001
HDL-C	-0.176	144	0.035
LDL-C	0.307	144	0.001
Non HDL-C	0.446	144	0.001
TC/HDL-C	0.525	144	0.001
TG/HDL-C	0.381	144	0.001
LDL-C/HDL-C	0.432	144	0.001
hsCRP	0.486	144	0.001
IMTc	0.463	144	0.001

Graph 4.29 Correlation between duration of vegan diet and HbA1c



Duration of vegan diet ($r = 0.457.p < 0.01$)

Graph 4.30 Correlation between duration of vegan diet and TG levels



Duration of vegan diet($r = 0.419.p < 0.01$)

4.3.10. Multivariate regression analysis independent predictor

Table 4.3.10. Multivariate regression analysis independent predictor between the HbA1c and the risk factors

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.158	.521		7.977	.000
	Vegan duration	.016	.006	.264	2.779	**.006**
	Triglycerid	.145	.067	.188	2.173	**.032**
	Cholesterol	.156	.071	.180	2.204	**.029**
	SBP	.002	.006	.037	.298	.766
	DBP	-.003	.010	-.036	-.333	.740
	F Insulin	.039	.016	.180	2.405	**.018**

Duration of vegan diet was considered as independent risk factor for hyperglycemia. Dependent Variable: HbA1C

Table 4.3.11. The prediction of age and duration of vegan diet cut-off values for cardio-metabolic risk factors in vegan group

Number	Cardio-metabolic Risk factor	Vegan group	
		Age (yrs)	Vegan duration (yrs)
1	BMI ≥ 23	38	20
2	WC ≥ 80 cm	44	30
3	BP ≥ 140/90 mmHg	58	41
4	HbA1c ≥ 5.7 %	43	18
5	Fasting Insulin ≥ 12µU/ml	62	22
6	HOMA-IR ≥ 2.6	44	23
7	TC ≥ 5.2 mmol/l	61	29
8	TG ≥ 1.7 mmol/l	43	27
9	HDL.C < 1.3 mmol/l	67	27
10	LDL-C ≥ 3.4 mmol/l	62	44
11	Non.HDL ≥ 3.4 mmol/l	46	26
12	TC/HDL.C	45	18
13	TG/HDL.C	50	18
14	LDL.C/HDL.C	46	18
15	IMTc ≥ 0.9 mm	61	40
16	hsCRP ≥ 3mg/l	50	49
17	IHD(+)	51	28
18	MS (IDF 2006)	44	30

5. DISCUSSION

5.1. THE EFFECT OF LONG–TERM VEGAN DIET ON CARDIO-METABOLIC RISK FACTORS .

5.1.1. Anthropometric parameters (BMI and WC)

In many developing countries as Vietnam, changes in diet and life style have led to the increase in the prevalence of obesity, which is one of the major risk factors of cardiovascular and other chronic diseases. From various anthropometric indices only four of these, include body mass index (BMI), waist circumference (WC), waist to hip ratio (WHR), waist to height ratio (WHtR), are the most commonly used predictors of cardiovascular risk factors in clinical practice and large scale epidemiological studies.

Ashwini* 2016 [125] A comparative study of metabolic profile, anthropometric parameters among vegetarians and no vegetarians. It show that vegetarian have a more favorable lipid profile and anthropometry, with lower weight, body mass index, waist and hip circumference when compared to no vegetarians, that reduces cardiovascular risk among them.

EA Spencer*2003 [126] Age-adjusted mean BMI was significantly different between the four diet groups, being highest in the meat-eaters (24.41 kg/m2 in men, 23.52 kg/m2 in women) and lowest in the vegans (22.49 kg/m2 in men, 21.98 kg/m2 in women). Vegetarians and especially vegans had lower BMI than meat-eaters.

In our study, though the average BMI was not different between vegan and control group but the prevalence of overweight in female vegan group was significantly higher than in control group. Especially, the prevalence of android obesity in female vegan group was significantly higher compared to control group. There was significant difference in WC between vegan and control group. It could be explained that vegan females in our study lacked daily exercise, they spent more time on learning, teaching at the temple. Particularity, they consumed more carbohydrate (over 70% of daily total energy). High triglycerides driven by more carbohydrate consumption, increase fatty acid synthesis, then accumulate in abdominal fat, it explicate their high waist circumference and being overweight.

5.1.2. Arterial Blood Pressure

Hypertension and cardiovascular disease are leading causes of morbidity and mortality. Accumulating data demonstrate a relationship between hypertension and several vascular and metabolic abnormalities that are components of the cardio metabolic syndrome. The components of the cardio metabolic syndrome include insulin resistance/hyperinsulinemia, central obesity, dyslipidemia, hypertension, microalbuminuria, increased inflammation, and oxidative stress.

Krithiga Shridhar1*2014 [129] Evaluated the association between vegetarian diet (chosen by 35%) and CVD risk factors across four regions of India. Results: vegetarians also had decreases in SBP (ABP =20.9 mmHg (95% CI: 21.9 to 0.08), p>0.05) when compared to no vegetarians.

Christopher 1989 [130] After further adjusting BP for body mass index and waist/hip ratio, the systolic BP among Black vegetarians remained lower (122.8) than Black no vegetarians (129.7) but higher than that of the Whites who showed no diet-related BP differences. (Am J Public Health 1989; 79:1283-1288.)

In our study, the prevalence of hypertension (SBP and/or DBP) was higher in vegan group and the prevalence of hyper blood pressure ≥ 130/85 mmHg (Metabolic Syndrome) was also higher. The average SBP in vegan group was higher. We can conclude from the study that vegetarian diet may have preventive role in hypertension and the hill subjects have lesser chance of hypertension due to healthy work culture and better adaptability in sodium excretion.

Our results were different from the others' results, which could explicate that Vietnamese female vegans take daily salt more than recommended by the guidelines of WHO (5 gam/day). Moreover, the prevalence of overweight and android obesity of vegan female causes insulin resistance with high levels of cardiovascular biomarkers including leptin, angiotensinogen, resistine, IL, TNF alpha …Insulin resistance is an important risk factors for type 2 diabetes and can cause vasoconstriction and renal sodium reabsorption leading to increase blood pressure.

5.1.3. Intima Media Thickness of Carotid Artery (IMTc)

Intima Media Thickness (IMT) was early atherosclerotic lesions can be detected by ultrasound with high resolution. IMT of carotid artery, it was considered as cardiometabolic risk factors.

