An- Najah National University

Faculty of Graduate Studies

The Effect of Different Dietary Patterns on Anthropometric Measurements Amongst Obese and overweight People Visiting different Dietetic Centres In West Bank: A Prospective Cohort Study

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Dedication

First of all to my mother may God have mercy on her

To my father who supported all times in my life

To my wife, sons and my daughter

To my brothers, my sisters and their families who have supported me

I dedicate this work

Acknowledgement

First and Foremost, praise is to ALLAH, the Almighty, the greatest of all, on whom ultimately, we depend for sustenance and guidance.

Many thanks and gratitude to my supervisors Dr. Mohammad Al-Tamimi for his academic, technical ,guidance and unlimited support that I found from him during this work.

My deepest gratitude to my family; who support me ……..

My thanks to all nutritionists that support me and for their advices…..

الإقرار

أنا الموقع أدناه، مقدم الرسالة التي تحمل العنوان:

The Effect of Different Dietary Patterns on Anthropometric Measurements Amongst Obese and overweight People Visiting different Dietetic Centres In West Bank: A Prospective Cohort Study

أقر بأن ما اشتملت عليه هذه الرسالة إنما هي نتاج جهدي الخاص، باستثناء ما تمت الإشارة عليه حيثما ورد، وأن هذه الرسالة ككل، أو أي جزء منها لم يقدم لنيل أي درجة أو لقب علمي أو بحثي لدى أي مؤسسة تعليمية أو بحثية أخرى.

Declaration

The work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification.

Student Name: Yousef Subhi Salman **إسم الطالب:**

Signature: **التوقيع:**

Date: 1/11/2020 **التاريخ:**

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List of Abbreviations

Ac Ac	Acetoacetate
ACC	American College of Cardiology
AHA	American heart Association and
AHS	Adventist Health Study
AIC	Akaike's Information Criterion
ANOVA	Analysis Of Variance
ATP III	ATP III
BCM	Body Cell Mass
BF	Body Fat
BIA	Bioelectrical impedance analysis
BMI	Body Mass Index
CARDIA	Coronary Artery Risk Development in Young Adults
CHO	Carbohydrate
CVD	Cardiovascular disease
DALY	Disability-Adjusted Life Years
DBP	Diastolic Blood Pressure
DER	daily energy restriction
DFI	dietary fibre intake
ECW	Extracellular Water
EWL	Excess Weight Loss
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
FFM	Fat Free Mass
FTO	fat mass and obesity-associated gene
GDP	Gross Domestic Product
GLP-1	glucagon-like peptide
HB	Hydroxybutyrate
IOM	Institute of Medicine's
HDL	High-Density Lipoprotein
HP	High-Protein
ICW	Intracellular Water
IER	intermittent energy restriction
IFD	Intermittent Fasting Diet
LBM	Lean Body Mass
LCD	Low Carbohydrate Diet
TBW	Total Body Water
LBM	lean body mass
MENA	Middle East and North Africa

LF	Low-Fat
LFD	Low Fat Diet
MD	Mediterranean Diet
MetS	Metabolic syndrome
MOH	Ministry Of Health
NCEP	National Cholesterol Education Program
NHANES	National Health and Nutrition Examination Survey
NHL	Non-Hodgkin Lymphoma
POUNDS	Preventing Overweight Using Novel Dietary Strategies
PYY	Peptide YY
RDA	Recommended Dietary Allowances
SBP	Systolic Blood Pressure
SCFA	short-chain fatty acids
TDCI	Total Dietary Carbohydrate Intake
TEE	total energy expenditure
TG	Triglycerides
TOS	The Obesity Society
UNRWA	United Nations Relief and Works Agency
WC	Waist Circumference
VD	Vegetarian Diet
VLCKD	Very low-carbohydrate ketogenic diet
WHO	World Health Organization
YLD	Years Lost due to Disability
YLL	Years of Life Lost

The Effect of Different Dietary Patterns on Anthropometric Measurements Amongst Obese and overweight People Visiting different Dietetic Centres In West Bank: A Prospective Cohort Study

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Abstract

Background

Overweight and obesity are major public health problems and the most common nutritional disorders. The prevalence of overweight and obesity is rising at an alarming level worldwide and Palestine shares world in this epidemic. The aim of this study is to evaluate the effect of different diet patterns practised by Palestinians on body weight, as well to evaluate effect of different variables on weight loss.

Methodology

A prospective cohort study was conducted on 1368 participants (19.86% males and 81.14%females), data were collected from Nutrition centres in West Bank.

In nutrition centres they used BOCA X1 body composition analyser to calculate LBM. The nutrition analysis for prescribed diet programmes was done by ESHA software.

Statistical analysis was done by SPSS version 25.

The body mass index (BMI) weekly changes for each participant were taken over 12 consecutive visits. All participants must have Initial BMI between 25 and 60. The duration of 1 diet pattern was between 7 to 9 days. Females participants must not be pregnant or lactating.

The effect of 5-isocaloric dietary patterns namely; low carbohydrate diet (LCD), low fat diet (LFD), vegetarian diet (VD), intermittent fasting diet (IFD) and Mediterranean diet (MD), in addition to, gender, initial BMI, lean body mass (LBM), total dietary carbohydrate intake (TDCI) an dietary fibre intake (DFI) on BMI were evaluated using General linear model. Different one-way ANOVAs were conducted to compare the effect of the 5-dietary patterns on BMI, the effect of different dietary patterns in different weeks and the difference between males and females.

Results

The results indicated a significant effect (p-value<0.05) of the seven variables on BMI lowering. Being Males have more effect on lowering BMI (0.34) than female. BMI lowering effect has increased by (0.0021) for each one gram increase in daily fibre intake. Increasing LBM led to increase in BMI lowering by (0.001). BMI lowering effect was inversely related with TDC (0.0005). Initial BMI has correlated positively with BMI lowering effect (0.0046).

With regard to week numbers(visit order), the results have shown that all dietary patterns had high decrease in BMI in the first week of visits, however, such lowering effect on BMI has gradually declined from week 2 through week 12. The BMI lowering of the first week was 0.5791 more than the 12^{th} week.

With regard to the 5-dietary patterns effect on lowering BMI, results from ANOVA have shown that LCD has the highest lowering effect on BMI while VD has the lowest lowering effect on BMI. The other 3-diet patterns IFD, MD and LFD have no significant difference between them on their BMI-lowering effect.The mean BMI change for each of the five diets pattern was LCD (0.3310 ±0.3291), LFD (0.2756 ± 0.3003), IFD (0.2658 ± 0.2961), MD (0.2627 ± 0.3230) and VD (0.2233 ± 0.2546).

Conclusion

Weight loss is positively affected by initial BMI, LBM and TDF. Males lose more weight than females .TDCI had negative effect on losing weight. It was concluded that short term weekly effect of diet patterns was obvious for all 5-dietary patterns however, LCD was the best especially in the first weeks of weight management. MD and IFD, were practically more sustainable for long term effect. Therefore, LCD can be recommended for initial stages of weight management to show weight loss. Time factor is important for all diet patterns as the weight loss was more in the first weeks and declined gradually.

Chapter One
Introduction

1.1 General introduction:

Obesity and the related health risks have been noted to be an epidemic problem worldwide [1]. The factors leading to this widespread increase in obesity have been suggested to include economic growth, modernisation, westernisation of lifestyles (including foods high in fats and decrease in exercise levels), and the globalisation of food markets [2].

Statistics for prevalence of obesity in Palestine are limited and usually came from Palestinian Ministry Of Health or from Non-Governmental Organizations [3].Other statistics came from Surveys done by National universities in Palestine.

Obesity became a worldwide epidemic and in Arabic countries the prevalence of obesity increased ,as a part of Arabic world Palestine [4] also has an increase in prevalence of obesity and overweight from 10.9% in 2005[5] to be more than 30% in 2011[6].

In Palestine, different ways for management of obesity were followed as sport, surgery and dietetic centres to change diet habits. Engagement with dietetic centres in Palestine to lose weight, became one of main accepted strategies by obese and overweight people. Dietetic centres help individual to change their diet habits by following different diet patterns which provide different levels of macronutrients. Usually individuals will be

recommended to increase their physical activity, and as a general practice amongst dieticians the dietary programmes will be changed weekly.

Based on the weight loss, the new dietary programme may have the same dietary pattern like previous week or has a different dietary pattern, however, switching between dietary patterns has to be scientifically proven and based on solid basis.

1.2 Literature review

1.2.1 Defenition of obesity

Overweight and obesity are defined as abnormal or excessive fat accumulation that presents a risk to health [7]. Body Mass Index (BMI) which is calculated by dividing body weight in kilograms on square of a person's height in meter.

Overweight and obesity have been assessed according to the World Health Organisation (WHO) by different ways, the most two important ways were; evaluating Body Mass Index (BMI) and Waist Circumference (WC) [3]. Imbalance between energy intake and energy expenditure is the fundamental cause of overweight and obesity [8].

In general, measurements of body weight and body dimensions (anthropometry) are used in large studies that need to reflect the fatness of a society [9]and it is a cheap and a fast way .Other techniques like Densitometry or imaging are used in smaller scale study and clinical trials [9]. Body mass index (BMI) has widely been used to classify individuals

who are the most likely to be overweight or obese. In general, a high value indicates excessive body fat and can be indicator for increasing health risks. Table (1) showed the classification of weight status according to BMI value. An exception can be seen in trained athletes whose BMI can increase to 30 and still not classified as obese as the increase will be in skeletal muscle and not in fat mass [9].

Bioelectrical impedance analysis (BIA) is widely used for measurements of body composition. BIA is based on the principle of resistance to the flow of electrical current due to water content differences of fat and lean tissue in

Table (1): Classification of body fatness based on body mass index according WHO[9].

BMI	Classification
<18.5	Underweight
18.5-24.9	Healthy
25-29.9	Overweight
30-39.9	Obese
≥40	Morbidly obese

the body [10]. Lean tissue is a good conductor of electrical current due to high content of water and electrolytes. On the other hand, fat tissue, has less water content so it is poor conductor; as a result, more fat tissue in the body means more resistance to electrical current and this will be indication for higher adiposity [10].

The human body is divided into two parts: body fat mass and lean body mass [LBM]. The LBM is divided into protein, mineral, and body water. Protein is the main constituent of muscles, and minerals are mainly found in bones [11].Total body water (TBW) is the sum of Intracellular water (ICW) along with extracellular water (ECW) [11].

1.2.2 Obesity prevalence worldwide, Middle East and in Palestine.

Obesity becomes an epidemic problem that affects both developed and developing countries. According to WHO, worldwide obesity between 1975 and 2016 has tripled. If we took 2016 as an example, we will find that in adults there are 1.6 billion of age from 18 and older are overweighed and 650 million of them are obese. If these numbers expressed as percentages so 39% of world population in 2016 are over weighted and 13% were obese [12].

As an Arabic country, people in Palestine share other Arabic countries many habits especially food consuming [4] habits and sedentary life style. So, obesity prevalence in Palestine is comparable with other Arabic countries [4]. Table (2) shows the prevalence of obesity and overweight in selected Arabic countries.

According to FAO report in 2005 the percentage of obesity in Palestine was 10.9% and we can see that this percentage is less than other percentages in other Arabic countries [5].

The STEPS survey of chronic disease risk factors in Palestine was carried out from April 2010 to March 2011. A total of 6,957 adults participated in the survey. The results indicated that percentage of people who are overweight (BMI ≥ 25 kg/m2) was 57.8%(55.2% for males and 60.7% for females).The percentage of people who are obese (BMI ≥ 30 kg/m2) was 26.8% (23.3% for males and 30.8% for females) [6].

Table (2): Prevalence of overweight and obesity in Arabic countries [3]

Country	Date	Sample size	Sex	Age (y)	Overweight (%)	Obesity (%)	Reference
Bahrain	2007	863	M	20-65	34.8	32.3	MOH(2010)
		906	F		31.1	40.3	
Kuwait	2007	918	M	20-65	38.9	39.2	MOH(2007)
		1362	F		28.9	53	
Lebanon	1995 -96	501	M	20-70	43.4	14.3	Sibai et al.(2003)
		715	F		30.6	15.5	
Libya	2000	334	M	15-50	19.2	5.8	FAO(2005)
		350	F		21.1	7.1	
Morocco	2005	9120	M	18+	28	5.7	Mokhtar et al(2001)
		8200	F		33	18.3	
Oman	2005	3076	M	20-70	30.6	15.5	MOH(2000)
		3367	F		27.2	22.3	
Saudia Arabia	2005	1658	M	25-65	43.0	31.5	MOH(2010)
		1621	F		28.8	50.4	
Tunisia	2005	2379	M	30-70	51.7	37.0	El-Ati et al.(2008)
		2964	F		71.1	13.3	
Palestine	2002	1534	F	15-49	--	10.9	FAO(2005)

In Palestine there is a few studies and statistics that dealt with obesity and overweight, so we will review available studies to have better estimation for obesity prevalence in Palestine.

In 2007 UNRWA conducted an obesity screening for Palestinian refugees.

