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Factors Affecting the Development of Dyslipidemia among Overweight and Obese Adult Females

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ABSTRACT

Obesity is one of the most prevalent public health problems among adult females in Egypt. Obesity is associated with several health problems especially cardiovascular diseases and hyperlipidemia. The aim of this study was to investigate the impact of several dietary and socio-economic factors on lipid abnormalities among overweight and adult females suffering from different grades of obesity. The sample of the study included 188 females. The degree of overweight and grade of obesity was identified according to BMI. A pre-coded questionnaire was used to collect data on socio-economic characteristics. Dietary intake was determined using a 24-hour recall method. Fasting blood samples were collected and were used to determine the lipid profile. Hyperlipidemia was diagnosed using reference standard. The results show that mean total cholesterol of overweight females was within normal range (199.3mg/dl) , increased significantly among grade 1 and grade 2 obese females , 221.3mg/dl and 235.s mg/dl respectively. A similar pattern was noted with LDL-C and triglycerides. The opposite trend was noted with HDL-C which was lowest among grade 2 obese females. The results showed a significant association between lipid concentrations and the degree of obesity. All blood lipid parameters increased with age particularly above the age of 40 years. Unemployed and illiterate obese females showed elevated blood lipids, while females with middle education and employed in occupation requiring mild activity showed lower blood lipid concentrations.. The grade of obesity was associated with excessive caloric intake and the diet of grade 2 obese females contained a higher percentage of sugar, animal fat and protein . Total cholesterol, LDL-C and triglycerides were positively correlated with total caloric intake, percent calories from sugar, total fat and animal fat intake, total protein and animal protein intake .HDL-C was negatively correlated with the same dietary variables. The results of this study confirm the association between blood lipid concentration and the degree of obesity. The impact of age, educational level and employment on lipid indices is demonstrated. Total caloric intake, percentage of calories derived from sugar, quantity and nature of fat and protein consumed had a significant role in the elevation of blood lipids.

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INTRODUCTION

The high and sustained prevalence of obesity is one of the most serious public health problems in Egypt. The epidemic of obesity took off since 1980, and has been rising inexorably ever since. Obesity is prevalent among various population groups, however, the prevalence among adult females is one of the highest in the world. The prevalence of obesity starts to increase among adolescents females to reach its peak among adult females in the age group 20 to 50 years (Gallal., 2002; Tawfik *et al*., 2003; Asfaw., 2007).

Obesity among adult females has been associated with infertility (Moran and Norman., 2002), pregnancy complications and increased neonatal mortality (Bongain *et al*.,1998). Obesity has also been associated with cardiovascular disease and hyperlipidemia (Rexrode *et al*., 1996). It has been reported that obese women are five times more probable to die from cardiovascular disease than women with normal body weight (Manson *et al*., 1995).

The link between diet and plasma lipids has been recognized since the 1950s. Since then, several studies have established the link between dietary animal saturated fats and LDL cholesterol (Howard *et al*.,2010). Previous studies have focused on changes within the different lipoprotein fractions. These provide convincing evidence that saturated fats elevate TC, LDL-C (Choudhury *et al*., 1995; Zhang *et al*., 1997). Dietary cholesterol

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which is found in animal fats raises TC and LDL-C (Weggemans *et al*., 2001). There is strong evidence that plant sterols and stanols lower TC and LDL-C independent of changes in Fatty acid composition (Law, 2000).

Despite of the global increase in Obesity, Serum total and LDL-C concentrations have fallen in several economically developed countries where the fat supply has changed from animal fats rich in saturated fatty acids to vegetable oils rich in unsaturated fatty acids (Carrol *et al*.,2005). In contrast, TC and LDL-C are increasing in emerging economies and that this was accompanied by an increase in total and saturated fat consumption (Critchley *et al*., 2004)

Diets high in either saturated fat or refined carbohydrates are not suitable for IHD prevention. Refined carbohydrate may cause even greater metabolic damage than saturated fat in a predominantly sedentary and overweight population (BHU., 2010).