Shu-Yu Yang1. 2*†, Hui-Jie Zhang2†2011 [132] Study of One hundred and seventy-one Chinese male vegetarians were screened for metabolic profile,

cardiovascular risk and carotid IMT. Results: IMT was thinner in the vegetarian group than in the omnivore group (0.59 ± 0.16 vs. 0.63 ± 0.10 cm, $p < 0.05$). The vegetarians were divided according to duration of vegetarian diet (< 6 years, 6 to ≤ 11 years, > 11 years), those in tertile 1 (< 6 years) and tertile 2 (6 to ≤ 11 years) had shown thinner IMT as compared to the omnivores, and tertile 3 had shown no reduction. Conclusion: low-protein, or vegetarian diet might have great beneficial effects on IMT through improved lipid profile, and the beneficial effects appeared to be correlated with the duration of vegetarian diet.

Intima Media Thickness (IMT) was early atherosclerotic lesions can be detected by Ultrasound with high resolution. IMT of carotid artery was consider as cardio metabolic risk factors.

In our study, there were not significant differences in prevalence of IMTc ≥ 0.9 mm between two groups but the average IMTc in vegan group was thinner than in control group because of TC, LDL-C levels were lower in vegan group.

5.1.4. hs CRP

C-reactive protein (CRP) is a liver-derived pattern recognition molecule that is increased in inflammatory states. Since cardiovascular disease is at least in part an inflammatory process, CRP has been investigated in the context of arteriosclerosis and subsequent vascular disorders. Based on multiple epidemiological and intervention studies, minor CRP elevation [high-sensitivity CRP (hsCRP)] has been shown to be associated with future major cardiovascular risk (hsCRP:< 1 mg/L=low risk; 1-3 mg/L=intermediate risk; 3-10 mg/L=high risk.

Chakole SA1 2014 [133] Compared hsCRP as a cardiovascular risk marker in vegetarian and non-vegetarian groups. Age and gender matched 50 vegetarian and 50 non-vegetarian healthy subjects were selected. It was found that serum hsCRP was significantly lower in vegetarian than non-vegetarian group (0.67+ 0.04 mg/l vs. 1.5 + 0.09 mg/l; p value < 0.0001).

It can be concluded that high consumption of plant foods viz. vegetables, fruits and cereals are associated with lower values of hsCRP and a favorable lipid profile. This explains the role of vegetarian diet in suppressing the inflammation and thus in reduction in cardiovascular disease risk.

In our study, the most of vegan subjects and control group were normal cardiovascular so the proportion of hs CRP ≥ 3 mg/l and the mean were not significantly different between two groups.

5.1.5. Ischemic heart disease

The cardio metabolic syndrome is a prevalent metabolic disorder. Epidemiologic studies correlate the cardio metabolic syndrome with an increased risk of coronary heart disease, ischemic stroke, cardiovascular mortality, and total mortality. There is also evidence that the cardiometabolic syndrome is a risk factor for abnormalities in myocardial metabolism, cardiac dysfunction, and arrhythmias such as atrial fibrillation. Multiple imaging modalities, both invasive and noninvasive, may help physicians better define the presence or risk of cardiovascular disease in their patients with the cardiometabolic syndrome

Tanuja Rastogi and et al 2014 [134] They observed a significant and dose-dependent inverse association between vegetable intake and IHD riskCereal intake was also associated with a lower risk. Use of mustard oil, which is rich in-linolenic acid, was associated with a lower risk than was use of sunflower oil. **Conclusion:** diets rich in vegetables and use of mustard oil could contribute to the lower risk of IHD among Indians.

In our study, IHD (+) detected by ECG in control group present not significantly higher than vegan group. IHD can be caused by coronary artery disease (atherosclerosis) and or endothelial dysfunction of the coronary vessels (coronary microvascular dysfunction) related increase glucose blood levels and blood TG. In the results showed IHD (+) related increase blood glucose and TG on vegans.

5.1.6. Glycemia (Fasting glucose and HbA1c)

Hyperglycemia is one of important components in cardio metabolic syndrome, causing microvascular complications in this population.

Yoko Yokoyama1 2014 [135] conducted a systematic review and meta-analysis of controlled clinical trials examining the association between vegetarian diets and glycemic control in type 2 diabetes. Results: Of 477 studies identified, six met the inclusion criteria (n=255. mean age 42.5 years). Consumption of vegetarian diets was associated with a significant reduction in HbA1c compared with consumption of comparator diets. Consumption of vegetarian diets is associated with

improved glycemic control in type 2

Nguyen Trung Huy and et al (2003-2004) [148] evaluated the nutrition in subjects with vegetarian diet in Hue showed that quantities of carbohydrate accounted 71% of daily energy of nutrition.

In our study, although the proportion of hyperglycemia (based on fasting glucose) in vegan group was not higher than those in control group but the mean fasting glucose was higher in vegan group than in control group. The mean average HbA1c in vegan group was higher than those in the control group. The proportion of hyperglycemia (based on HbA1c) in vegan group was higher than those in control group with prediabetes accounting for 34% in vegan group and 10.3% in control group. In natural progression of diabetes the postpradial glycemia increase before fasting glucose. The HbA1c levels correlate with postprandial glycemia level more than fasting glucose concentration. It explained for high prevalence of hyperglycemia in vegan group. We found that the carbohydrate daily consumption accounted for more than 70% of total energy, with high proportion of BMI and WC contributing to high risk of hyperglycemia in this study population.

5.1.7. Insulin resistance

Metabolic syndrome (MS) is a collection of cardio-metabolic risk factors that includes obesity, insulin resistance, hypertension, and dyslipidemia. Although there has been significant debate regarding the criteria and concept of the syndrome, this clustering of risk factors is unequivocally linked to an increased risk of developing type 2 diabetes and cardiovascular disease.

Mi-Hyun Kim1. Yun-Jung Bae 2015 [137]

The present study was conducted to compare serum leptin and insulin resistance levels between Korean postmenopausal long-term semi-vegetarians and non-vegetarians. The HOMA-IR of the vegetarians was significantly lower than that of the non-vegetarians ($p < 0.01$) after adjustment for the % of body fat. A long-term vegetarian diet might be related to lower insulin resistance independent of the % of body fat in postmenopausal women.