The sample size was 7762 and people were classified according to their BMI; if BMI is more than 30 so classified as obese. Results of screening are shown in Table (3) [13].

Table 3: UNRWA screening for obesity among Palestinian refugees [3]

	Obesity			
	Male		Female	
Area of operation	No.	(%)	No.	(%)
Jordan	280	32.7	957	53.7
Syria	72	22.4	168	38.7
Lebanon	105	24.0	493	42.7
Gaza Strip	168	34.1	471	41.6
West Bank	102	28.7	429	52.6

As depicted in Table (3) the percentage of obesity in female was more than in male.

The First National Health and Nutrition Survey that was conducted between October 1999 and October 2000, was a cross-sectional study design contained a sample of 3617 adults aged between 18 and 64 years. The results indicated that prevalence of obesity was 31.5% for women and 17.5%for men while overweight prevalence was 48.1% for men and 37.2% for women [14].The results also showed the BMI according to age as shown in Figure (1).More recently, a cross-sectional study conducted in Tarqumia, Palestine

with sample size of 720 schools, students showed that the prevalence of overweight and obesity was 27.8% (18.6% overweight and 9.2 % obese) and was significantly higher among male students, students with moderate income families and those aged 13 years old or younger [15] .

Al-Lahham S et al(2019) conducted a cross-sectional study in Palestine in 2017. A total of 1320 school-age children were involved in this study. The results indicated that the prevalence of underweight, overweight and

obesity among the children was approximately 7.3%, 14.5% and 15.7% respectively[50].

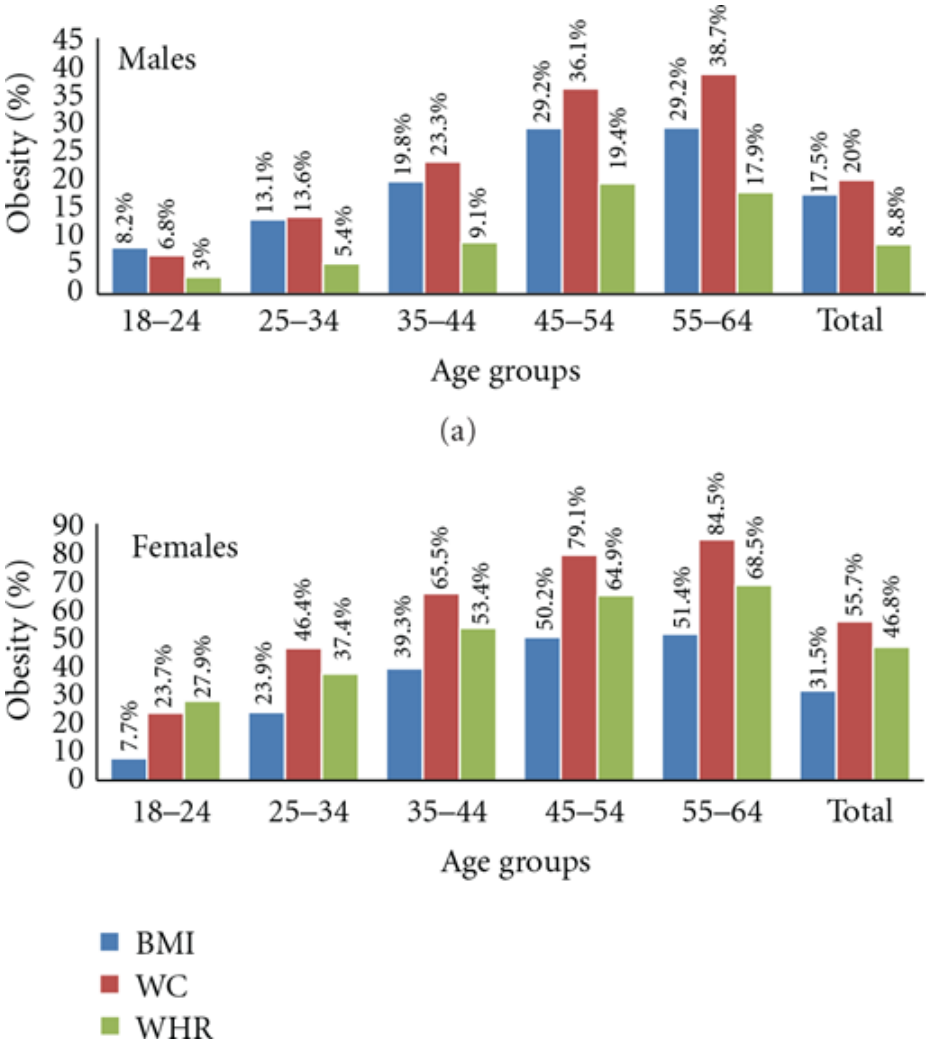

Figure 1: Prevalence of obesity as yielded by BMI, WC, and WHR, in Palestinian adults by gender: findings of the first national health and nutrition survey (FNHANS) 1999-2000. BMI (body mass index ≥30 kg/m2),WC (waist circumference ≥102 cm in men and ≥88 cm in women), and WHR (waist-to-hip ratio ≥1 in men and ≥ 0.85 in women).[14]

1.2.3 Obesity causes and risk factors

Obesity pathogenesis is complex and affected by several factors which can be genetic, epigenetic and environmental [16]. Positive energy balance along with sedentary life style are risk factors for developing obesity. Genetic mutations like Fat Mass and Obesity Associated (FTO) region plays a role in the development of obesity along with several other genes which regulates body weight, satiety and hunger which affect food intake

[16].The mechanisms regulating hunger and satiety in our body are extremely complex, involving several organs and systems which in turn interact with the external environment integrating different kind of inputs [16].

Several hormones secreted by gastrointestinal tract, adipose tissue, and pancreatic-liver axis, such as glucagon-like peptide (GLP-1), leptin, and insulin, are well-known factors acting on this fine regulation system [16].

Adequate dietary habits, regular practice of physical activities and avoidance of stressful situations are important components of a healthy lifestyle that are associated with decreased risk of overweight, obesity and its comorbidities. Nonetheless, sleeping problems, sedentary behaviour (or physical inactivity), and lacking of leisure time, allied to a lower intake of fruits, vegetables, cereals, and fibres, as well as higher intake of fatty, fried and caloric foods, snacks, and soft-drinks have been associated with increased overweight and obesity risks in children and adults [17].

1.2.4 Consequences, chronic diseases and cost

Obesity has major adverse medical consequences largely due to its health risks and association with hypertension and non-insulin dependent diabetes mellitus. The medical problems seen among obese people include cardiovascular complications like hypertension. It has been found that every10kg increase in body weight was associated with an increase of 3mmHg and 2 mmHg in systolic and diastolic blood pressures, respectively [18]. The reason for this association between elevated blood pressure and

increased weight is unclear. Several reasons have been hypothesised, including a decreased renal filtration surface, which may lead to renal sodium retention. Obesity also causes insulin resistance resulting in hyperinsulinemia. The risk of coronary (ischaemic) heart disease is present due to the fact that obese persons have the tendency to produce high levels of free fatty acids, which build up in the liver and leads to the development of hypertriglyceridemia and an increase in production of very low-density lipoproteins [18].

In the Framingham Heart Study, participants were followed-up for 26 years. The relationship between obesity and the incidence of CVD was studied with obesity as an independent factor [19].

The results from this cohort study indicated that weight gain after the young-adult years conveyed an increased risk of CVD in both sexes. However, that could not be attributed to either the initial weight or the levels of the risk factors that may have resulted from weight gain. Intervention to decrease obesity, in addition to the well-established risk factors, appeared to be an advisable goal in the primary prevention of CVD [19].

In a research done by Wolin et al (2010), it was found that almost 22% of the whole cancer cases resulted from obesity and overweight [20]. Excess weight gain can cause different types of cancers such as adenocarcinoma of oesophagus, colorectal cancer, endometrial cancer (the lining of the uterus), post-menopausal breast cancer and renal cell cancer [20].

Obesity also can increase the risk of other cancers like gallbladder cancer, pancreatic cancer, hepatocellular cancer (subtype of liver cancer), thyroid cancer, cervical cancer (adenocarcinoma of the cervix), Non-Hodgkin Lymphoma (NHL), leukaemia, multiple myeloma and malignant melanoma (a type of skin cancer) [21].

There is no certain or exact mechanism that explain the role of obesity to increase risk of cancer and this can differ according to cancer type but an association between waist hip ratio and waist circumference have been found to be more relevant than BMI because abdominal obesity can be diagnosed better with waist hip ratio and waist circumference [21].

Obesity or overweight is a main risk factor to develop type 2 diabetes. Both duration and severity of obesity increases the risk of developing type 2 diabetes. The risk of developing type 2 diabetes is associated with incremental increases in body weight in early adulthood. In addition, duration of obesity has also been found to increase risk of developing type 2 diabetes, with greater risk amongst people who have been obese for longer periods of time. A recent study found that severely obese people (BMI ≥40)were at an even greater risk of type 2 diabetes, when compared to obese people with a lower BMI (BMI 30- 39.9) [22].

The disability from certain disease like obesity can be understood by considering deaths and disability-adjusted life years (DALY). According to the WHO, “one DALY can be thought of as one lost year of ‘healthy’ life”. DALYs are calculated as the sum of years of life lost (YLL) due to

premature mortality in the population and years lost due to disability (YLD) for people living with the health condition or its consequences [23].

In a study to quantify the burden of obesity related to high BMI between 1990 and 2015, using data from Global Burden of Disease study so the results indicated that excess weight contributed to 4.0 million deaths (7.2% of all cause deaths) and 120 million DALYs (4.9% of all-cause DALYs) among adults globally [24].

Nearly 39% of deaths and 36% of DALYs related to high BMI occurred in those with a BMI >30 kg/m^2. Cardiovascular disease was the leading cause of deaths and DALYs related to high BMI, accounting for 2.7 million deaths and 66.3 million DALYs. Globally, 41% of BMI-related deaths and 34% of BMI-related DALYs were due to cardiovascular disease among obese people (BMI>30 kg/m^2). Diabetes was the second leading cause of BMI-related deaths in 2015, contributing to 0.9 million deaths and 39.1 million DALYs; 9.5% and 4.5% of all BMI-related deaths were due to diabetes at BMI >30 and <30, respectively. Chronic kidney disease was the second leading cause of BMI-related DALYs in 2015; 18.0% of DALYs occurred at BMI >30 and 7.3% at BMI <30. High BMI also accounted for 28.6 million years lived with disability (YLD) (3.6% of all-cause YLDs) globally. Diabetes was the leading cause of YLDs related to BMI (19.3 million) followed by musculoskeletal disorders (5.7 million) and cardiovascular disease (3.3 million) [24].

There has also been a marked increase in disability-adjusted life years (DALYs) owing to obesity in the Middle East region, which is another important indicator of the growing disease burden. According to data from the WHO's 2015 Global Burden of Disease Study, DALYs as measured by the risk factor "high body-mass index" increases by 62% across the Middle East and North Africa (MENA) region between 2000 and 2015, with even more significant increases in the UAE (314%), Oman (161%) and Qatar(139%) for example[24].

Obesity also imposes a large economic burden on the individual, and on families and nations. In 2014, the global economic impact of obesity was estimated to be US $2.0 trillion or 2.8% of the global gross domestic product (GDP). Besides excess health care expenditure, obesity also imposes costs in the form of lost productivity and foregone economic growth as a result of lost work days, lower productivity at work, permanent disability and mortality [25]. When comparing the results of two studies in the USA estimating obesity annual direct costs per capita, the costs increased from US $2741 in 2005 to US $6899 in 2011[26,27].

Another example is Thailand, Withrow and Alter (2011) conclude that obese individuals in Thailand spends approximately 30% more on health care than those with normal weight. They also indicated that obesity accounts for 0.7% to 2.8% of a country's total health expenditure [28].

1.2.5 Nutrition transition

The changes in nutrition habits and physical activity occurred along history of mankind since Palaeolithic era and those shifts affect human body composition and affect their health [29]. In the last 3 centuries ,there is acceleration in the change in dietary habits and food consumption patterns in different parts in the world in different rates. The concept of the nutrition transition focuses on large shifts in diet and activity patterns, especially their structure and overall composition. These changes are reflected in nutritional outcomes, such as changes in average stature and body composition. Furthermore, dietary and activity pattern changes are paralleled by major changes in health status and by major demographic and socioeconomic changes [29].

When data for food availability from FAOSTAT and survey of food consumption in the Middle East and North Africa (MENA) were analysed so results were shown in shown in Table (4). Data from table (4) showed gradual increase in fat, protein and daily energy intake per capita in the last 30 years in the most MENA region countries. During this period the total daily energy intake increased from 2,200 to 2,930 kcal/day.The sharpest increase occurred in Algeria, Saudi Arabia and Iran, and the lowest in Sudan, Yemen and Djibouti [30].