Dietary carbohydrates play an important role in the development of CHD through their effect on body weight and serum lipid level. Results of several studies on the effect of increased carbohydrate intakes, especially of sugar revealed an elevated triglycerides and sometimes lower HDL-cholesterol concentration and changes in LDL-cholesterol composition (Mensink *et al*., 2003). Glycemic index and or glucose load have positive association with the concentration of triglycerides and inverse association with HDL-cholesterol (Maki *et al*., 2007; Mosdal *et al*., 2007; Sichier *et al*.,2007). A low carbohydrate diet rich in vegetable fat and protein has lipid lowering advantage over a high carbohydrate diet (Jenkins al., 2009). Moderate carbohydrate restriction and weight loss provide equivalent but non additive approaches to improving atherogenic dyslipidemia (Krause *et al*., 2006)

The traditional diet in Egypt, like other southern Mediterranean counties, has always been thought to be effective in reducing the prevalence of metabolic syndrome, its associated cardiovascular risk, the rate of all causes and cause-specific mortality (Yusuf *et al*., 2005). Following the rapid process of urbanization, Egyptians have changed their life style and food habits and shifted from traditional food habits to a trend characterized by a fall in whole grain intake with a rise in animal food sources (Belahsen and Rguibi., 2006). This is always associated with a shift from high prevalence of infectious diseases to a pattern of high prevalence of chronic and degenerative diseases associated with urban-industrial life style (Chedid *et al*., 2009; Sibai *et al*., 2010; Ng *et al*., 2011).

The high prevalence of overweight and obesity among adult females in Egypt is associated with the fast change in the dietary pattern prevailing in the country. The drastic social and economic changes especially among low income groups is enforcing unhealthy food pattern associated with limited food purchasing power. Peoples resort to low quality cheaper unhealthy foods. Subsidized bread is the main source of calories (Ezzat, 2009). Low priced subsidized sugar is used in preparing sweets and strong tea commonly consumed after meals as a replacement of the more expensive fruits. Cheaper imported frozen meat rich in fat has replaced fresh meat. In addition, the high price of butter and vegetable oils forced the people to resort to increase their intake from hydrogenated vegetable oils and animal fats.

Literature review revealed very few studies investigating the effect of such factors on the blood lipids of obese adult females. Investigations concentrated on the comparison of blood lipids between normal and obese subjects without considering the degree of obesity. This study was carried out to investigate the impact of several dietary and socio-economic factors on lipid abnormalities in overweight and adult females suffering from overweight and different grades of obesity.

Subjects and methods:

The sample of this study was taken at random from adult females in the age group 20 to 60 years attending the outpatient clinic of Alexandria University hospital for the first time seeking nutritional counseling for the treatment of obesity. The clinic serves a large number of patients from different socioeconomic strata. Using G power program, based on the prevalence of abnormal total cholesterol level of 22.9% among overweight as compared to 11.6% among normal weight subjects (Al-Kabba, 2012), and using a 95% confidence, 5% error and 95% power, the resulting minimal sample size amounted to 145 subjects. In order to increase the accuracy of the data, the sample size was increased to 188 Subjects.

Each female was privately interviewed to inform her about the objective of the study and to gain her consent to participate in the study and to collect the needed data. The body weight of each female was measured to the nearest 0.5 Kg and height was recorded to the nearest 0.1 cm using standard techniques (Gibson, 2005). Height and weight were used to calculate the body mass index (BMI= weight in Kg divided by the square of height in meters). Females were classified according to their BMI as normal when their BMI was less than 25, overweight when the BMI was between 25.0 and 29.9, obese grade 1 when their BMI was between 30 and 34.9 and grade 2 when their BMI was between 35 and less than 40, (WHO, 1995). No cases with BMI above 40 were identified in this study. All subjects with BMI less than 25 were excluded from the study. Eligible subjects were not taking lipid lowering medications, not following a lipid lowering or weight control diet, free from possible causes of secondary hypercholesterolemia such as hypothyroidism, pregnancy and free from life threatening illness.

During the interview, data were collected on females' age, educational level and employment status using a pre- tested coded questionnaire. Subjects were divided according to their educational level into three groups: the first group included subjects who were illiterate or who could only read and write, the second group included subjects who received secondary level of education while the third group included those having a university degree. Females were classified according to their employment status in to three categories, the first category included unemployed females, the second included subjects having a professional or technical work that required mild activity during the working hours, while the third included those having administrative work which requires a minimum level of activity.