In our study, proportion of Fasting insulin ≥ 12 µU/ml in Vegan group was 7.6% but not case in control group. Mean fasting insulinemia in vegan group was higher than in control group (6.9 ± 4.3 vs 5.55 ± 2.13 µU/ml, $p < 0.05$)

The proportion of HOMA-IR and the mean in Vegan group was higher than

control group.

The hyperinsulinemia in female vegans due to high daily carbohydrate consumption, beta cell produced more insulin than normal physiologic recommendation for glycemic regulations. Otherwise central obesity, hypertriglyceridemia contributing to insulin resistance in this population.

5.1.8. Lipid profiles and Atherogenic indices

In recent years, adopting a vegetarian diet has become increasingly popular. Vegetarian diets exclude all animal flesh. Varieties of vegetarianism include vegan, raw vegan, ovovegetarian, lactovegetarian, lacto-ovovegetarian, and pescovegetarian. Vegetarian diets exclude all animal flesh and are being widely adopted by an increasing number of people; however, effects on blood lipid concentrations remain unclear.

Pranay Gandhi and et al 2014 [139] A Study of Vegetarian Diet and Cholesterol and Triglycerides Levelsa. Results: Significant difference was reported for TC, LDL and TG levels among the samples. Higher levels were reported by omnivores, with decreased levels for vegetarians as animal products were restricted, with lowest levels having been reported by vegans. Mean and standard deviation for TC were 208.09 ± 49.09 mg/dl in the group of omnivores, and 141.06 ± 30.56 mg/dl in the group of vegans ($p < 0.001$). Conclusion: Vegetarian diet was associated to lower levels of TG, TC and LDL as compared to the diet of omnivores.

Nguyen Trung Huy and et al (2003-2004) [148]. In his study about nutrition in population with vegetarian diet in Hue-Vietnam showed that the amount of lipid in ingredients accounted for only 16.6% daily energy nutrition.

Simone Grigoletto De Biase 2005 [140] Vegetarian Diet and Cholesterol and Triglycerides Levels. Conclusion: vegetarian diet was associated to lower levels of TG, TC and LDL as compared to the diet of omnivores.

Christopher L Melby and et al 1994 [144] Blood pressure and blood lipids among vegetarian, semivegetarian, and nonvegetarian African Americans. VEGs had a lower mean waist-to-hip ratio (WHR) and lower dietary intakes of protein, saturated fat, and cholesterol compared with the NONVEGS. Only 16% of the VEGS were confirmed to be hypertensive compared with 35.7% of the SEMIVEGS and 31.1% of the NONVEGS. Independent of differences in WHR,

the VEGs had significantly lower concentrations of serum total cholesterol (STC), LDL.C, triglycerides, STC/HDL.C, and LDL.C/HDL.C than the NONVEGs. The SEMIVEGs had lipid values intermediate to the VEG and NONVEG groups. Among African-American 5DM**,** a vegetarian diet was associated with lower cardiovascular disease risk factors than is an omnivorous diet.

In our study, the proportion of total lipids were significantly lower than in control group. Proportion of non.HDL.C (≥ 3.4 mmol/L) in vegan group was significantly lower than in control group (50.7% vs 67.65 %, $p < 0.05$). The prevalence of high risk atherogenic indices was not significantly lower in vegan group than in control group.

5.1.9. Metabolic Syndrome

Metabolic syndrome is a multiplex risk factor that arises from insulin resistance accompanying abnormal adipose deposition and function. It is a risk factor for coronary heart disease, as well as for diabetes, fatty liver, and several cancers.

NICO S. RIZZO and et al [146] RESULTS—A vegetarian dietary pattern was associated with significantly lower means for all MRFs except HDL (P for trend, 0.001 for those factors) and a lower risk of having MetS (OR 0.44.95% CI 0.30–0.64.P, 0.001) when compared with a nonvegetarian dietary pattern. Conclusions—A vegetarian dietary pattern is associated with a more favorable profile of MRFs and a lower risk of MetS. The relationship persists after adjusting for lifestyle and demographic factors.

Penghui Shang PhD and et al 2011 [147] As for MS components, no vegetarians and pescovegetarians had 0.72 (95% CI, 0.62. 0.84), 0.70 (95% CI, 0.57.0.84) times risk of developing low high density lipoprotein cholesterol (HDL-C), while no vegetarians had 1.16 (95% CI, 1.02. 1.32) times risk of developing high fasting plasma glucose.

In our study, the proportion of MS (+) in vegan group was significantly than that of control group.

Our data suggest that the vegan diets did not decrease the risk of metabolic syndrome compared with pesco-vegetarian, lactovegetarian and no vegetarian diets in a Taiwanese cohort.

5.2. THE RELATIONSHIP BETWEEN AGE AND DURATION VEGAN DIET WITH THE CARDIO-METABOLIC RISK FACTORS IN STUDY GROUPS

5.2.1. Anthropometric indices with age and vegan duration

Sutapa Agrawal*et al 2014 [127] Association between types of vegetarian diet (vegan, lacto-vegetarian, lacto-ovo vegetarian, pesco-vegetarian, semi-vegetarian and non-vegetarian) and self-reported diabetes status and measured body mass index (BMI) were estimated using multivariable logistic regression adjusting for age, gender, education, household wealth, rural/urban residence, religion, caste, smoking, alcohol use, and television watching. Mean BMI was lowest in pesco-vegetarians (20.3 kg/m2) and vegans (20.5 kg/m2) and highest in lacto-ovo vegetarian (21.0 kg/m2) and lacto-vegetarian (21.2 kg/m2) diets.

PK Newby and Alicja Wolk et al 2005 [128] In secondary analyses, we reclassified women as lactovegetarians on the basis of food intakes reported on the food-frequency questionnaire. The prevalence of overweight or obesity (BMI $\geq$ 25) was 40% among omnivores, 29% among both semi-vegetarians and vegans, and 25% among lactovegetarians.

In our study the prediction of overweight and obesity in vegan group was 38 yrs and in control group was 39 yrs. Anthropometric indicators (BMI, WC) both of vegans and controls were not different by age. Vegans were less active and consumed so much carbohydrate (CHO) converted into TG and stored in the liver that causes abdominal fat accumulation and the organ and controls were too.

The age cut-off values for WC $\geq$ 80cm was higher in vegan group than in control group (44 vs 41 yrs).