Table (4): daily energy, protein and fat consumption per capita over the past 3 decades in most countries of the MENA region (FAOSTAT)

	1969-1971	1979-1981	1995-1997	2001-2003	2002-2004	2005
	Energy, Kcal					
Alegria	1820	2640	2910	3040	3070	3094
Djibouti	1686	1635	1899	2100	2113	2210
Egypt	2350	2900	3320	3350	3330	3331
Bayyari WD, Henry LJ, Jones C., 2013)	2096	2724	3079	3091	3098	3102
Jordan	2240	2610	2660	2680	2730	2909
KSA	1900	2910	2800	2820	2800	3061
Kuwait	2590	2980	3030	2060	3110	3099
Lebanon	2330	2710	3170	2170	3190	3180
Libya	2361	3275	3287	3180	3017	3018
Morocco	2470	2750	3040	3070	3110	3167
Palestine	-	-	2350	2240	2240	2168
Sudan	2083	2150	2206	2271	2277	2300
Syria	2380	2950	2980	3060	3070	3042
Tunisia	2340	2820	3210	3250	3280	3264
UAE	2980	3300	3170	3220	3250	2922
Yemen	1755	1908	1986	2012	2005	2001
	Protein, g					
Alegria	48	67	78	82	91	87
Djibouti	39	42	41	47	49	49
Egypt	64	72	91	93	98	95
Iran	57	71	83	84	85	87
Jordan	62	67	70	69	76	74
KSA	49	77	78	76	82	85
Kuwait	75	92	94	84	94	92
Lebanon	60	75	83	89	99	86
Libya	60	90	80	77	72	74
Morocco	65	72	81	84	97	87
Palestine	-	-	64	61	73	60
Sudan	59	61	69	71	73	80
Syria	65	80	72	78	89	73
Tunisia	60	77	88	89	106	91
UAE	82	104	102	106	119	96
Yemen	49	57	53	57	56	53
	Fat, g					
Alegria	36	62	69	68	65	69
Djibouti	34	36	54	65	57	66
Egypt	47	65	57	58	56	56

Iran	39	60	66	62	63	63
Jordan	52	62	76	80	74	90
KSA	33	76	473	82	78	84
Kuwait	69	88	98	113	102	116
Lebanon	63	82	103	113	103	117
Libya	62	91	102	94	93	97
Morocco	43	52	60	59	54	57
Palestine	-	-	67	63	69	62
Sudan	65	74	65	74	68	66
Syria	60	83	99	101	91	104
Tunisia	63	70	86	94	83	90
UAE	97	130	107	92	92	74
Yemen	29	38	34	41	44	47

A change in the source of food had occurred, those changes in diet included consuming of more energy dense foods, more sweet and consuming less amount of high fibre foods [30].

In the MENA region there is also changes in nutrition habits ,for example the increase in the consumption of meat products lead to protein and fat rich diet. The average daily intake of protein from meat per capita was increased in Egypt in 2000 to be 25.5 g/ person/day but in 1981 it was only 16.3 g [31] In rich countries in Gulf area like Kuwait and Saudi Arabia there is increase in oil intake during last 50 years in the past century. A decrease in consumption of cereal products, fruits and vegetables was noted also. Fat supply has almost doubled in countries such as Algeria, Kuwait, Lebanon and Saudi Arabia, and food consumption surveys showed a similar increasing trend in fat consumption. In Saudi Arabia, for example, the total fat intake contributed to approximately 38% of daily energy intake of adults [32].The fat consumption in Egypt exceeded 30% of total daily energy intake for 30% of children and 20.5% of mothers [31].A decrease in consumption of fruit and vegetables occurred also in many MENA

countries. In a study conducted in Bahrain to estimate vegetables and fruits consumption in adults of age above 19 years, the results showed fresh fruits are not consumed by 11.6% of male and 11.9% of females and other hand fresh vegetables are not consumed by 9.4% of males and 11.3 % of females [29]. Another change in diet habits was the increase in sugar consumption, an example was Egypt rural area where people used to consume too much heavily sweetened tea [31]. The WHO recommendation for sugar daily intake is not more than 10% of total daily energy intake but in Lebanon the sugar intake was 11.4% and in Jordan 14.0% [29].

1.2.6 Role of dietician and dietetic Centres

Dieticians have a skill set that enables them to lead on the therapeutic support provided to patients with certain conditions that are amenable to treatment with dietary manipulation. Examples of such conditions include diabetes mellitus, cardiovascular disease, over- and underweight, food allergies, chronic obstructive pulmonary disease, gastrointestinal conditions, and renal and liver conditions[33] .Given the ability of dietary modification to improve biomarkers of chronic disease, dietary behaviour change is recognized as a first-line approach to optimal management of chronic disease. Referral to ‘nutrition professionals’ is recommended, in particular Registered Dieticians, as they are the only members of the health workforce specifically trained in facilitating dietary behaviour change by providing nutrition care. Dietetic workforces have grown considerably in developed countries, including the United States, the United Kingdom and

Australia, increasing the opportunity for dieticians to contribute to improvements in the health behaviours of populations. An aim of the dietetic consultation is to assist individual patients to modify dietary behaviours in order to improve health outcomes. Dietetic consultations follow a structured nutrition care process of nutrition assessment, nutrition diagnosis, nutrition intervention, and nutrition monitoring and evaluation [34].

Dieticians are the preferred primary health care professionals to provide nutritional care to overweight individuals. Dietary and lifestyle modifications are the primary treatment goals for the treatment of overweight patients [35].

One of the main objectives of nutrition research is to study the roles of foods and nutrients in causes and prevention of disease to ensure the highest quality of health recommendations. Currently, a one-size-fits-all strategy is adopted in nutrition recommendation; and such an approach requires substantial simplification and a strong assumption that there is no interindividual variance.

Personalized nutrition holds great promise to understand interindividual variation in response to specific foods and nutrients, and such knowledge would be translated into public health benefit. There are examples reflecting some of the triumphs of the systems approach in deciphering the relation between nutrition and obesity. While whole population-based nutrition recommendations may continue to be effective in improvement of

health, personalized intervention would be more efficient to reduce obesity-related disorders especially among high-risk populations determined by genetic make-up. Solid evidence should be achieved before the application of personalized diet intervention in practise [36].

Dietetic centres in Palestine are relatively new as the law of dietetic centre was released in 2011. This law enabled dieticians to open independent clinic while before that dietician used to work in hospitals or under supervision of physician in their clinics.

According to law that regulates dietician work in Palestine, dietician can work in fitness clubs as well. The role of dietician is to plan meals for patients suffer from different nutrition-related diseases and to help people suffering from obesity to lose weight, especially under such a high prevalence of obesity in Palestine [37].

The common practice in dietetic centres based on weekly visits with dietician follow-ups and prescriptions for a diet programme.

Most dietetic centres in Palestine are using bioelectrical impedance analysis (BIA) instruments to measure body composition as fat mass, muscle mass and total body water. This will enable the dietician to evaluate the effect of different dietary patterns on body composition and to adjust the programme accordingly.

1.3 Factors affecting management of obesity

There are numerous factors influence body weight and further weight management. Some factors are uncontrollable; including developmental determinants, genetic makeup, gender, and age. While controllable factors include level of physical activity, diet, and some environmental and social factors [38].

Weight-management programmes may be divided into two phases: weight loss and weight maintenance. While exercise may be the most important element of a weight-maintenance program, it is clear that dietary restriction is the critical component of a weight-loss program that influences the rate of weight loss. Activity accounts for only about 15 to 30 percent of daily energy expenditure, but food intake accounts for 100 percent of energy intake. Thus, the energy balance equation may be affected most significantly by reducing energy intake. A number of dietary programmes that are famous for weight management will be discussed later, but whatever the name, all programmes consist of reductions of some proportions of macronutrients; protein, carbohydrate (CHO) and fat [38].

In modern society, most adults spend most of their time sitting, whether at work, at home, or during leisure time. This leads to low levels of energy expenditure and is likely to be an important cause of the obesity epidemic. Increasing daily energy expenditure to tip the energy balance is an effective strategy in the treatment of obesity. The larger the negative energy balance, the greater the weight loss. Increased energy expenditure can be obtained

by increasing physical activity in forms of supervised or non-supervised exercise, occupational activity, work around the home, personal care, commuting, and leisure-time activities [39].

Physical activity and diet restriction provide comparable weight loss if they provide similar levels of negative energy balance. It seems that physical activity will increase weight loss in combination with diet restriction if the diet restriction is moderate but not if it is severe [39].

Other predictors of weight loss are baseline demographic factors. Older individuals lose more weight than younger ones; men lose more weight than women; individuals with a higher BMI lose more weight than those with a lower BMI; Whites lose more weight than African-Americans; and finally, married women lose more than unmarried women, something that was not true for men [40].

Interventions targeting different psychological and behavioural factors can lead to greater success in weight loss. Results from lost POUNDS study have indicated that craving for high-fat foods was a predictive of greater weight loss, whereas craving for carbohydrates was a predictive of less weight loss. While, cognitive restraint was a predictive of less weight loss and more weight regain [41].

Another factor that can affect weight loss is the thyroid gland function so the higher baseline of free triiodothyronine (T3) and free thyroxine (T4) predicted more weight loss, but not weight regain among overweight and obese adults with normal thyroid function [42].

Williamson et al (2010) found that behavioural adherence and dietary adherence accounted for 66% of the variance in weight loss [43,44].

Recent studies have demonstrated the existence of several epigenetic markers that may modify gene expression and could be involved in the outcome of weight loss interventions. Moreover, different studies have shown that dietary interventions could affect the composition of gut microbiota and have an impact on body weight [45].

Nineteen genes from the POUNDS Lost study were examined and the results have indicated that several of these genes have allowed the selection of diets which will provide greater magnitude of weight loss or improvement in metabolic and cardiac risk factors. These observations provide a guidance toward selection of a personalized weight loss diet and improvement in metabolic profile [46].

Dietary fibres are non-starch polysaccharides including cellulose, hemicellulose, lignin, pectin, gum and mucilage and non-polysaccharide (lignin). Health benefits of the consumption of fibre rich foods ranging from prevention and treatment of obesity, reduction of blood glucose and cholesterol level, glycaemic regulation, and prevention of intestinal diseases, like constipation, haemorrhoid, diverticular disease and colon cancer. The Institute of Medicine's (IOM's) recommends consuming about 21-38 grams of total fibre per day, or 14g of fibre per 1,000 calories. (Women should aim for 25 grams of fibre per day, while men should target 38 grams, or 14 grams for every 1,000 calories)[47].

Moreover, epidemiological and cross-sectional studies have indicated that lower intake of dietary fibre is associated with obesity development [48]. In this study we will investigate if there is effect on fibre in change in BMI.

1.4 Dieting and regimen

Modifying diet is the commonest strategy to reduce weight. The guidelines to control weight recommend the prescription of a hypocaloric diet for obese or overweight individuals who would benefit from weight loss, as part of a comprehensive lifestyle intervention. It has been acknowledged that there are several techniques for reducing dietary energy intake, using a variety of dietary approaches and patterns. In this essence, any dietary scheme is effective for weight loss, as long as it can induce a negative energy balance [49].

There are no specific guidelines for modifying dietary habits for obese and overweight people and here we will review guidelines which recommended by American heart Association (AHA), American College of Cardiology (ACC) and The Obesity Society (TOS) [49].

According to these guidelines different dietary approaches can be followed to lose weight if reduction in energy intake has been achieved. Also, the guidelines recommended 1200–1500 kcal/day for women and 1500–1800 kcal/day for men or reduction of daily energy intake by 500 kcal/day or 750 kcal/day or 30% energy deficit [49].

Dietary programmes are usually based on the inclusion or exclusion of different foods or food groups. Historically, several dietary programmes have become popular and then faded away due to a lack of reliable scientific support.

These strategies have been classified into three main categories:

1. dietary programmes based on the manipulation of macronutrient content (i.e., low-fat [LF], high-protein [HP], and low- carbohydrate diets [LCDs]).
2. dietary programmes based on the restriction of specific foods or food groups (i.e., gluten-free, Paleo, vegetarian/vegan, and Mediterranean diets).
3. dietary programmes based on the manipulation of timing (i.e., fasting) [51]. For review purposes we are going to explain the main features of 5 types of diet only; MD, LFD, IFD, LCD and VD.

1.4.1 MD and obesity

This is a dietary pattern followed by population of countries around Mediterranean Sea. This pattern is characterised by high intake of olive oil (high monounsaturated/saturated fat), legumes, grains, fruits, and vegetables; moderate intake of milk and dairy products, alcohol; and low intake of meat and meat products [52]. Epidemiological studies have noted an increased longevity and reduced health risks in Mediterranean countries compared with the USA or Northern Europe. The positive effects on health were attributed to the dietary pattern followed by these countries [52].

Recent studies tried to find relation between adherence to MD diet and obesity. Buckland et al (2008) have found the relation between adherence to MD in 13 studies out of 21 studies, Such studies have reported that probability of overweight/obesity was significantly reduced in people of higher adherence of MD and weight loss was promoted in people with higher adherence to MD. In contrast, eight remaining studies found that there was no significant association between MD adherence and overweight/obesity [53].

MD is characterized by relatively high fat content (30-40%) of total energy but the quality of fat is one of the most important characteristics of MD as olive oil is the main source of fat which is rich in monounsaturated fat (which represents 67% of fat energy in MD) [53].