Food intake was assessed using a 24 –hours dietary recall method .Each subject was privately interviewed to provide exact data on her food intake during a 24 hours period, this included foods consumed in the major meals, between meals and drinks consumed throughout the day. Household measures were used to improve the quality of the collected data.

The energy and total macronutrient intake were calculated using the food composition table issued by the national nutrition Institute (N.I., 2006). Dietary variables considered in this analysis were total energy intake (Kcal/day), percent of calories derived from carbohydrates, sugar, total fat and total protein. The intake from animal protein and vegetable protein was calculated as a percentage of total protein intake, while animal fat and vegetable fat intake was calculated as a percentage of the total fat intake.

Females were requested to come the next day after a 12 hour fast to donate a fasting blood sample which was collected between 9 and 10 AM. Serum was separated and delivered to the hospital laboratory for analysis. The concentration of total cholesterol, triglycerides and HDL-C was determined using Cobasc 311, Roch. LDL-C was calculated by the Friedewald formula, [LDL-C] = [total cholesterol]-{HDL-C + triglycerides/5} (Friedewald et. al., 1972). The concentrations were given in mg/ dl. Dyslipidemia was characterized by 3 lipid abnormalities: elevated triglyceride levels, elevated levels of small LDL-C particles and reduced HDL-C levels. These included low HDL-C level for women (< 50 mg/ dl), High LDL-level (> 130 mg / dl) or high triglyceride (> 150 mg/dl), (Britcher and Ballanty., 2004).

Data were analyzed using statistical package for social sciences version 16.0. The 0.05 level was used as the cut off value for statistical significance. Several statistical measure were used. Count and percentage were used for describing and summarizing qualitative data. Arithmetic mean, and standard deviation were used as measures of central tendency and dispersion respectively for normal distributed quantitative data. Chi square test were used to test the association between two qualitative variables or to detect difference between two or more proportions. Monte Carlo Exact Probability (MCP) was used when > 20% of the expected cells have count less than 5. One way analysis of variance (ANOVA) was used for testing the difference between more than 2 group means. In case of significant ANOVA, F test for the Post Hoc Tukey test was used for multiple comparison of each couple of groups.

The protocol of the study was approved by the ethics committee of the High Institute of Public Health, Alexandria University, this included subjects recruitment and data collection procedures.

Results:

The impact of the grade of obesity on blood cholesterol, LDL and HDL in obese adult females is illustrated in table1. The mean total cholesterol for overweight females was 199.3 ± 41.6 mg/dl increased significantly (F=12.67, P=0.00) to 221.3 ± 40.6 mg/dl and 235.2 ± 35.6 mg/dl for grade 1 and 2 obese females respectively, however the difference between the means of the last two groups was not significant. The results show that the mean blood cholesterol for 22.4% of the overweight females was above 260 mg/dl, such ratio increased to59.5% of females with grade 2 obesity. The corresponding ratio for females with blood cholesterol less than 200 mg/dl were 49.4% and 14.3 % respectively. The difference was statistically significant (X^2 = 23.169. P=0.000). The concentration of LDL cholesterol followed a similar pattern as it was 121.0 ± 31.67mg/dl for overweight females, increased significantly (F= 7.26, P=0.000) to 139.6 ± 36.5 mg/dl for grade1 obese females and slightly increased to 142.14 ± 40.2 for grade 2 obese females. The results show that the LDL cholesterol concentration for 30.6% of overweight females was less than 100mg/dl, such ratio was as low as 14.3% of grade 2 obese females , the corresponding figures for females with LDL above 190 mg/dl were 30.6% and 16.7% respectively , the difference was statistically significant (X^2 = 22.03 , P= 0.00).

The mean HDL cholesterol concentration for overweight females was 49.0 ± 5.5mg/dl, declined significantly to 46.8 ± 8.9 g/dl for grade1 obese females and slightly declined to 45.0 ± 9.9 mg /dl for grade2 obese females. The data show that 38.6% of overweight females had HDL concentration above 50 mg/dl and 10.6% had HDL less than 40 mg/ dl, the corresponding figures for grade 2 obese females were 28.6% and 38.15% respectively, the differences were statistically significant, X^2 =13.77, P=0,03.