In vegan females, there were significantly different between the duration of vegan diet with the mean of BMI and WC ($p < 0.001$). Moreover the duration of vegan diet cut-off value for BMI $\geq$ 23 was 20 yrs and for WC $\geq$ 80cm was 30yrs

5.2.2. Arterial Blood Pressure with age and vegan duration

So, in our study, the age cut-off for Hyper BP (SBP and/or DBP) in vegan group was older than control group (60 vs 52 yrs), age cut-off values for high SBP in vegan group was 60 yrs and in control group was 52 yrs.

Hypertension, particularly systolic hypertension in vegans and outside the age-related (atherosclerosis). They consumed a high-salt in meals (soy, chao, soy sauce…) that increased sensitivity to old people. This explained the increasing age of women hypertension later than non-vegetarians.

There were significantly difference between the duration of vegan diet with the mean of Systolic Blood Pressure (SBP) ($p < 0.001$) and Diastolic Blood Pressure (DBP) ($p < 0.05$). Duration of vegan diet cutoff for hyper BP (SBP and/ or DBP) was 41yrs and for hyper Systolic blood pressure was 40 yrs.

5.2.3. Glycemia with age and vegan duration

Yoko Yokoyama [135] (2014). 477 studies identified, six met the inclusion criteria (n=255. mean age 42.5 years). Consumption of vegetarian diets was associated with a significant reduction in HbA1c [−0.39 percentage point; 95% confidence interval (CI), −0.62 to −0.15; P=0.001; I2=3.0; P for heterogeneity =0.389], and a non-significant reduction in fasting blood glucose concentration (−0.36 mmol/L; 95% CI, −1.04 to 0.32; P=0.301; I2=0; P for heterogeneity =0.710), compared with consumption of comparator diets. Conclusions: Consumption of vegetarian diets is associated with improved glycemic control in type 2 diabetes.

In our study, there were significant difference between duration of vegan diet with the mean of FG and HbA1c. The age cutoff for HbA1C ≥ 5. 7% (prediabetes) in vegan group was younger than control group (43 vs 49 yrs). Age cut-off for HbA1C ≥ 6.5% (diabetes) in vegan group was younger than control group (62 vs 66 yrs).

There were significant differences between duration of vegan diet with the mean of fasting glucose and HbA1c. The prediction of vegan duration cut-off values for HbA1C ≥ 5. 7% (prediabetes) was 18 and for HbA1C ≥ 6.5% (diabetes) was 42 ys.

5.2.3. Insulin resistance with age and vegan duration

H. Kahleova, M. Matoulek* and et al 2010 [138] The aim of this study was to compare the effects of calorie-restricted vegetarian and conventional diabetic diets alone and in combination with exercise on insulin resistance, visceral fat and oxidative stress markers in subjects with Type 2 diabetes. Conclusions: A calorie-restricted vegetarian diet had greater capacity to improve insulin sensitivity compared

with a conventional diabetic diet over 24 weeks.

Shu-Yu Yang, Hui-Jie Zhang, Su-Yun Sun, Li-Ying Wang, Bing Yan, Chang-Qin Liu, Wei Zhang & Xue-Jun Li, [132] Compared to the omnivores, the vegetarians had lower BMI, weight, systolic blood pressure and diastolic blood pressure. Omnivores had significantly higher fasting blood glucose than that of vegetarians. However, there were no differences in fasting insulin, C- reactive protein and HOMA-IR between the two groups.

So, there were significantly differences in the mean of fasting insulinemia levels with age groups in vegan group while there were not significantly differences in control group

There were only significantly differences the mean of HOMA-IR with age in vegan group. The age cut-off values for fasting insulin levels ≥ 12 μU/ml in vegan group was 62 yrs. The age cutoff for HOMA-IR ≥ 2.6 in vegan group was younger than in control group (44 vs 68yrs). There were significantly differences between duration of vegan diet with the mean of FI, HOMA-IR. Duration of vegan diet cutoff for fasting insulin was 22 yrs and HOMA-IR was 23 yrs.

5.2.4. Lipid profiles, Atherogenic indices with age and vegan duration

Yee-Wen Huang and et al 2014 [141] vegan diet and blood lipid profiles: a cross-sectional study of pre and postmenopausal women

Conclusions: Vegan diet was associated with reduced HDL.C level. Because of its effects on lowering HDL.C and LDL.C, ovo-lacto vegetarian diet may be more appropriate for premenopausal women.

Sumon Kumar Das1. Abu Syed Golam Faruque 2012 [145]. To examine the association between consumption of vegetable-based diets and lipid profile of aged vegetarians in rural Bangladesh. Results: the mean age of the vegetarians and no vegetarians were 58 and 57 years respectively with normal kidney and liver function. The vegetarians had significantly lower mean serum. **Conclusion:** Findings of this study suggest that compared to no vegetarians, rural Bangladeshi vegetarians had better serum lipid profile.

Manish Verma1*and et al 2015 [142] Conclusions: this systematic review and meta-analysis provides evidence that vegetarian diets effectively lower blood concentrations of total cholesterol, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol, and non–high-density lipoprotein cholesterol. Such diets

could be a useful no pharmaceutical means of managing dyslipidemia, especially.

Neal d. Barnard and et al 2006 [136] Individuals with type 2 diabetes (*n* _ 99) were randomly assigned to a low-fat vegan diet (*n* _ 49) or a diet following the American Among those who did not change lipid-lowering medications, LDL cholesterol fell 21.2% in the vegan group and 10.7% in the ADA group (*P* _ 0.02).

Vegans were less saturated fatty acids, so the amount of cholesterol in the vegan diet was lower than controls. Besides reducing lipid transport protein (lipoprotein) cholesterol was not reduced while decreased HDL.C cardioprotective factors decreases, combining increased blood TG and glucose metabolic syndrome contributes to increased rate (metabolic syndrome) in women.

Relationship between lipid profiles with different age groups in vegan group.

There were significantly differences in the mean of lipid profiles and atherogenic indices with age groups but HDL.C was not different in vegan group.

With TC/HDL.C and TG/HDL.C were not significantly differences with age groups in control group.

There were significantly different in the duration of vegan diet with the mean atherogenic indices. Duration of vegan diet cutoff values with atherogenic indices in vegan group was 18 yrs.