1.4.2 LFD and obesity

Each gram of fat give 9 kcal/gram which is more than energy from protein or carbohydrate which is 4 kcal/gram so restricting fat consumption as a part of diet modification as this will lead to appreciable decrease in total daily calories intake which can lead to lose weight [54] .But no consistent relationship was demonstrated by randomized trials between lowering fat intake and long term weight loss when compared with other diet patterns[54]. Current National Cholesterol Education Program (NCEP) guidelines for adults based on ATP III (Adult Treatment Panel III) recommends reducing intake of saturated fats to less than 7 % of the total calories and cholesterol to less than 200 mg/day. Guidelines also

recommend that polyunsaturated fat constitute up to 10% of total calories, and monounsaturated fats constitute up to 20% of total calories so total fat to be less than 30% of total calories[55].

1.4.3 LCD and obesity

The main characteristic of low carbohydrate diet is restriction of carbohydrate to different levels [56]. This diet became popular as it gives better weight loss than other diet patterns so it is used commercially under many trade names with differences in the percentage of carbohydrate in the diet [56].

Consumption of CHO greater than 230 g per day is consistent with no restriction of carbohydrate. In general, the greater the degree of carbohydrate restriction, the greater the degree of ketogenesis, such that carbohydrate intakes of more than 50 g per day are not usually sufficient for ketogenesis. Hence, “low-carbohydrate” and “ketogenic” are not synonymous dietary terms, but do overlap [57].

The diets can be classified in term of carbohydrate content as follows:

1. Very low-carbohydrate ketogenic diet (VLCKD) in which quantity of Carbohydrate, 20–50 g/d or <10% of the 2000 kcal/d diet .

2. Low-carbohydrate diet which has <130 g/d or <26% total energy

3. Moderate carbohydrate diet which provides 26

4. %–45% of total daily energy from carbohydrate.

5. High-carbohydrate diet which provide >45% of total daily energy requirements from carbohydrate [58].

In a randomized trial that last for one year to compare the effect of low carbohydrate diet on weight loss in extreme obese adults with conventional diets [56].The results have found similar weight loss in people followed a low-carbohydrate diet or a conventional diet after 1 year. The difference was insignificant. Despite modest overall weight loss in both diet groups [51], the low-carbohydrate group had more favourable effect on triglyceride level, HDL cholesterol level, and glycaemic control in the smaller subgroup of patients with diabetes. These results suggested that low carbohydrate diet has favourable metabolic effects on diabetic patients who overconsumed carbohydrates [56].

Another study was conducted to compare the effect of low carbohydrate diet with low fat diet on weight and glycaemic control on type 2 diabetic patients [59]. The results reported better weight loss with low carbohydrate diet in the first 3 months but after one year both groups has similar weight loss [59].

1.4.4 IFD and obesity

Most weight-control programmes use daily energy restriction (DER), but intermittent energy restriction (IER) has been suggested as a possible alternative approach. IER may be easier to follow and potentially has greater positive metabolic effects since it includes repeated spells of more

profound energy restriction than achieved with DER, even for shorter periods [60].

Intermittent fasting has different pattern, alternates days of ‘normal’ calorie consumption with days of restricted energy intake. This has two ways, either to have normal food intake in one day and restricted food intake in the next day, or as recently new strategy has been developed with 5:2 days regimen. In this strategy there is more than one model. The most common model restricts energy intake to less than 600 Kcal for men and less than 500 Kcal for women for only two days in the week and rest of week will have normal energy consumption [61].With regard of weight loss, this dietary pattern shows to be either similar or more effective than modest continuous restriction of calories. Also, it has a positive effect on insulin sensitivity [61].

Despite the seemingly strict nature of the fasting days, intermittent fasting has generally a good adherence record and can cause significant reductions in body weight in individuals with obesity [62], suggesting that this is a clinically relevant therapeutic approach.

A Systemic review and meta-analysis done by L Harris et al (2018) focused on the effect of short-term intermittent fasting on weight loss. The results identified that short-term periods of IER (weekly IER $\geq$7 d) has same results in mean weight loss as continuous energy restriction for the first 3 to 6 months of intervention [63].

1.4.5 VD and obesity

People adopted vegetarian pattern for different reasons some are religious and other are health reasons so the vegetarian patterns as results are not same and vary from excluding meat products to restriction off all animal based product like milk and egg to raw vegan pattern which depend only on raw plants like fruits ,vegetables and beans. Exclusion of animal products can reduce the intake of certain nutrients, which might lead to nutritional deficiencies of protein, iron, zinc, calcium, and vitamins D and B12 [64].

These patterns include vegan (Does not contain any animal products meat, fish, poultry, eggs, or dairy) but emphasizes plant-based foods, such as fruits, vegetables, whole grains, and legumes/beans, vegetarian (Does not contain meat, fish, or poultry but does contain eggs and dairy, in addition to plant-based foods, such as fruits, vegetables, whole grains, and legumes/beans), pesco-vegetarian (Does not contain meat or poultry but does contain fish and shellfish, eggs, and dairy, in addition to plant-based foods, such as fruits, vegetables, whole grains, and legumes/beans) and semi-vegetarian (Contains all foods, including meat, poultry, fish and shellfish, eggs, and dairy, in addition to plant-based foods, such as fruits, vegetables, whole grains, and legumes/beans. However, red meat and poultry are fairly limited). Data from the Adventist Health Study (AHS) have shown that BMI increases as the amount of animal foods in the diet increases, such that vegans had the lowest BMI, Pesco-vegetarian diet, Semi-vegetarian diet, and Omnivorous diet, Moreover, findings from the

European Prospective Investigation into Cancer and Nutrition (EPIC-Oxford) study, have shown that vegans gain significantly less weight as they age compared to omnivores [64].

1.5 Surgical management of obesity

The management choices for obesity differs according to obesity degree and health status and the front line of intervention is to change life style and dietary choices. In case, if all medical interventions and unsuccessful weight loss with dietary and exercise interventions, the surgical treatment of obesity will be the last resort. This is the practical decision for patients with either BMI $\geq$40 kg/m^2 or BMI 35–39.9 kg/m^2 with more than one of the following comorbidities such as type 2 diabetes mellitus, hypertension, or obstructive sleep apnea [65].

Bariatric surgical procedures reduce caloric intake by modifying the anatomy of the gastrointestinal tract. These operations are classified as either restrictive or malabsorptive. Restrictive procedures limit intake by creating a small gastric reservoir with a narrow outlet to delay emptying. Malabsorptive procedures bypass varying portions of the small intestine where nutrient absorption occurs.

Restrictive operations for the treatment of morbid obesity and its coexisting conditions become popular today particularly because of laparoscopic surgical approaches, including adjustable gastric banding (Panel A) and vertical (sleeve) gastrectomy (Panel B). Roux-en-Y gastric bypass (Panel C), a procedure that combines restriction and malabsorption, is

considered by many to be the gold standard because of its high level of effectiveness and its durability. More extreme malabsorption accompanies biliopancreatic diversion procedures, commonly performed with a duodenal switch (Panel D), in which a short, distal, common-channel length of small intestine severely limits caloric absorption. This procedure also includes a sleeve gastrectomy [65].

The effects of bariatric surgery is not limited to weight loss but also has positive effects on components of metabolic syndrome (hyperglycaemia, hyperlipidaemia and hypertension), weight loss, perioperative morbidity and mortality, and the long-term impact on cardiovascular risk and mortality [66].

The overall percentage of excess weight loss (EWL) following bariatric surgery has been reported to be 47–70% in long-term series. Other metabolic changes have been reported after bariatric surgery but the results differed according to different types of surgeries. Fasting triglycerides and total cholesterol significantly improved at the beginning of 2 weeks post-surgery [66].

Also, bariatric surgery has positive effect on mortality of obese people so results have indicated that weight loss surgery can reduce mortality by 30%. Buchwald's meta-analysis (2004), demonstrated a hypertension resolution rate of 62% and improvement in 17% of patients after bariatric surgeries [66]. After bariatric surgery the patients showed better glycaemic control. In a randomized control trial conducted in 2008 to evaluate

bariatric surgery vs. pharmacotherapy and lifestyle intervention (60 obese patients with T2DM), it was found that the surgical group achieved T2DM remission in 73% compared to 13% in the nonsurgical group (after 2 years follow-up) [66].

1.6 Hypothesis of the study

This study based on a hypothesis that there a difference on weekly BMI lowering effect between the five dietary patterns (LCD, LFD, IFD, VD and MD).

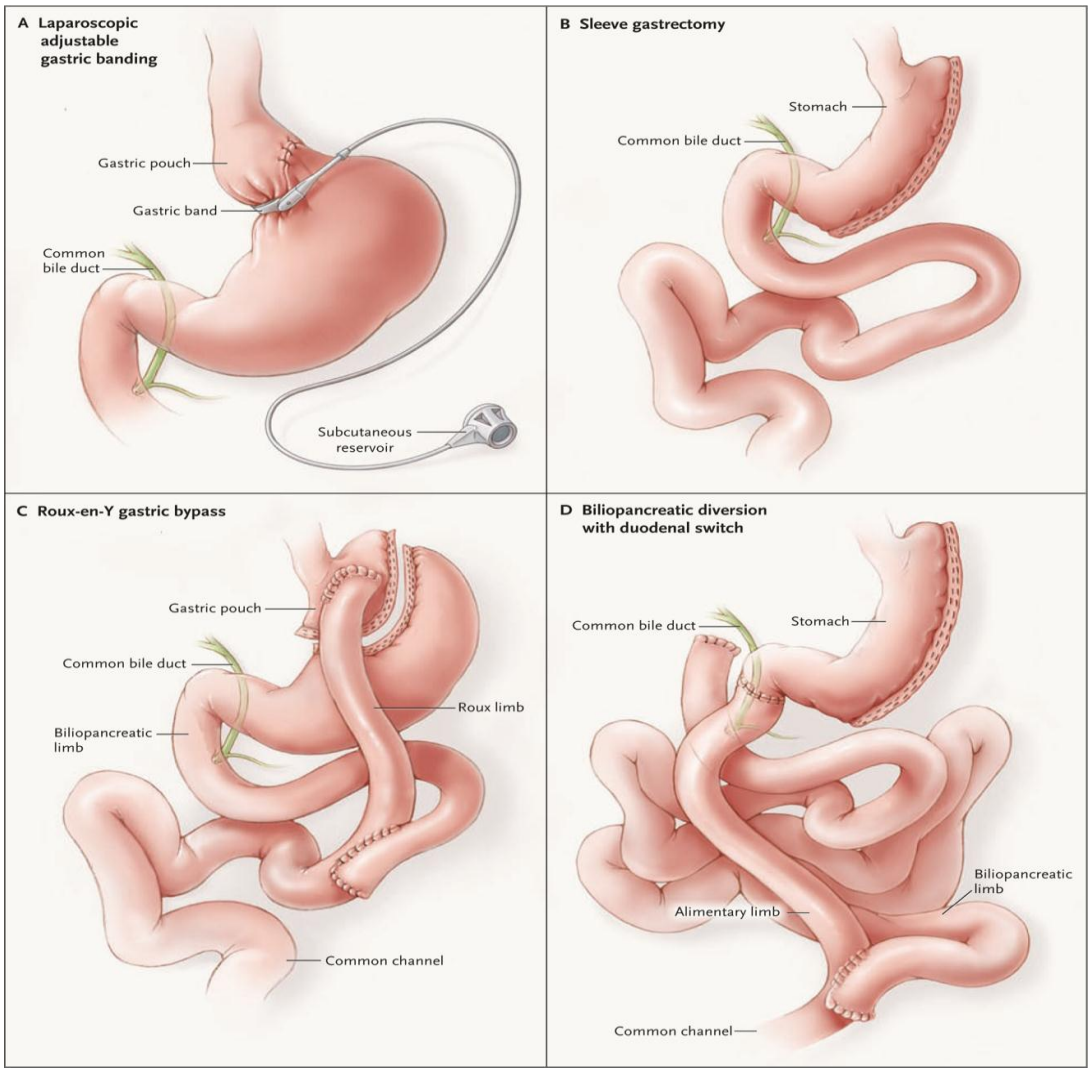

Figure (2): Types of weight loss surgeries [65]

Also there is a another hypothesis that TDFI,LBM and starting BMI have positive effect on BMI lowering effect and TDCI has negative effect on BMI lowering effect.

The last hypothesis of this study is that gender has effect on BMI lowering effect.

1.7 Study objectives

Several epidemiological studies have examined differences in body weight based on dietary patterns but most of studies are conducted based on long term effect and the same thing when comparing diet patterns with each other.

Thus, the main objective is to determine the changes of BMI according to dietary pattern after 3 months of weight management programs.

Other objectives were:

1. Determine the factors that may influence the weight loss.

2. Compare between dietary patterns in their effectiveness on weight loss.

The diet patterns that followed by dieters were Mediterranean diet, low fat diet, low carbohydrate diet, intermittent fasting and vegetarian diet. Usually most studies are focusing on following certain dietary pattern during weight loss period. However, the real practice in many dietetic centres will depend on using different dietary patterns to encourage long term adherence of weight loss.