The results presented in table2 show that the concentration of the triglycerides of females with different grades of obesity varied significantly, X^2 = 20.04, MPC = 0.00. The triglyceride concentration of 71.8% of the overweight females was less than 150 mg/dl, such ratio declined significantly to 31.0% among grade2 obese females. On the other hand, the concentration of triglycerides of females was above 500 mg/dl among 3.5% and

11.9% percent of both groups respectively. The overall mean of triglycerides was highest among grade 2 obese females ($\bar{X}$ = 231.5 ± 160.5 mg/dl) declined to 175.4 ± 133.3 mg/dl among grade 1 obese female and was significantly lower to 144.4 ± 105.1 mg/dl among overweight females , F= 6.48, P = 0.00.

The change in the lipid profile of obese adult females with age, educational level and employment status is illustrated in table 3. The results show that age had a significant effect on the concentration of blood lipids. The mean blood cholesterol was 194.4 ± 27.6 mg/dl for females younger than 30 years and increased significantly (F = 8.55, P= 0.00) with age to its highest level (228.7 ± 35.4 mg/dl) for obese females older than 50 years. The concentration of LDL followed a similar pattern and was 114.3 ± 15.4 mg/dl and 146.9 ± 15.1 mg/ dl for both groups respectively. The data show that the mean HDL was highest, 51.6 ± 8.9 mg/dl, for young females, decreased slightly to 49.8 ± 7.3 mg/dl for the group aged 30 to 40 years and significantly (F= 10.64, P = 0.00) decreased to 43.1 ± 7.1 mg/dl among the group older than 50 years. A significant increase in blood triglycerides level with age was also observed (F= 8.154, P= 0.00). The mean triglycerides levels was least (145.6 ± 42.6 mg/dl) among females younger than 30 years and increased gradually with age to the highest level in the group older than 50 years ($\bar{X}$ = 199.4 ± 46.3 mg/dl).

The results show that the lipid profile of obese females was significantly affected by their level of education (table 3). The mean total cholesterol was lowest ($\bar{X}$ = 190.6 ± 26.8 mg/dl) among females with middle level of education, increased significantly to 226.8 mg/dl among university educated females and was significantly highest ($\bar{X}$ = 230.5 ± 29.1mg/dl) among illiterate females (F=37.94, P=0.000). The LDL concentration was comparable among illiterate and university educated females, 148.2 ± 19.3 mg/dl and 143.9 ± 18.2 mg/dl respectively and was significantly lower to 109.5 ± 14.7 mg/dl among females with middle level of education (F= 94.39, P= 0.000). The highest concentration of HDL was recorded among females with middle level of education (52.9 ± 9.2 mg/dl) and decreased significantly to 43.8 mg/dl among illiterate females and 44.5 mg/dl among university graduates respectively, (F= 21.25, P= 0.000). A comparable trend was recorded in the concentration of the triglycerides which was 193.1 mg/dl and 192.1 mg/dl among illiterate and university educated females and was significantly lower to 141.2 mg/dl among females with middle education, (F=36.7, P=0.000).

Blood lipids of obese females were significantly affected by their employment status (table 3). Total cholesterol concentration was highest among unemployed females ($\bar{X}$ = 228.7 ± 25.6 mg/dl) and was significantly (F=22.08, P= 0.000) reduced to 215.7 mg/dl and 198.3 mg/dl among females having administrative and technical jobs respectively. The data show that the LDL concentration of the latter two groups, 133.2 and 117.3 mg/ dl respectively, was significantly (F=54.06, P = 0.000) lower than that of unemployed females ($\bar{X}$ = 146.2 ± 16.9mg/dl). The concentration of HDL was highest among females having technical work ($\bar{X}$ =51.7 ± 8.4 mg/dl) decreased significantly to 47.2 mg/dl among the group having administrative work and was least ($\bar{X}$ = 43.5 ± 5.9 mg/dl) among unemployed females, the differences were statistically significant, F =20.15, P=0.000. The results show that females from the latter group recorded the highest concentration of triglycerides ($\bar{X}$ = 195.4 ± 51.1 mg/dl) which declined to 176.9 mg/dl and 147.8 mg/ dl among females having administrative or technical work respectively, the differences were statistically significant, F =15.96, P =0.000.