5.2.5. Metabolic Syndrome with age and vegan duration

Penghui Shang PhD1 2011 [147] The purpose of the present study was to assess the risk of the metabolic syndrome (MS) with vegan, pesco-vegetarian, lactovegetarian and no vegetarian diets in Taiwan. Compared with vegans, hazard ratios of MS for no vegetarians, pesco-vegetarians, lacto-vegetarians were 0.75 (95% CI, 0.64.0.88), 0.68 (95% CI, 0.55. 0.83) and 0.81 (95% CI, 0.67.0.97) after adjusting for sex, age, education status, smoking status, drinking status, physical activity at work and leisure, respectively. MS components, no vegetarians and pesco-vegetarians had 0.72 (95% CI, 0.62. 0.84), 0.70 (95% CI, 0.57.0.84) times risk of developing low high density lipoprotein cholesterol (HDL.C), while nonvegetarians had 1.16 (95% CI, 1.02. 1.32) times risk of developing high fasting plasma glucose. Our data suggest that the vegan diets did not decrease the risk of metabolic syndrome compared with pesco-vegetarian, lacto-vegetarian and no vegetarian diets in a Taiwanese cohort.

NICO S. RIZZO 2011 [146]. RESULTS—A vegetarian dietary pattern

was associated with significantly lower means for all MRFs except HDL (Pfor trend, 0.001 for those factors) and a lower risk of having MetS (OR 0.44.95% CI 0.30–0.64.P, 0.001) when compared with a nonvegetarian dietary pattern. CONCLUSIONS—A vegetarian dietary pattern is associated with a more favorable profile of MRFs and a lower risk of MetS. The relationship persists after adjusting for lifestyle and demographic factors

So, the proportion of MS (+) in vegan group was higher significantly than in control group. The mean age of vegan group with MS (+) was younger than control group with MS.

The duration of vegan diet of MS (+) was significantly than in group without MS. Duration of vegan diet cutoff value with MS(+) in vegan group was 30 yrs

5.2.6. hs CRP with age and vegan duration

Shu-Yu Yang, Bing Yan, Chang-Qin Liu, Wei Zhang & Xue-Jun Li, (October 12. 2011) [132]"Compared to the omnivores, the vegetarians had lower BMI, weight, systolic blood pressure and diastolic blood pressure. Also, the levels of triglyceride, total cholesterol, HDL.C, LDL.C, ApoA1. ApoB, uric acid, albumin and g-glutamyl transferase were significantly reduced in vegetarians. Omnivores had significantly higher fasting blood glucose than that of vegetarians. However, there were no differences in fasting insulin, C-reactive protein and HOMA-IR between two groups.

So, there weresignificantly differences in the mean of hs CRP with different age groups in vegan group but not with control group.

Age cutoff value for hsCRP ≥ 3 mg were also 49 yrs in two groups.

Duration vegan diet was 49 yrs in vegan group.

5.2.7. Intima Media Thickness of Carotid Artery (IMTc) with age and vegan duration

There were significantly differences in the mean of IMTc with different age groups in study groups. Age Cutoff for IMTc in vegan group was older than control group. (61 vs 56 yrs)

IMT was an early symptom of atherosclerosis-related dyslipidemia that increased TC, LDL.C and non HDL.C. In my studying, the concentration of these three substances lower than controls. That explained that why vegans thick IMTc later than no vegetarian females.

Tyler R McClintock and et al 2014 [149] Objective: carotid intima-media thickness (IMT) is a validated surrogate marker of preclinical atherosclerosis and is predictive of cardiovascular morbidity and mortality. However, research on the association between IMT and vegan diet have not been cleared yet. Especially, in low-income countries or low-BMI populations. Conclusions: A gourd/root vegetable diet in this Bangladeshi population positively correlated with carotid IMT, while a balanced diet was associated with decreased IMT.

Shu-Yu Yan, Hui-Jie Zhang et al 2011 [132] Study of One hundred and seventy-one Chinese male vegetarians were screened for metabolic profile, cardiovascular risk and carotid IMT. In this study, the vegetarians had thinner IMT compared to the omnivores. Our results demonstrated that the reduction of IMT is dependent on duration of vegetarian diet; however, the effects on reduction of IMT are not significant in those whose duration is beyond 11 years

5.2.8. Ischemic heart disease with vegan duration and age

Timothy J Key and eta al 1999 [150]. The lower mortality from ischemic heart disease among vegetarians was greater at younger ages and was restricted to those who had followed their current diet for > 5 yrs. Further categorization of diets showed that, in comparison with regular meat eaters, mortality from ischemic heart disease was 20% lower in occasional meateaters, 34% lower in people who ate fish but not meat, 34% lower in lacto-ovo-vegetarians, and 26% lower in vegans. There were no significant differences between vegetarians and no vegetarians in mortality from cerebrovascular disease, stomach cancer, colorectal cancer, lung cancer, breast cancer, prostate cancer, or all other causes combined.

There were significantly differences in the prevalence of IHD (ECG+) with age in study groups. Age cut-off values for ECG (+) in vegan group was 51 yrs and in control group was 53yrs.

5.2.9. Multivariate regression analysis independent predictor

There were highly significant relations between the risk factors and duration of vegan diet. The risk factors were increased in following long- term vegan diet.

Multivariate regression analysis independent predictor between the duration time vegan diet with the risk factors. Duration of vegan diet was considered as independent risk factor for hyperglycemia. Dependent Variable: WC, HbA1C.

CONCLUSIONS

144 Buddhist nuns aged 20-75 years with duration of vegan diet ranged 10-70 years were screened for cardio metabolic risk factors. They were compared with 68 age-matched women aged 22-84 years with non-vegan diet.

1. The prevalence of the cardio-metabolic risk factors in study groups.

The prevalence of overweight (BMI ≥ 23) was significantly higher in the vegan group than in control group (34.7% vs 10.3%, $p < 0.05$).

There was a significant difference in the mean WC between vegan group and control group (81.2±13.0 vs 74.18 ± 7.14 cm, $p < 0.05$). The prevalence of android obesity (WC ≥ 80cm) in vegan group was higher than in control group (53.5% vs 20.6%, $p < 0.05$).

The prevalence of high BP (SBP and/or DBP) in vegan group was higher than in control group (26.4.5% vs 11.8 %, $p < 0.05$). The average SBP was higher in vegan group than in control group (120.9±19.50 vs 115.59 ± 17.22 mmHg, $p < 0.05$).

The prevalence of hypertension ≥ 130/85 mmHg (Metabolic Syndrome) in vegan group was higher than in control group (34.03 % vs 26.47 %, $p < 0.05$).