In this study we will compare the effect of different diet patterns on weekly weight loss and other anthropometric measurements so the effect of certain dietary pattern will be compared in different weeks and the effect of different dietary patterns will be compared in same weeks.

Chapter 2

Methodology

2.1 Study design

One Diet centre in each city in west bank was selected, the diet patterns to be studied were identified (LCD, LFD.IFD.MD and VD).

The prescribed diet program for each visitor in each visit to the diet centre was recorded by the dietician with macronutrient analysis.

The records for diet centres visitors were observed without any interference with the prescription of the diet programs. For 12 months there was continuous follow up for the records of diet centres visitors.

When all inclusion and exclusion criteria were applied the final participants were selected. The outcome of the study was the change in the BMI.

2.2 Participants

The study population was defined as all visitors to diet centres during the 12 months of observation in this study and the samples was the number of population that were eligible for the inclusion and exclusion criteria.

The participant's inclusion criteria were:

1- Both sexes (males and females)

2- BMI range (25-60)

4- Period of inclusion to be 3 month (12 consecutive visits)

5- Period of 1 dietary pattern between 7 to 9 days.

Exclusion criteria:

1- Visitors with kidney or liver dysfunction.

2- Females who were pregnant or lactating

3- Visitors taking any weight loss medication

The physical activity for all participants was 45 minutes walking 4days each week except first week there was no physical activity.

Total 1368 participants were met the inclusion criteria and were involved in the study. 258 were males (19.86%) and 1110 were females (81.14%) and the (mean ±SD) of age, BMI, TDCI, TDFI, LBM and TDC for each gender in the first week were shown in Table (6) while Table (5) showed geographical distribution of participants.

Table (5): The distribution of participants according to governorate of the west bank

	Frequency	%
Nablus	256	18.71
Ramallah	353	25.80
Tulkarem	137	10.01
Qalqalyah	43	3.14
Hebron	246	17.98
Bethlehem	109	7.98
Jenin	121	8.85
Jericho	91	6.65
Salfit	7	0.51
Tubas	5	0.37
Total	1368	100

Table (6): Distribution of male and female participants according to their age, TDC and anthropometric characterisations in the first visit.

		Mean	SD	minimum	maximum
Female 1110	Age (year)	33.07	12.20	9.00	72.00
	BMI (kg/m^2)	35.61	5.80	25.03	58.26
	TDCI (gram)	145.17	35.64	61.54	301.11
	TDFI (gram)	24.99	6.12	12.48	133.15
	LBM (kilogram)	47.82	6.22	29.90	70.70
	TDC (kcal)	1301.05	183.09	849.38	2298.71
Male 258	Age (year)	30.80	13.16	8.00	72.00
	BMI (kg/m^2)	37.26	5.21	25.23	52.24
	TDCI (gram)	171.90	47.22	64.06	323.73
	TDFI (gram)	24.06	6.70	14.68	67.52
	LBM (kilogram)	65.08	10.47	29.20	89.00
	TDC (kcal)	1516.99	294.67	946.96	2553.44

2.3 Characteristics of diet patterns

The participants were followed one of 5 dietary patterns every week and the characteristics of each dietary pattern (TDCI, TDFI and TDC) of people following are shown in Table(7) for males and females and as stated before analysis for diet programs was done by ESHA software and table(7) also showed number of time of prescription of each dietary pattern.

Table (7): Distribution of participants on dietary patterns and there characteristic according to TDCI,TDFI and TDC

			Mean	SD	Minimum value	Maximum value
LCD	Females n=1086	TDCI	81.33	8.97	42.29	1518.37
		TDFI	18.91	3.27	9.91	28.16
		TDC	1134.49	130.17	803.56	1518.37
	Males n=193	TDCI	82.84	11.37	46.20	132.28
		TDFI	19.07	3.39	9.38	26.07
		TDC	1202.84	147.05	868.40	1850.35
LFD	Females n=1145	TDCI	165.10	30.01	86.40	316.06
		TDFI	26.88	10.78	10.24	231.91
		TDC	1174.38	213.10	805.33	2182.27
	Males n=272	TDCI	175.04	36.17	104.46	323.73
		TDFI	26.47	7.57	12.50	57.95
		TDC	1306.25	281.50	824.56	2416.09
IFD	Females n=5495	TDCI	116.21	16.04	90.01	179.76
		TDFI	21.51	3.09	9.18	57.77
		TDC	1129.78	117.75	808.35	1842.81
	Males n=1232	TDCI	123.51	19.65	90.03	179.65
		TDFI	33.02	3.16	10.34	36.86
		TCD	1209.93	161.69	800.83	1919.67
VD	Females n=562	TDCI	155.35	13.97	100.82	179.89
		TDFI	28.28	4.50	15.61	38.19
		TDC	1158.78	99.12	970.47	1517.47
	Males n=57	TDCI	155.78	13.08	109.83	179.54
		TDFI	27.64	3.97	18.74	38.65
		TDC	1201.11	126.64	986.79	1559.36
MD	Females n=5032	TDCI	147.08	22.04	100.94	283.64
		TDFI	24.88	5.10	12.05	91.61
		TDC	1248.55	146.52	970.54	2298.71
	Males n=1342	TDCI	159.87	29.57	100.39	301.48
		TDFI	26.00	5.30	10.89	68.88
		TDC	1365.34	231.49	977.24	2610.25

The maximum carbohydrate contents of LCD in this study was 30% of the total daily energy while for LFD the fat contribution was maximum 30% of the total daily energy.

IFD in this study had two types; first one was 16-hour fasting and 8-hour eating and the second type was 5:2 days type.

2.4 measurements.

The weight and scales of participants in the diet centre was taken by weight scales model (H151-6) the weight unit was kilogram and height unit was centimetre. The maximum capacity for the scale was 250kg and accuracy was ±0.1kg.

The BMI and LBM measurements for participants were taken by (BOCA X1) body composition analyser which is working depending on BIA technology.

The nutrition analysis for the prescribed diet programs to participants were analysed depending on ESHA(Elizabeth Stewart Hands and Associates) software .

The data were collected from records of each participant for the 12 visits in 3 consecutive months. The following data were collected for each visit; Initial BMI, LBM, daily fibre intake, daily carbohydrate intake.

The dietary pattern was taken each week and the differences in BMI weekly was recorded.

2.5 Ethical consideration

The study protocol was approved by the institution review board (IRB no.) at the Faculty of Medical Sciences, An-Najah National University. Participant personal data haven’t been revealed, while all other records were confidentially handled for research purpose only.

2.6 Statistical analysis

2.6.1 Model selection and assumptions

The analysis of the data set based on General linear model. The dependent variable “BMI Progress” represented the change in body mass index (BMI) overtime. BMI was measured weekly for 12 visits and the effect of different 5 dietary patterns on the dependent variable was explored. The gender effect on BMI was explored also.

Four covariances which are initial BMI, total daily carbohydrate intake (TDCI), total daily fibre intake (TDFI) and lean body mass (LBM) were analysed against BMI changes over time.

For the normality assumptions of the dependent variables, we plotted the distribution of the results as in the Figure (3). The general shape of the data suggested enough evidence to accept that the normality of the data assumption was satisfied.

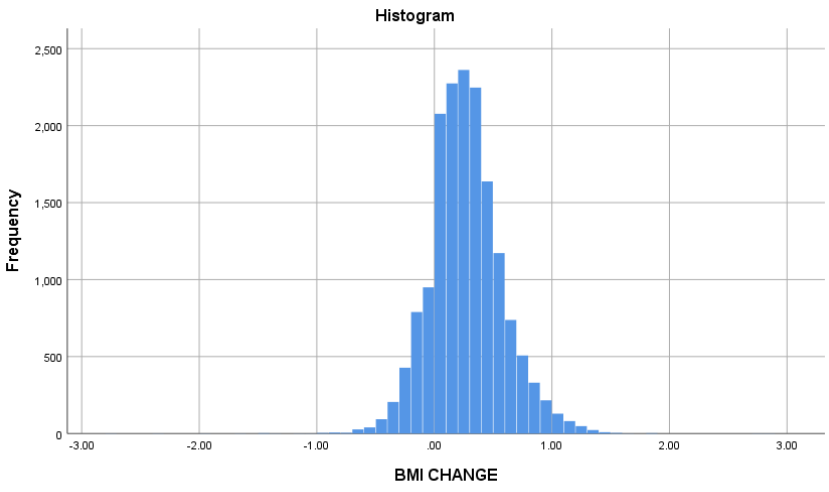

Figure (3): Histogram shows that dependent variable BMI change met the normality assumption

The model diagnosis had shown that presented data satisfied the normality assumption of residuals as per the Figure (4).

Then the 'best' variables were selected using statistical criterion Akaike's Information Criterion (AIC).The final model consisted of 2 independent variables which were dietary pattern (which has 5 levels) and gender (which has two levels). Also, the model had covariances as follows; initial BMI, LBM, total carbohydrate daily intake, total daily fibre intake and visit order.

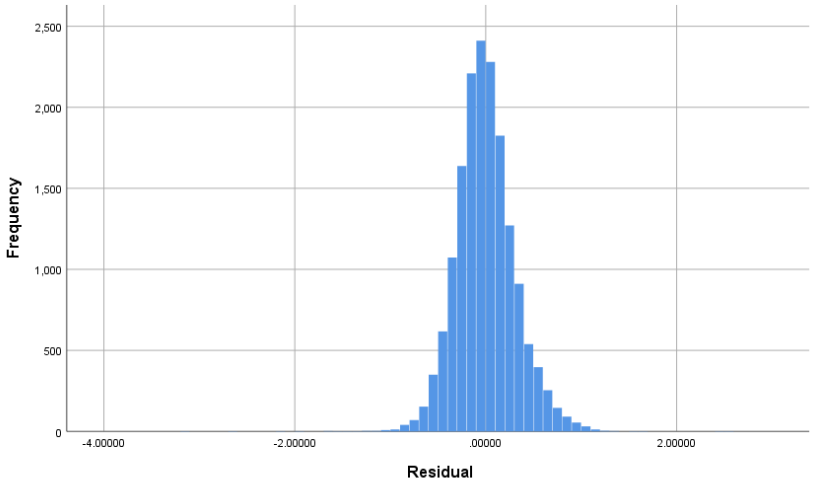

Figure (4): Histogram of residuals of dependent variable met the normality assumption

Chapter Three

Results

3.1 Effect of variables on BMI change

In the final model there were 7 variables that were statistically significant (p-value<0.05).Table (8) explained the lowering effect of each variable on the mean of BMI.

The first variable was being a female had lower decrease in the BMI by 0.034 when compared to male. The diet program that showed positive effect on lowering BMI was LCD. This program had better effect in lowering the BMI than the MD by 0.072. The BMI lowering effect of LFD was 0.036 when compared with MD. While, IFD had a BMI lowering effect of 0.023 compared to MD and the last diet which was VD had a BMI lowering effect of 0.041 when compared to MD. The third variable which was Daily carbohydrate intake had a negative effect in lowering BMI, therefore, each increase in daily carbohydrate intake by 1 gram had negative effect in lowering BMI by 0.0005.The fourth and fifth variables which were Daily fibre intake and initial BMI had positive effect in lowering BMI. Each increase in the BMI at the baseline had increased the progress of lowering of BMI by 0.005 and each 1 gram increase in daily fibre intake led to 0.002 increase in progress of lowering of BMI.

The sixth variable was LBM. It had a positive effect in lowering BMI. Each 1 kg increase in the LBM had increased the progress of lowering of BMI by 0.003.

The last variable which was the visit order. Time as a variable was included in the model to explain time effect on weight loss so there were 12 visits for each participant. The lowering effect of time on BMI was greatest in the first visit. While the lowest lowering effect on BMI was in the twelfth visit. The effect was descending from first visit to the twelfth visit as shown in Table (8).

Table (8): Different variables with estimates of their effect on the dependent variable (BMI change).

Parameter	Estimate	Sig.
TDCI	-0.0005	0.000
BMI	0.0046	0.000
LBM	0.0010	0.009
TDFI	0.0021	0.000
LCD	0.0720	0.000
LFD	0.0360	0.000
IFD	0.0230	0.000
VD	0.0410	0.000
MD	Reference	-
Female	-0.0340	0.000
Male	Reference	-
week	0.5791	0.000
week 2	0.2047	0.000
week 3	0.1824	0.000
week 4	0.1374	0.000
week 5	0.1022	0.000
week 6	0.0962	0.000
week 7	0.0719	0.000
week 8	0.0672	0.000
week 9	0.0442	0.000
week 10	0.0264	0.011
week 11	0.0253	0.015
week 12	Reference	-

3.2 Comparison of dietary patterns effect on BMI changes

A one-way analysis of variance (ANOVA) was conducted to compare the effectiveness of the five dietary patterns. The shape of histogram of dependent variable showed that normality assumption was met and as the equality of variance assumption was violated according to Levene's test (P value<0.05) so Welch's test was carried out and the (P value <0.05) was significant.