The mean energy intake and percent consumption from macronutrients by adult females with different grades of obesity is presented in table 4. The results show that the mean daily Caloric intake by overweight females was 2718 ± 141 Calories increased significantly to 2994 ± 167 Calories among females suffering from grade 1 obesity and was highest (3427 ± 235 Calories) among grade 2 obese females, the differences were statistically significant, F=193.5, P= 0.000. The data show that the mean percent energy derived from carbohydrate was highest by overweight females (57.1%) and declined significantly to 51.6% and 46.2% among females suffering from grades 1 and 2 respectively (F=116.6, P =0.000). On the contrary, the mean percent sugar intake was least by overweight females (12.7%) and was highest (15.9%) by grade 2 obese females.

The results show that overweight females derived 29.3% of their energy intake from fat, such percentage increased significantly to 36.1% by grade 2 obese females (F= 132.5, P=0.000). The results also show that the type of fat consumed varied with the grade of obesity. Overweight females derived 23.5% of their fat from animal sources and 76.5% from vegetable sources, the corresponding figures for grade 2 obese females were 36.1% and 68.9% respectively. The differences were statistically significant.

The mean energy intake from protein sources was 13.6% by overweight females, increased significantly to 17.7% by grade 2 obese females, (F=351.8, P=0.000). The latter group derived 21.6% of their protein intake from animal sources and 78.4% from vegetable protein, the corresponding figures for overweight females were 15.3% and 84.7% respectively, the differences were statistically significant

The results show a strong correlation between dietary intake variables and blood lipid concentration (table 5). Total daily caloric intake was positively correlated with total cholesterol (r=0.251), LDL (r= 0.263), triglycerides (r=0.275) but was negatively correlated with HDL concentration (r= -0.247). Total carbohydrate intake expressed as percent of total energy intake was not significantly correlated with blood lipids, however, a positive significant correlation was recorded between percent energy derived from sugar with total cholesterol (r=0.296), LDL (r=0.279), triglycerides (r=0.276) but was not correlated with HDL. The results show that the percent energy derived from fat was positively correlated with total cholesterol (r= 0.281), triglycerides (r= 0.231) and negatively correlated with HDL–C (r= - 0.131). Animal fat expressed as percent of total fat was positively correlated with total cholesterol, LDL and triglycerides and were negatively associated with HDL. On the other hand the percent fat derived from vegetable fat was only positively associated (r=0.296) with HDL and negatively correlated with other variables. The percent energy derived from total protein and, animal protein intake expressed as a percent of total protein intake were positively correlated with total cholesterol, LDL ad triglycerides but were negatively correlated with HDL. The percent protein derived from vegetable protein intake was negatively correlated with total cholesterol (r= -0.273), LDL (r= -0.292) and triglycerides (r= -0.319) but was positively correlated with HDL (r=0.334).

Discussion:

The prevalence of obesity among adult females in Egypt is a serious health problem. The prevalence is increasing and the number affected is rising which necessitates the implementation of a national nutrition intervention program to control obesity. The prevalence of chronic non-communicable diseases associated with obesity such as Diabetes, hypertension, cardiovascular disease and bone osseous problems is expected to increase and impose additional burden on the already exhausted health facilities.

The results of this study not only confirms the fact that obesity is associated with dyslipidemia but it also shows that the elevation of blood lipids is correlated with the grade of obesity. Data presented in tables 1 and 2 show that the mean concentration of various blood lipids among overweight females is close to the upper limits of the normal cutoff values. This does not indicate that this group of females is not susceptible to the health hazards induced by the elevated blood lipids. The results show that the total cholesterol concentration of 50.6 % of the overweight females was above the normal cutoff point, LDL-C was high among 37.6%, triglycerides among 28.2% and HDL-c was less than 50 mg/dl among 62.4 % of the females. This suggest that overweight females are at relative risk of developing chronic diseases associated with hyperlipidemia. The prevalence of dyslipidemia was previously reported among overweight children and adolescents (Boyd *et al*., 2005), this supports the recommendation that blood lipids must be evaluated both in overweight and obese subjects.