The average fasting glucose in vegan group was higher than in control group (5.00 ±1.4 vs 4.67 ± 0.98 mmol/l, $p < 0.05$). The prevalence of hyperglycemia (based on fasting glucose) in vegan group was higher than in control group (13.2% vs 10.3%, $p < 0.05$).

The average HbA1c in the vegan group was higher than in control group (5.9 ±0.9 vs 4.3 ± 0.90.$p < 0.05$). The prevalence of hyperglycemia (based on HbA1c) in vegan group was higher than in control group (45.1% vs 13.2%, $p < 0.05$), in which prediabetes were 34% in vegan group and 10.3% in control group.

The average fasting insulinemia in vegan group was higher than in control group (6.9 ± 4.3 vs 5.55 ± 2.13 μU/ml, $p < 0.05$). Proportion of fasting insulin ≥ 12 μU/ml in vegan group was 7.6%.

The average HOMA-IR index in vegan group was higher than in control group (1.67±1.62 vs 1.16 ± 0.55. $p < 0.05$). Proportion of HOMA-IR ≥ 2.6 in vegan group was higher than in the control group (9.7% vs 1.5%, $p < 0.05$).

The mean TC in vegan group was significantly lower than in control

group (4.8±1.11 vs 5.31 ±1.32 mmol/l, $p < 0.05$). Proportion of TC (≥ 5. 2mmol/L) in vegan group was significantly lower than in control group (31.9% vs 51.47%, $p < 0.05$).

Proportion of TG (≥ 1.7 mmol/l) in vegan group was significantly lower than in the control group (43.8% vs 63.2%, $p < 0.05$), Proportion of LDL.C (≥ 3.4 mmol/l) in vegan group was significantly lower than in control group (20.1% vs 41.1%, $p < 0.05$).

The average HDL.C in vegan group was significantly lower than in control group (1.2±0.2 vs 1.35 ± 0.39 mmol/l, $p < 0.05$). Proportion of HDL.C (< 1. 3 mmol/l) in vegan group was significantly higher than in control group (60.4 % vs 45.59%, $p < 0.05$).

The mean non-HDL.C in vegan group was significantly lower than in control group (3.6 ± 1.00 vs 3.97 ± 1.20 mmol/l, $p < 0.05$). Proportion of non-HDL.C (≥ 3.4 mmol/l) in vegan group was significantly lower than in control group (50.7% vs 67.65 % $p < 0.05$).

The mean TC/HDL in vegan group was not significantly lower than in control group (3.9±0.9 vs 4.14 ± 1.23, $p < 0.05$).

The average IMT of carotid artery in vegan group was thinner than in control group (0.64± 0.39 mm vs 0.73 ± 0.11 mm, $p < 0.05$).

The prevalence of MS (+) in vegan group was significantly higher than in control group (31.35% vs 2.9%, $p < 0.001$)

2. The relationship of age with the cardio-metabolic risk factors and prediction of age in study groups

Benefits of vegan diet with respect to the prevalence of cardiometabolic risk factors were studied by using the ROC curves for predicting the age cutoff values between vegan group and control group; BP (58 vs 52 years), TC (61 vs 44 years), LDL.C (62 vs 44 years), non-HDL-C (46 vs 35 years), LDL.C/HDL.C (46 vs 39 years), IMTc (61 vs 56 years), respectively. The vegan diet group seems to be disadvantageous towards prediabetes (43 vs 49 years), HOMA-IR (44 vs 68 years), TG (43 vs 53 years), hsCRP (50 vs 57 years) and MS (44 vs 68 years).

3. Relationship between duration of vegan diet and the time began appearing these cardio metabolic risk factors.

BMI was 20 yrs, WC was 30 yrs, SPB was 40 yrs, Hyper SBP and / SDP was 41 yrs, IMTc was 40 yrs, IHD (+) was 28 yrs, CRP was 49 yrs.

Prediabetes was 18 yrs and diabetes was 42 yrs, IR was 22 yrs.

Dyslipidemia: TC was 29 yrs, TC was 27 yrs, decrease HDL.C was 27 yrs, increase LDL.C was 44 yrs and atheroclerosis was 18 yrs.

MS (+) was 30 yrs.

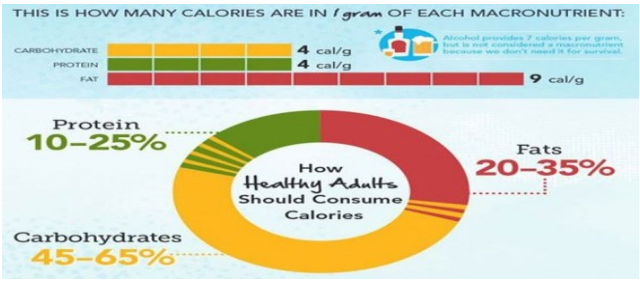
There were correlations between duration of vegan diet and cardiometabolic risk factors including BMI (r = 0.374), WC (r = 0.411), SBP (r = 0.539), FG (r = 0.312), HbA1c (r = 0.403), lipid profile (r = 0.307), hsCRP (r = 0.486) and IMTc (r = 0.463), in which the duration of vegan diet was considered as independent risk factor for hyperglycemia.

We conclude that:

There were many benefits healthy for vegetarian diet or vegan diet in short time and may be also a lower risk for some other diseases. Howerver, in our study showed that if you were a long - term vegan diet, it could increase Metabolic Syndromes. That was one of risk factors due to visceral obesity and hyperglycemia. So, all of us must be careful with the duration of vegan diet.

Hyperglycaemia and its comorbidities of hypertension, dyslipidemia and obesity projects the multifaceted nature of the problem which requires an urgent need for greater public awareness on risk factors for hyperglycaemia status and strengthening of diabetes related health services to early detect, prevent, and treat individuals with diabetes. To prevent diabetes related morbidity and mortality; the role of clinicians in promoting self-care, and further following a dedicated self-care behaviour by patients in multiple domains of food choices, physical activity, proper medications intake and regular blood glucose monitoring has to be emphasized.

Visceral obesity, Hyperglycemia, Hypertension



Limitations

Several limitations of present study should be noted.

First, the sample size appears too small and second, there was a high proportion of sedentary women in vegan group. However, our results suggest that further works should be carried out to investigate the effect of long-term vegan diet on metabolic syndrome.

STUDY IN ITALY

During the period I spent in Sassari University, I collaborated to a study whose aim was to identify differentially expressed plasma proteins between T2DM and non-diabetic patients undergoing carotid endarterectomy, by means of two-dimensional electrophoresis (2-DE) coupled with LC-MS/MS analysis.