The results of ANOVA had shown differences in mean BMI change [F(4,16411)= 17.353, p = 0.000] between the 5 dietary patterns in all weeks as shown in Figure (5).

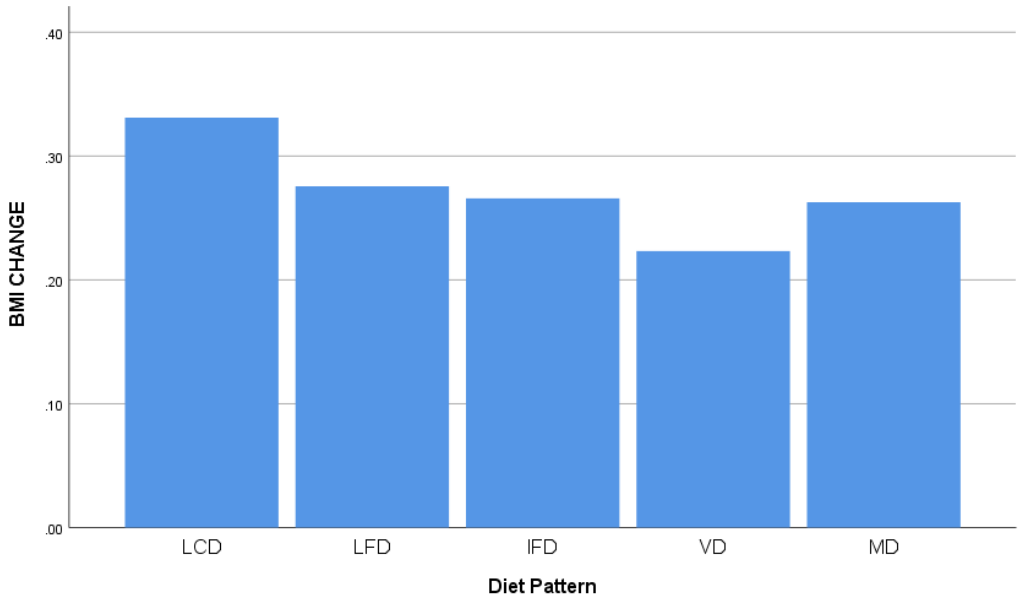

Figure (5): The effect of the five dietary patterns on changes in BMI.

Post hoc comparison was carried out using Games Howell test Table (9) (The Games-Howell test is applicable when equivalence of variance assumption is violated and it used Welch's degree of freedom) [67].

Table (9): Games Howell test for multicomparison between the five dietary patterns according to their effect on Mean BMI Change

		Mean Difference between diet patterns	Sig.
LCD	LFD	.05542*	0.000
	IFD	.06525*	0.000
	VD	.10777*	0.000
	MD	.06832*	0.000
LFD	LCD	-.05542*	0.000
	IFD	0.00983	0.795
	VD	.05235*	0.001
	MD	0.01290	0.601
IFD	LCD	-.06525*	0.000
	LFD	-0.00983	0.795
	VD	.04252*	0.001
	MD	0.00307	0.980
VD	LCD	-.10777*	0.000
	LFD	-.05235*	0.001
	IFD	-.04252*	0.001
	MD	-.03945*	0.003
MD	LCD	-.06832*	0.000
	LFD	-0.01290	0.601
	IFD	-0.00307	0.980
	VD	.03945*	0.003
*. The mean difference is significant at the 0.05 level.			

According to Games Howell post hoc test comparison there was a significant difference between LCD and LFD (p = 0.000) with people on LCD had an average 0.055 decrease in BMI more than those on LFD. There was also a significant difference between LCD and VD (p = 0.000) with people on LCD had more decrease in BMI of 0.108 than those on VD. There was also a significant difference between LCD and MD (p = 0.000)

with people on LCD had more decrease in BMI of 0.068 than those on MD. A significant difference existed between LCD and IFD (p = 0.000) with people on LCD had more decrease in BMI of 0.065 than those on IFD. A significant difference also existed between LFD and VD (p = 0.001) with people on LFD had more decrease in BMI of 0.052 than those on VD. There was also a significant difference between IFD and VD (p = 0.001) with people on IFD had more decrease in BMI of 0.043 than those on VD. There was also a significant difference between MD and VD (p = 0.003) with people on MD had more decrease in BMI of 0.039 than those on VD.

3.3 Effect of gender on response to 5 dietary patterns.

To compare the gender effect on the response to different diet patterns, one-way ANOVA was conducted for females and males separately and results were shown in Figure (6).

For females there was violation in the assumption of equality of variances so Welch's test was used instead of Levene's test and Games Howell test was used for multiple comparison. However, for males the data met the assumption of equality of variances as Levene's test result was not significant (p-value=0.056). The post hoc test conducted for

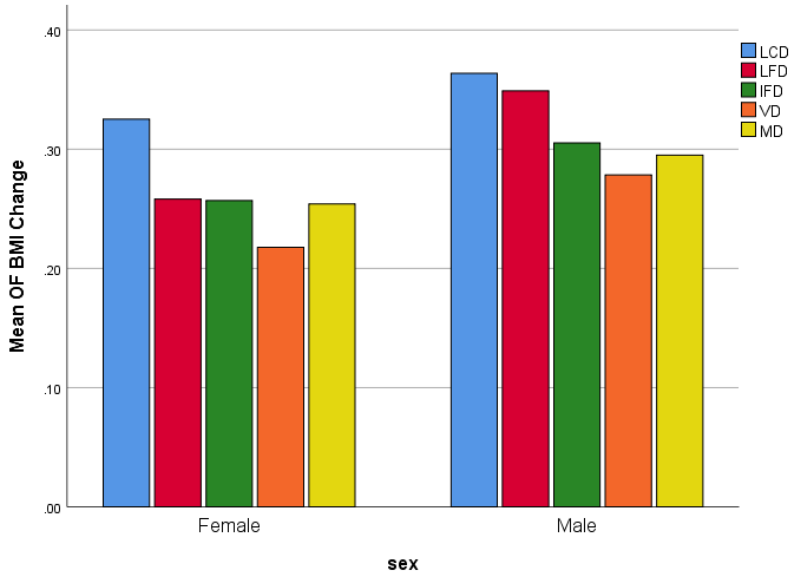

Figure (6): Differences in response to the 5 diet pattern between males and females.

multicomparison between the 5 diet patterns in there effect of BMI change in males, was Tukey HSD (Table 11).

The ANOVA results for both female [F (4, 13315) = 15.511, p = 0.000] and male [F (4, 3091) = 3.489, p = 0.008] had shown significant differences in mean BMI changes between the different 5 diet patterns. Post hoc comparisons for females using the Games Howell test table(10)showed that.

Table (10): Games-Howell test for multicomparison between the 5 diet patterns according to their effect on Mean BMI Change for females.

		Mean Difference between diet patterns	Sig.
LCD	LFD	.06705*	0.000
	IFD	.06830*	0.000
	VD	.10757*	0.000
	MD	.07115*	0.000
LFD	LCD	-.06705*	0.000
	IFD	0.00125	1.000
	VD	.04052*	0.029
	MD	0.00409	0.994
IFD	LCD	-.06830*	0.000
	LFD	-0.00125	1.000
	VD	.03927*	0.006
	MD	0.00285	0.990
VD	LCD	-.10757*	0.000
	LFD	-.04052*	0.029
	IFD	-.03927*	0.006
	MD	-.03642*	0.017
MD	LCD	-.07115*	0.000
	LFD	-0.00409	0.994
	IFD	-0.00285	0.990
	VD	.03642*	0.017
*. The mean difference is significant at the 0.05 level			

There was a significant difference between LCD and LFD (p = 0.000) with females on LCD lost an average of 0.0671 more than those on LFD.

There was also a significant difference between LCD and IFD (p = 0.000) with females on LCD lost an average of 0.0683 more than those on VD. A significant difference existed also between LCD and VD (p = 0.000) with females on LCD lost an average of 0.1076 more than those on VD. There was also a significant difference between LCD and MD (p = 0.000) with females on LCD lost an average of 0.0712 more than those on MD. There

was also a significant difference between LFD and VD (p = 0.029) with females on LFD lost an average of 0.0405 more than those on VD. A significant difference existed also between IFD and VD (p = 0.006) with females on IFD lost an average of 0.0393 more than those on VD. A

significant difference existed also between VD and MD (p = 0.017) with females on VD lost an average of 0.0364 more than those on MD.

Table (11): Tukey HSD test results for multi comparison between the 5 diet patterns according to their effect on Mean BMI Change for males.

		Mean Difference between diet patterns	Sig.
LCD	LFD	0.01468	0.987
	IFD	0.05842	0.106
	VD	0.08521	0.359
	MD	.06860*	0.033
LFD	LCD	-0.01468	0.987
	IFD	0.04374	0.217
	VD	0.07053	0.521
	MD	0.05391	0.067
IFD	LCD	-0.05842	0.106
	LFD	-0.04374	0.217
	VD	0.02679	0.969
	MD	0.01017	0.921
VD	LCD	-0.08521	0.359
	LFD	-0.07053	0.521
	IFD	-0.02679	0.969
	MD	-0.01662	0.995
MD	LCD	-.06860*	0.033
	LFD	-0.05391	0.067
	IFD	-0.01017	0.921
	VD	0.01662	0.995
*. The mean difference is significant at the 0.05 level			

On the other hand, the Tukey HSD Post Hoc test for males table (11) had shown the following results. A significant difference existed only between LCD and MD (p = 0.033) with males on LCD lost an average of 0.0686 more than those on MD. No significant differences existed between other dietary patterns.

3.4 Effect of gender on response to similar dietary pattern.

The third ANOVA was conducted to show if there is different in response to the same dietary pattern between males and females. The assumption for the equality of variances is met for ANOVAs of LCD and VD as the (p-values>0.05) for Levene's test. For the ANOVAs of LFD, IFD and MD the assumption for the equality of variances was not met (p-value<0.05). The results of ANOVA had shown no significant difference in mean BMI progress [F(1,1277)= 2.234, p = 0.135] between males and females following LCD. The same result was for people following VD, so no significant difference in mean BMI progress [F(1,617)= 2.957, p = 0.086] between males and females. While, for LFD, IFD and MD, the ANOVA results showed significant differences in mean BMI progress as [F(1,6794)= 55.725, p = 0. .000], [F(1,6725)= 26.873, p = 0.000] and [F(1,6372)= 17.079, p = .000] respectively, between males and females following same dietary patterns. Figure (7) showed the differences in the BMI changes between males and females among people following the same dietary patterns.

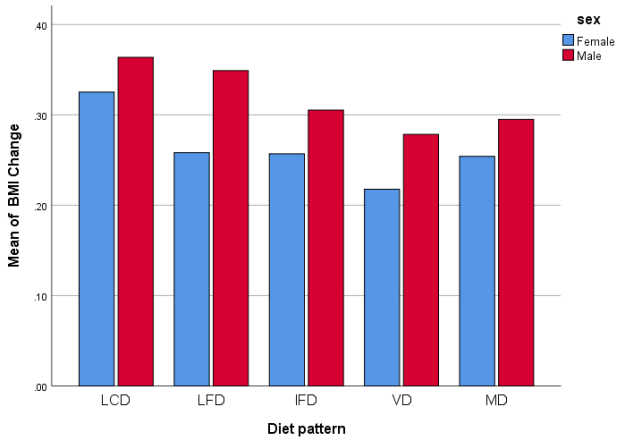

Figure (7): Difference between male and female on response to same dietary pattern.

3.5 Effect of visit order on BMI changes

To compare the mean BMI change for participants in the 12 visits we conducted one-way ANOVA. The results of ANOVA [F(11,16404) = 471.854, p = 0.000] had indicated significant differences between the 12 visits in their effect on mean change in BMI. As depicted in Figure (8) there was a gradual decrease in this effect from first week to twelfth week.

To compare if there was difference in the effect of each diet pattern on the mean of BMI change according to week visit, another one-way was conducted for each diet pattern over the 12-week period. The results of ANOVAs had indicated significant differences in the effect of each diet pattern on mean of BMI changes in the different weeks. This effect was significant for all 5 diet patterns as follows; [F(11,1267)= 37.307, p = .000], [F(11,1405)= 46.758, p = .000], [F(11,6715)= 147.379, p = .000], [F(11,607)= 5.519, p = .000] and [F(11,6362)= 244.569, p = .000] for LCD, LFD, IFD, VD and MD respectively and figure(9) showed those results.

Figure (10) showed that in most weeks females has more change in the mean BMI than females.

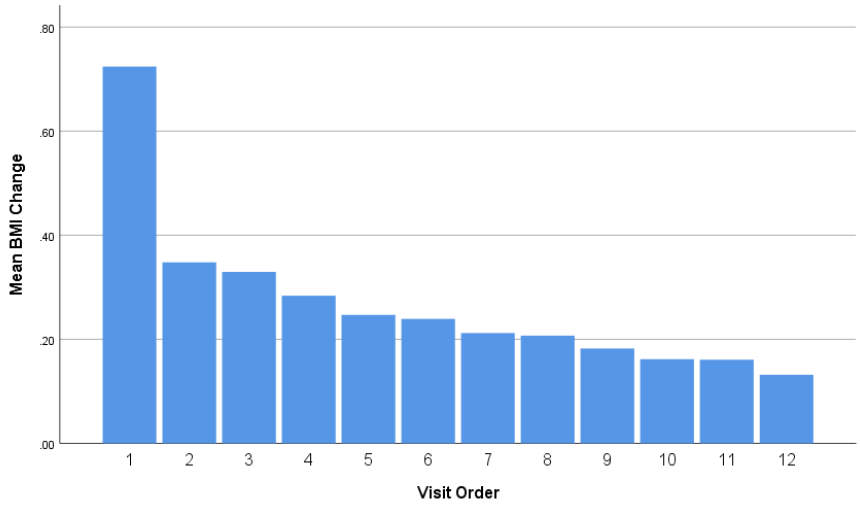

Figure (8): Mean of BMI changes according to visit order.

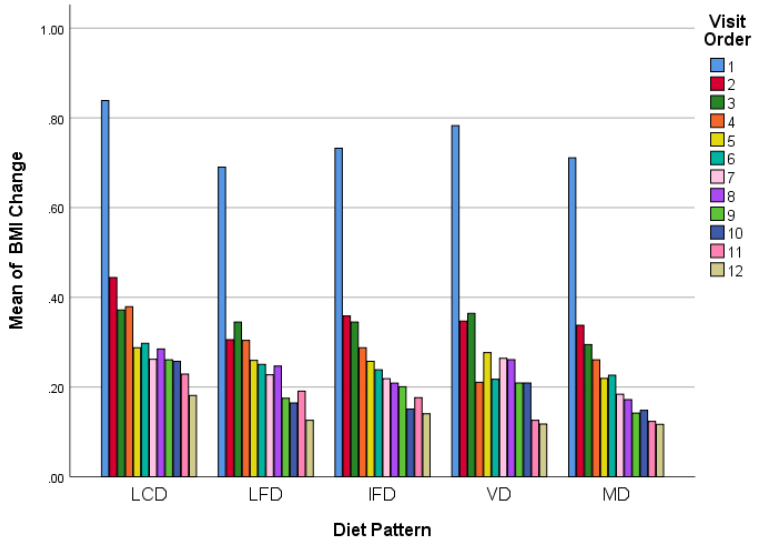

Figure (9): Mean BMI change for each diet pattern over 12 weeks.

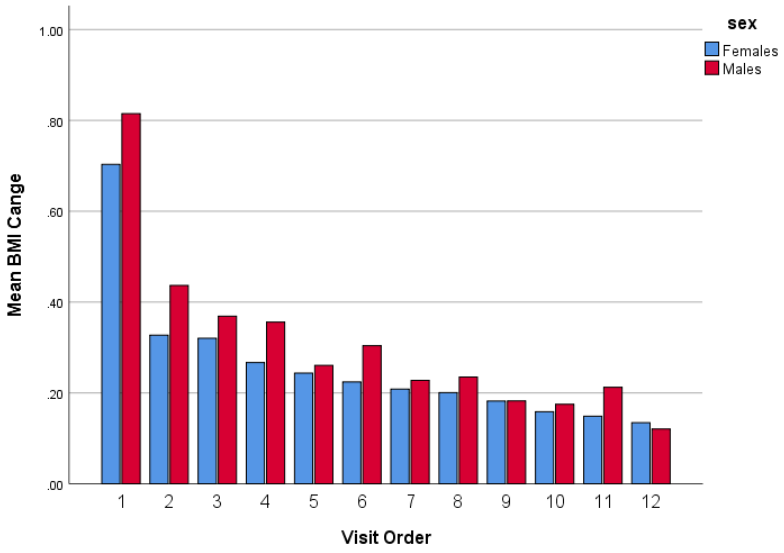

Figure (10): comparasion between male and females in all visits.

Chapter Four
Discussion

4.1 Effect of gender on mean change of BMI

The results of ANOVAs that conducted in this study had shown that males had more BMI change than females so males lost more weight than females. This can be explained by the difference in a number of characteristics between males and females that may contribute to the difference in weight loss success. The difference in body composition is important. Male and female are significantly different in their fat-free mass (FFM) and fat mass (FM). The National Health and Nutrition Examination Survey III (NHANES III) of 15,912 subjects, showed that non-Hispanic white females aged between 12 and 80 years have a higher percentage of FM than males, starting from puberty and varying from 6% to 11% higher for every decade studied [68].

Body fat distribution may have an influence on the amount of weight that could be lost. Men and women with excess abdominal fat were found to lose more body weight than subjects with obesity with a gluteal-femoral fat pattern [69]. Previous studies have reported that differences in metabolic outcome according to gender occur because men mobilize more intra-abdominal fat than women during weight loss [70].The difference in appetite control and reproductive hormone signals, result in gender-specific responsiveness to weight loss programs [71].

The characteristic that has positive effect on weight loss in men, is the greater percentage of muscle mass compared with fat mass. This will contribute to higher resting and total energy expenditure. On the contrary, women have higher concentrations of leptin, an appetite regulating hormone that reduces energy intake which has positive effect to lose more weight [72].

Other studies also support the notion that the significant sexual divergence in body composition commences with puberty. This sex difference holds across all ethnic groups and has been observed in all populations although its magnitude is influenced by ethnic, genetic, and environmental factors [73].

It may be postulated that women store more fat because they consume more energy than they expend or that they store the consumed fat more efficiently. However, when daily energy intake is compared in the cohort of subjects from NHANES III, men consumed more energy, even after adjusting for fat-free mass (187 kJkg−1 versus 170 kJkg−1). One possible explanation is that women are more efficient at conserving and storing energy as fat. Supporting this notion is the recognition that women must reduce their dietary intake by a greater proportion to achieve the same degree of weight loss as men. This ability to increase FM without substantial increases in energy intake points to the existence of metabolic adaptations that may contribute to the gender difference in FM [73].

4.2 Effect of Initial BMI on mean change of BMI

The second variable that has positive effect on BMI change was initial BMI. The results indicated that people with higher initial BMI have lost more weight. These findings are in agreement with previous studies. A previous study showed that under the same absolute level of energy intake, it was obvious that subjects with higher body mass and thus higher energy expenditure will have a greater energy gap and will lose weight faster [74]. Furthermore, Bild et al (1996), in a 2-year longitudinal observation study (CARDIA), found that weight loss in young adults was most consistently associated with greater baseline fatness together with low initial physical fitness level and self-perception of being overweight [75]. In addition, Leibbrand and Fichter (2002) have reported that initial BMI was the only significant predictor of weight outcome at 18-month follow up ($R2 = 0.07$, $P=0.01$) [76].

4.3 Effect of LBM on mean change of BMI

The third variable that has significant effect on lowering BMI was lean body mass. This effect can be explained due to the role of body composition in determining energy expenditure. The total body weight represents the sum of body compartments (lean mass and fat mass). An important determinant of resting energy expenditure is body composition, specifically metabolically active tissues, i.e. fat-free mass, with lower influences of fat mass. This compartment includes bone mass, skeletal muscle, and highly active organs such as brain, heart, liver, kidneys, and

gastrointestinal tract. Differences in body composition may directly affect the values of resting energy expenditure [77]. Rudolph et al. (1995) demonstrated that the fat free mass may be related to total energy expenditure, resting energy expenditure, energy expenditure by activity and the thermal effect of food. So the effect of muscle mass on weight loss can be understood from its effect on total energy expenditure as more muscle mass will have positive effect on total energy expenditure (TEE) [78].

4.4 effect of Daily fibre intake on mean change of BMI

The results from this study indicated positive association between daily fibre intake on BMI lowering effect. There are several epidemiological studies suggesting a negative association between fibre intake and obesity [79].The results of these studies have evaluated fibre effect on satiety. The majority of studies with controlled energy intake reported an increase in post-meal satiety and a decrease in subsequent hunger with increased dietary fibre. With *ad libitum* energy intake, the average effect of increasing dietary fibre across all the studies indicated that an additional 14g of fibre per day resulted in a 10% decrease in energy intake and a weight loss of over 1.9 kg during 3.8 months of intervention [86].

Dietary fibre can, furthermore, entrap or bind nutrients in the intestinal content, which lowers the bioavailability of fatty acids and proteins and results in a reduced energy absorption and an increased faecal loss of nutrients [81]. As a consequence of the slower uptake of nutrients, blood glucose concentrations tend to be lower after high fibre diets [81]. Lower

postprandial blood glucose concentrations blunt insulin secretion, which is suggested to be related to an increased satiety [81].

The main end products of fermentation of dietary fibre are gases such as hydrogen and carbon dioxide, and short-chain fatty acids (SCFA) such as acetate, propionate, and butyrate [82]. These byproducts of bacterial fermentation acidify the colonic content, modify the microflora composition and are metabolized by human tissues [81]. There are indications that bacterial fermentation may play a role in the regulation of food intake, but the processes are unclear. It was suggested that butyrate and propionate may enter the circulation via the portal blood system and stimulate GLP-1 and PYY secretion. Furthermore, SCFAs may slow down gastrointestinal transit time of intestinal content. DF may affect satiety by changes in glucose and lipid metabolism, and oxidation of SCFAs may provide long-lasting energy and may lead to a longer sensation of satiety [81].

4.5 The comparison between the 5 dietary patterns and effect of total daily carbohydrate intake on mean change of BMI

The comparison results between the 5 dietary patterns indicated that LCD had more BMI lowering effect than other 4 dietary patterns. This was consistent with another result from this study which indicated negative significant effect of daily carbohydrate intake on BMI lowering effect. The effect of LCD on weight loss is controversial as weight loss clearly requires a negative energy balance: calorie expenditure must exceed intake. One

proposed mechanism of LCD suggested that it provided a metabolic advantage, Meaning that, there is greater weight loss if carbohydrates are low compared to isocaloric diets of different macronutrient composition. Although the effect had been experimentally demonstrated, the idea of a metabolic advantage had been frequently criticised as a violation of the law of thermodynamics, and it was frequently claimed that ‘a calorie is a calorie’ so we will focus on the metabolic pathways that may be affected by carbohydrate restriction [83].

Several literature reports had compared isocaloric diets, however, and there was often an apparent metabolic advantage in low carbohydrate diets, defined as an increased weight loss per calorie compared to similar diets with higher carbohydrate levels [83].

Carbohydrates, especially the simple carbohydrates, raise insulin levels to a greater extent than either proteins or fats do. Insulin promotes glucose uptake by cells, a process necessary for survival. However, it also initiates signal transduction cascades that result in inhibition of lipolysis (fat breakdown), inhibition of fatty acid oxidation, and inhibition of glycogen breakdown by synthesis. These effects explain why elevated insulin levels (hyperinsulinemias) are associated with obesity. Therefore, LCD seek to minimize insulin release while favouring release of glucagon. Where they differ is in the extent to which carbohydrates are restricted [84].

The weight loss effect of carbohydrate restriction can affect metabolism so in case of fasting, exercise or carbohydrate restriction when

gluconeogenesis depletes oxaloacetate so that the rate at which acetyl CoA enters the citric acid cycle is low, acetyl CoA build up in the liver. As a result of the build-up of acetyl CoA, this metabolite and partially oxidized fatty acids are converted to aceto-acetone, acetoacetate (Ac Ac), and D-B-hydroxybutyrate (HB), the substances known as ketone bodies. HB was identified as the principal ketone .

During fasting ketone bodies can be used as alternative source of energy. From a theoretical point of view, HB has a higher *H*-combustion than the glycolytic product pyruvate (243.6 kcal/mol *versus* 185.7 kcal/mol) [84]. Some of these ketones enter cells and are used for energy, but others are expelled via the breath, the skin, and the urine without being metabolised. An additional reason for the increase in lipolysis (fat breakdown) observed in low-carbohydrate diets, is believed to be the use of fats for gluconeogenesis. When glucose is needed, lipases degrade fats to release glycerol, which can be converted to glucose. In fasting and starvation, approximately one-fifth of *de novo* glucose synthesis is from glycerol [85, 86].

The need for gluconeogenic substrate may explain how lipolysis can continue when caloric intake exceeds caloric expenditure. If only fat is consumed, for example, 1000 g of fat per day would be needed to provide enough gluconeogenic substrate (glycerol) for conversion to 50 g of glucose representing a caloric intake of 9000 kcal/d (This is the estimated

minimal amount of glucose needed to prevent lipolysis and ketogenesis) [87].

Some researchers claimed that the greater short-term success of very low-carbohydrate diets was not due to ketosis, but is primarily due to voluntary caloric restriction. A study comparing non isoenergetic diets revealed that individuals on low-carbohydrate diets tended to consume one-third fewer calories than individuals on typical low-calorie diets did [88]. LCD usually contains more protein and some individuals reported a decreased appetite when protein was abundant in their diet [89]. Alternatively, a primary mechanism for both ketogenic and nonketogenic (but reduced carbohydrate) diets may simply be the elimination of insulin mediated swings in blood glucose levels that stimulate hunger [90].