Topic: Identification of differentially expressed plasma proteins in atherosclerotic patients with type 2 diabetes

Diabetes mellitus is a huge global health problem affecting more than 380 million people worldwide (**International Diabetes Federation, 2013**). It represents the fifth-leading cause of mortality and a major risk factor for cardiovascular diseases (CVD). Type 2 diabetes mellitus (T2DM), or adult-onset diabetes, represents over 90% of cases of diabetes mellitus and is characterized by hyperglycaemia caused by insulin resistance. A major issue of T2DM is that it may remain undetected for several years and its diagnosis is often made incidentally, through an abnormal blood or urine glucose test, when vascular complications are already present in most of patients. Furthermore, hyperglycemia and insulin resistance alone could not justify the high cardiovascular risk associated with T2DM suggesting that other factors significantly contribute to increase the residual cardiovascular risk in diabetic patients. Atherosclerosis is a form of chronic inflammation characterized by the accumulation of lipids and fibrous elements in medium and large arteries that represents a major cause of death and disability in people with diabetes. Although apparently independent, many of these risk factors are correlated with each other owing to common origins or pathways. In this scenario, a better understanding of the mechanisms underlying diabetic vascular disease is mandatory, as it may provide novel approaches to prevent or delay the development of its complications.

1.Objectives:

To identify plasma biomarkers useful for elucidating the biochemical mechanisms underlying the strong associations between diabetes and atherosclerosis, by differential proteomic analysis of plasma samples from diabetic and non-diabetic atherosclerotic patients.

2.Material and Methods:

Proteomic analyses were conducted on plasma samples from 29 patients undergoing carotid endarterectomy for severe artery disease at Centro Cardiologico "F. Monzino", IRCCS (Milan). Carotid atherosclerosis was assessed by ultrasonography using a Mylab 70 X vision echocolor Doppler equipped with a LA332 AppleProbe 11–3 MHz (Esaote).

Briefly, 14 plasma samples from diabetic patients and 15 plasma samples from non-diabetic patients were subjected to a low-abundance proteins enrichment step using hexapeptide combinatorial ligand libraries (ProteoMiner™ enrichment kit, Bio-Rad Laboratories) followed by two-dimensional electrophoresis. This analytical technique allows resolving hundreds of different protein isoforms according to both isoelectric point and molecular weight. Protein profiles were compared by using PD-Quest software (Bio-Rad Laboratories) and differentially expressed proteins were identified by LC-MS/MS analysis. Furthermore, a protein–protein interaction network was built by using STRING v10.a database of known and predicted physical/functional protein associations.

3. Results and Discussion:

Reproducible 2-DE profiles of plasma proteins enriched of low expressed fraction were obtained from both groups of patients (Figure 1 panel A). Image analysis allowed the detection of a panel of sixteen spots differentially expressed between two groups (Figure 1 panel B, Fig. 2), nine of them with higher expression in diabetic patients.

Sixteen differentially expressed spots were identified with a high score. Among them, there were fibrinogen beta and gamma chains, complement C1r, C3 and C4-B subcomponents, alpha-1-antitrypsin (AAT), vitronectin and CD5 antigen-like. Protein–Protein interaction analysis evidenced a network among differentially expressed proteins (figure 3) in which vitronectin seems to represent a potentially pivotal node among fibrinolysis, complement dependent immune responses and inflammation in accordance with a number of in vitro and in vivo evidences for a contributory role of these proteins to the development of diabetic atherosclerosis.

Figure1. Representative 2-DE profile of plasma low-abundance proteins enriched fraction after mass compatible Coomassie Brillant Blue G-250 staining. Molecular weight standards (All Blue Prestained Protein Standards, Bio Rad) were run alongside focused strip in the second dimension. Circled spots, which were differentially expressed between T2DM patients and controls, are reported, and shown in panel B at higher magnification.

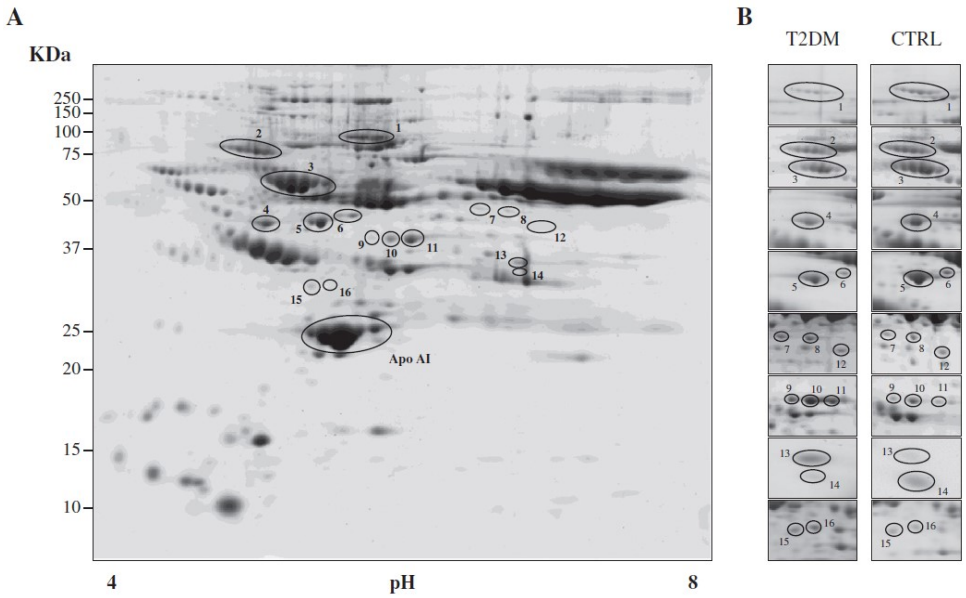


Figure 2. Bar chart reporting relative abundances of both sixteen differentially expressed proteins (panelA) and apolipoproteinAI (panelB), inT2DM patients(□) and controls(■), obtained by image analysis on 2-DE maps. Numbers correspond to the protein spots circledin (Fig. 1). Error bars represent standard deviations.