The greater initial weight loss seen with low-carbohydrate diets can be due to water loss. Breakdown of liver and muscle glycogen results in diuresis (depletion of water). In a typical 70-kg adult, muscle typically stores 400 g of glycogen and the liver typically stores 100 g. Complete mobilisation of these stores (representing about 1,600 kcal of energy) can result in a loss of over 2 lbs. (about 1 kg) body weight. For each gram of glycogen used as an energy, twice this mass is loss of water [84].

Results from this study as shown in Figure (3) that LCD has more BMI lowering effect than the other 4 patterns in all weeks but also the results indicated that the differences between LCD and other diet patterns was not significant in all visits after the first week. Also, the BMI lowering effect of

LCD was gradually decreased from visit one to visit 12. One possible reason for this was water loss which was great in the beginning of the dieting in the first week.

The BMI lowering effect of other dietary patterns was on the following descending order LFD, IFD, MD and VD but the difference between MD, LFD and IFD was not significant.

A review by Tobias and Deirdre (2015) has included 53 studies representing 68,128 participants which compare low-fat dietary diets ranged from very low-fat ≤10% of calories from fat, to more moderate of ≤30% of calories from fat [91]. The results from this review indicated that LCD weight loss interventions led to an average 1.15 kg greater than low fat weight loss in long-term weight loss interventions. No difference, however, was observed between low-fat and other higher fat dietary interventions which consistent with results from this study as discussed earlier [91].

A systemic review by Joseph et al (2015) for long term effect of MD on weight loss, had shown a modest effect at reducing body weight. However, when compared with LCD, the MD was less effective in weight loss [92].

The results from clinical trial lasted for 2 years by Iris Shai et al (2008) had indicated a mean weight loss of 2.9 kg for the low-fat group, 4.4 kg for the MD group, and 4.7 kg for the LCD group [93].

In a randomised-control trial Austel et al (2015) had used five-meal modified MD with two daily portion-controlled sweet snacks. Intervention group (IG) was compared with control group (CG) after 12 weeks the results showed that mean change in body weight in completers was − 5.15 kg in IG compared with − 0.37 kg in CG. BMI went down by 1.82 kg/m^2 and 0.14 kg/m^2 for IG and CG, respectively. While, mean waist circumference was reduced by 4.7 cm vs. 0.88 cm. All differences between the groups had been highly significant [94].

Weight loss by MD and its protective effect against weight gain had several physiological explanations that could elucidate this effect as follows; MD is rich in plant-based foods that provide a large quantity of dietary fibre, which has been shown to increase satiety and satiation through mechanisms such as prolonged mastication, increased gastric distention, and enhanced release of cholecystokinin. Energy density has an important role in weight gain as palatable energy-dense food consumption is associated with poor appetite control and leads to over-consumption. The MD had a low energy density and also relatively low glycaemic load compared to many other dietary patterns, which along with its higher water content lead to increased satiation and lower calorie intake [92].

Also, the consumption of monounsaturated fatty acids in MD has been found to increase postprandial fat oxidation, diet induced thermogenesis and overall daily energy expenditure compared to other fats such as saturated fats. This may provide a physiological explanation of why olive

oil consumption is less likely to be associated with weight gain. Finally, the MD is highly palatable and therefore well-liked and tolerated among dieters and compliance to the MD has been found to be high [92].

In a systemic review by Welton et al (2020) had studied the weight loss effect of different patterns of IF. The results had shown that in all 27 trials

reviewed (n = 944 participants), IF resulted in weight loss ranged from 0.8% to 13.0% of baseline body weight. Twelve studies had used calorie-restricted diets to compare with IF and have found equivalent weight loss in both groups which was consistent with results in present study. For a short period (7days) comparison between IF, LFD and MD showed no significant difference in BMI lowering effect between the three diet patterns [95].

A study by Headland et al (2019) had compared IFD with calorie restriction for 244 obese adults. Participants had achieved a mean 4.97 kg weight loss over 52 weeks versus a mean weight loss of 6.65 kg with calorie-restricted diets (p-value= 0.24) [96].

Harvie et al (2011) indicated that 79% of weight loss was fat .Intermittent fasting studies generally find that hunger levels remained stable or decreased during IF [97]. While Kroeger et al (2012) found that over 12 weeks of IF amongst those with the highest weight losses, hunger has decreased and fullness has increased [98].

More recently, Soeters et al (2009) had thoroughly explained IFD effect on weight loss by interrelationships between lipid and glucose metabolism during short-term starvation. They had detailed how the occurrence of a large switch in substrate utilization had decreased reliance on carbohydrate and increased reliance on fatty acids as a fuel source [99].

Other Short-term starvation studies had shown that blood glucose concentrations declined and whole-body lipolysis and fat oxidation significantly increased within the first 24 hours of food deprivation [100]. The increase in lipolysis is thought to occur because of reduced plasma insulin concentration, increased sympathetic nervous system activity, and a higher concentration of growth hormone in the blood [101].

Zauner et al (2000) showed that in a brief fasting in healthy lean male and female subjects . They found that resting energy expenditure has increased significantly from 14 to 36 hours of starvation (3.976 0.9 kJ/min to 4.376 0.9 kJ/min), apparently due to increased norepinephrine concentrations. Between those same time points, increases in plasma fatty acids and b-hydroxybutyrate with a decrease in respiratory quotient and plasma triglycerides were observed [102].

Together, these changes provided additional support for the transition to reliance on fat for energy during brief fasting [95].

The last diet pattern which had the least BMI lowering effect was VD and this result was in contrary to results from several studies. Huang, et al.'s (2016) meta-analysis of clinical trials indicated significant weight loss

among individuals assigned to a VD. Among the 12 studies reviewed, participants randomized to some type of vegetarian diet lost an average of –2.02 kg more than the participants assigned to a non-vegetarian diet. Six of the 12

Studies had involved energy restriction. Unsurprisingly, the average weight loss was greater among the energy-restricted vegetarian diets than non-energy restricted vegetarian diets (mean of –2.2 kg vs. –1.6 kg, respectively [103].

On the other hand, Francesco et al, (2018) conducted a comparison between MD and VD for 3 months, the results indicated no significant differences between the 2 diets in body weight loss, a significant reductions obtained by both VD (−1.88 kg) and MD (−1.77 kg) compared with initial body weight [104].

The VD effect on weight loss can be explained by several mechanisms. Whole plant foods contain mostly water by weight; thus, these foods generally have a low-calorie density. Individuals generally consumed the same weight of food during meals, as such, the clear advantage of consuming foods low in calorie density is that these foods can contribute to

stomach volume, feelings of fullness and satiety while maintaining low caloric intake[105].

The effect of vegetarian diet on gut microbiota is another mechanism that can explain weight loss effect. This was confirmed by a randomized crossover trial, where 16 healthy subjects, both men and women (mean age 23.8 years) had consumed brown beans during an evening meal. This had resulted in an increase in breath SCFAs, (Peptide YY) PYY, and a decrease in ghrelin, a hormone that stimulates appetite and fat storage at breakfast compared to a white bread meal [106]. Plant-based foods are rich source of phytochemicals like polyphenols. An inverse association between polyphenol consumption and body weight had been observed [107]. In fact, in a randomized, interventional trial consisting of 17 obese, middle-aged men and women, 12-week consumption of 370 mg/d of polyphenols extracted from grapefruit, green tea, grape, black carrot, has resulted in a 6.7% reduction in body mass and 7.1% reduction in fat mass in obese subjects compared to placebo[106].

Chapter Five

Conclusion and recommendations

5.1 Conclusions

The obtained results from this study indicated that initial BMI, body muscle mass and total daily fibre intake have positive effect on BMI lowering effect of the diet. On the other hand, daily carbohydrate intake has negative effect on BMI change.

Gender was another predictor for BMI change and the results have indicated that males have more BMI lowering effect than females. The comparison between different 5 diet patterns on BMI lowering effect indicated that LCD has more effect than other four diet patterns and VD has the lowest BMI lowering effect. The other 3 diet patterns which are MD, IF and LFD did not show significant difference between them in BMI lowering effect.

The change in BMI in the first week for all the 5 diet patterns was more than BMI change in other 11 weeks and generally this effect is gradually decreasing from first week to 12 weeks.

5.2 Recommendations

According to results from this study it is recommended LCD to be prescribed for the first week of diet as it has more BMI lowering effect than other diet patterns.

It is recommended also to use different diet plan in different weeks to break the routine of having same diet patterns and assure sustainability of weight management.

Other dietary patterns IFD and MD are recommended in next weeks as weight loss with those patterns was comparable with LCD.

Also, by changing the diet patterns, people will have more experience to decide which pattern is best to adopt for weight maintenance.

It is recommended to prescribe MD and IF for weight maintenance and to be adopted for life-long due to superior health effect. It was, also, noted that majority of people in this study has followed either one of these two diet patterns.

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جامعة النجاح الوطنية

كلية الدراسات العليا

دراسة مستقبلية موسعة لتأثير الأنماط الغذائية المختلفة على قياسات الجسم بين الأفراد المصابين بالسمنة وزيادة الوزن والذين يراجعون مراكز التغذية في الضفة العربية

إعداد

يوسف سليمان

إشراف

د. محمد التميمي

قدمت هذه الأطروحة استكمالاً لمتطلبات الحصول على درجة الماجستير في التغذية وتكنولوجيا الغذاء، بكلية الدراسات العليا، في جامعة النجاح الوطنية، نابلس– فلسطين.

2020

دراسة مستقبلية موسعة لتأثير الأنماط الغذائية المختلفة على قياسات الجسم بين الأفراد المصابين بالسمنة وزيادة الوزن والذين يراجعون مراكز التغذية في الضفة العربية

إعداد

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الملخص

تعتبر السمنة وزيادة الوزن من أكبر التحديات الصحية التي تواجه العالم وتشترك الدول النامية والمتطورة في زيادة نسبة المصابين بالسمنة وزيادة الوزن مما يزيد من الأعباء وتكاليف علاج النتائج الصحية المباشرة وغيرة المباشرة الناتجة عن السمنة.

تزيد السمنة من مخاطر الإصابة بكثير من الأمراض مثل السكري من النوع الثاني وأمراض الجهاز الدوراني والسرطان أيضا.

تتعدد أسباب زيادة الوزن بين الإختلال في الإتزان ما بين كمية الطاقة المستهلكة عن طريق الغذاء وما بين كمية الطاقة التي يحتاجها الجسم هي اسباب أخرى مثل ضعف النشاط البدني والاسباب الجينية وبعض الأساب المرضية.

تختلف اساليب علاج السمنة ما بين الإعتماد على تغيير العادات الغذائية والإعتماد على زيادة النشاط البدني وأيضا التدخل الجراحي لبعض الحالات.

في هذة الدراسة قمنا بإختبار تأثير العوامل التالية على مؤشر كتلة الجسم وهذه العوامل هي كتلة الجسم الرخوة ومؤشر كتلة الجسم عند البداية بالحمية وكمية النشويات المستهلكة يوميا وكمية الألياف المستهلكة يوميا بالإضافة لتأثير الجنس.

تم دراسة تأثير 5 أنماط غذائية وهي النظام المنخفض بالنشويات والنظام المخفض بالدهون ونظام الصيام المتقطع وحمية البحر المتوسط والحمية النباتية.

تمت دراسة التأثير الزمني لاستخدام النظام الغذائي من الأسبوع الأول وحتى الأسبوع الثاني عشر.

أظهرت النتائج وجود تأثير إيجابي ساعد بنزول مؤشر كتلة الجسم لكل من زيادة مؤشر كتلة الجسم عند البداية وزيادة كمية الألياف الغذائية وزيادة كتلة الجسم الرخوة ولكن كان لزيادة كمية النشويات تأثير سلبي على نزول مؤشر كتلة الجسم.

كان للجنس تأثير على النزول في مؤشر كتلة الجسم حيث حقق الذكور معدل نزول أعلى من الإناث.

حقق النظام المنخفض بالنشويات أعلى معدل نزول في مؤشر كتلة الجسم وكان للنظام النباتي التأثير الأقل.

بقية الأنظمة وهي حمية البحر المتوسط والحمية النباتية وحمية الصيام المتقطع لم يكن هناق فرق مؤثر على معدل نزول مؤشر كتلة الجسم.

جميع أنواع الحمية حققت التأثير الأكبر على نزول مؤشر كتلة الجسم خلال الأسبوع الأول.

تظهر نتائج الدراسة تفوق النظام المنخفض بالنشويات بتأثير النزول في مؤشر كتلة الجسم خلال بداية اتباع الحمية وهذا قد يوفر دعم نفسي لمن يبدأ بالحمية ولكن بمرور الوقت يصبح الفارق أقل ولذلك قد ينصح بإتباع الحمية قليلة النشويات في بداية برامج تخفيف الوزن ولكن نظرا للفوائد الصحية لحمية البحر المتوسط والصيام المتقطع فينصح بإتباعهما بشكل أكبر خلال الفترات التالية لبداية الحمية وكنظام للحفاظ على ثبات الوزن وعدم عودته مجدد.