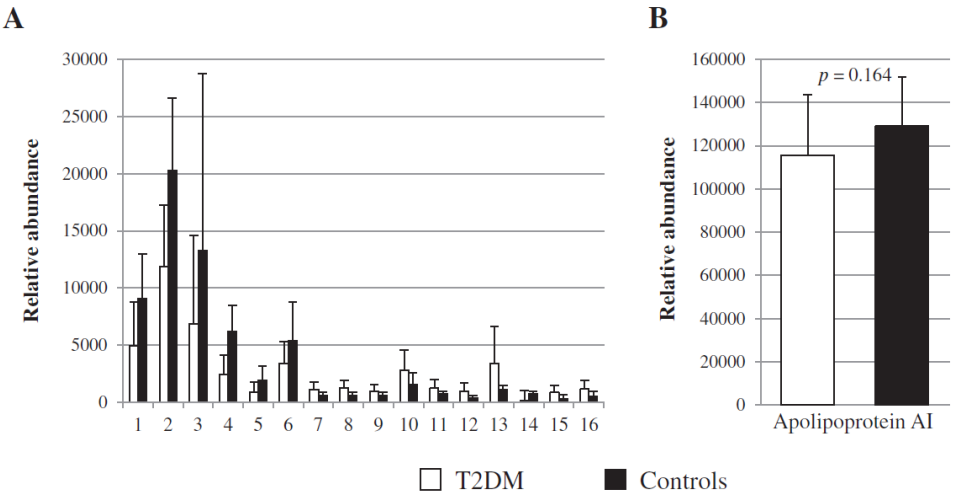
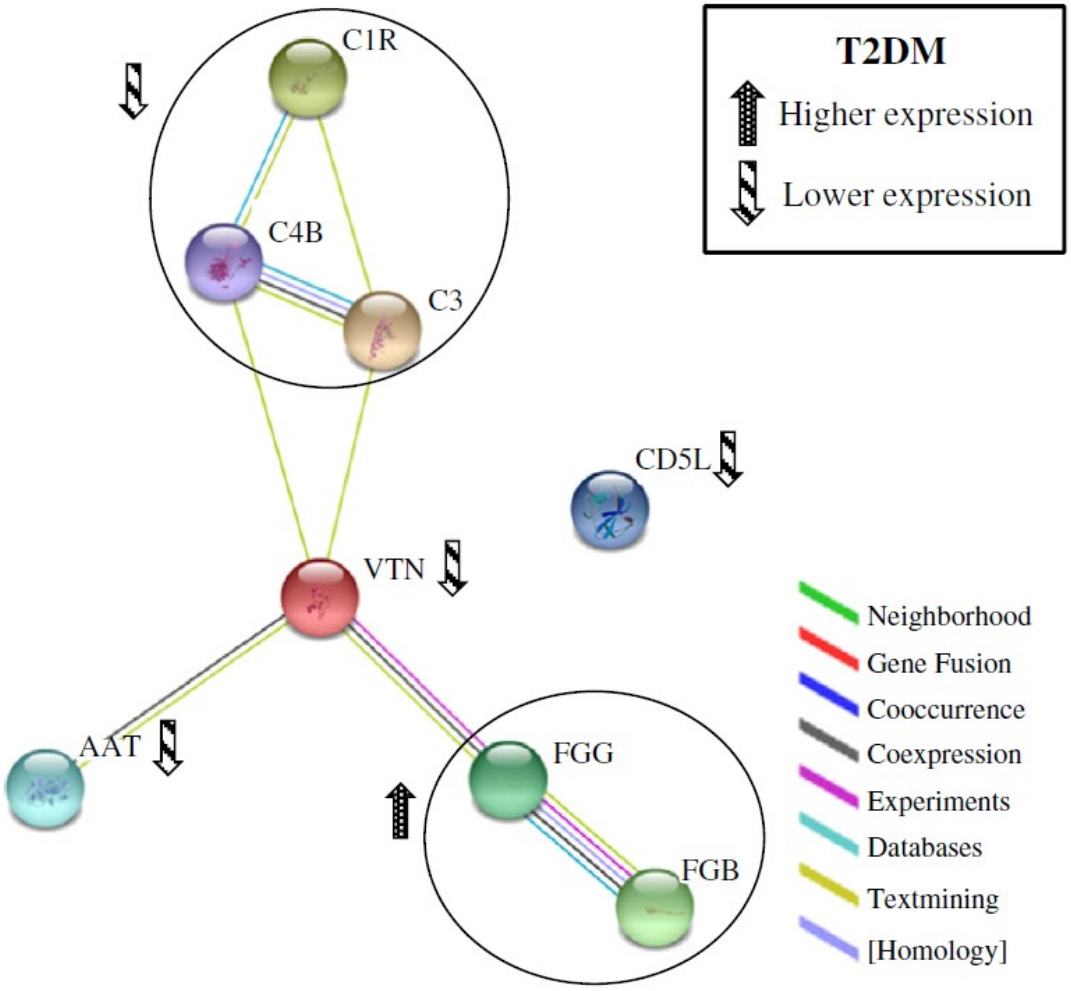


Figure 3. Interaction network of differentially expressed proteins according with STRING v10 database with reliability score higher than 0.4.FGG, Fibrinogen gamma chain; FGB, Fibrinogen beta chain; C1R, C3 and C4-B, complement subcomponents; AAT, alpha-1-antitrypsin; VTN, vitronectin; CD5L, CD5 antigen-like.



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1.De Muro P, Capobianco G, Lepedda AJ, Nieddu G, Formato M, **Tram NH**, Idini M, Dessole F, Dessole S. Plasma PP13 and urinary GAGs/PGs as early markers of pre-eclampsia. 2016; Arch Gynecol Obstet. 294:959-965.

2.De Muro P, Lepedda AJ, Nieddu G, Idini M, **Tram Nguyen HQ**, Lobina O, Fresu P, Formato M. Evaluation of Early Markers of Nephropathy in Patients with Type 2 Diabetes Mellitus. 2016; Biochem Res Int. 2016:7497614.

3.Lepedda AJ, Lobina O, Rocchiccioli S, Nieddu G, Ucciferri N, De Muro P, Idini M, **TramNguyen HQ**, Guarino A, Spirito R, Formato M. Identification of differentially expressed plasma proteins in atherosclerotic patients with type 2 diabetes. 2016; Journal of Diabetes and Its Complications 30:880-886.

Abstracts

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ATTESTATION OF AUTHORSHIP

I here by declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the qualification of any other degree or diploma of a university or other institution of higher learning, except where due acknowledgement is made in the acknowledgements.

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Sign:

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