The data showed a significant association between the concentration of various blood lipids and the grade of obesity. This was evident from the progressive increase in the concentration of all blood lipids among grades 1 and 2 obese females. However, the data show that the most significant increase in blood lipid concentration was recorded between overweight and grade 1 obese females. The data also show that while the concentration of blood lipids was higher among females with grade 2 obesity when compared with grade 1, the differences were not statistically significant. For example, the total cholesterol concentration increased from 199.3 mg/dl among overweight females and increased significantly to 221.3 mg/dl among grade 1 obese females and recorded additional increase to 235.2 mg/dl among grade 2 females, however, the difference between the last two groups was not statistically significant, this was also noted in the concentration of LDL-C and triglyceride concentrations. It seems that a body mass index of 30 is a crucial point above which blood lipids concentration shows a progressive increase. This is confirmed by the data showing that the percentage of females suffering from elevated blood levels above the normal level which was highest among grade 2 obese females when compared with either grade 1 obese females or the overweight group. These results suggest that grade 1 and 2 obese females are at a greater risk of developing health hazards associated with elevated blood lipids. It has been reported that the decrease in body weight was associated with a decrease in total cholesterol, triglycerides, LDL-C and an increase in HDL-C (Dattilo and Etheron., 1992). More specifically, it was reported that a 10% reduction in body weight is associated with a significant improvement in blood pressure, plasma lipids and blood glucose levels (Golditz *et al*., 1995).

The prevalence of obesity among adult females in Eastern Mediterranean countries increased as age increased up to 60 years of age when obesity declined (Musaiger., 2011). This may be related to other factors such as reduced physical activity with age and marriage which was also associated with weight gain (Fouad *et al*., 2006). The age of the females had a significant impact on the concentration of all blood lipids investigated. The age of 40 years seems to be very critical in the development of dislypidemia. The results show that all blood lipids of females older than 40 years were significantly higher than that of females from younger age groups. The results show that overweight and obese females younger than 30 years showed normal concentration of blood lipids. The results suggest that the effect of diet and other factors contributing to the elevation of blood lipids seems to be accumulative with age and shows its impact significantly above the age of 40 years. It is recommended that females above the age of 40 and their BMI is above 25 should have their blood lipids evaluated at frequent intervals.

Obesity among females have been attributed to socio-cultural factors in Egyptian communities, such as high unemployment, restricted outdoor activities and the high illiteracy rate among females (Tawfik *et al*., 2003). The data presented in table 4 suggest that the concentration of blood lipids among overweight and obese females is also associated with socioeconomic factors

The impact of the educational level of females on their blood lipids showed a clear pattern. The results show that both illiterate females and females with university education had significantly elevated blood lipids when compared with females with middle level of education. The mean concentrations of blood lipids of the latter group were within normal range. This could be attributed to the fact that illiterate females are mostly unemployed housewives who spend the whole day at home exerting minimum level of physical activity. In the mean time, their income is limited and resort to cheaper food sources such as hydrogenated vegetable oils, minced meat containing a large fat percentage. The main dietary source of calories is subsidized bread, and rice while their intake from fruits is very limited. On the other hand, university graduate have a higher income and are usually married to husbands having high income. The increased income is associated with the increased food and caloric intake, consumption of meat, animal fat and reduced physical activity. Females with middle level of education are usually employed in a technical profession that requires mild physical activity and are paid limited salaries. The increased activity and the limited income does not allow excessive food intake and consequently minimize the possibility of developing hyperlipidemia.

Several studies in the EMR countries have shown that employment of women is significantly associated with limited weight gain (Ahmed *et al*., 2006). It is assumed that the exposure of the women to the community may possibly put pressure on them to take care of their weight (Musaiger and Al-Ansari, 1992).The employment status of the females was also associated with the concentration of blood lipids. Unemployed females who are usually illiterate housewives showed the highest concentration of blood lipids. Females with administrative gobs who are mostly university graduates showed a similar pattern, while females having technical work who received a middle level of education had the least concentration of blood lipids which was mostly within normal range. This may be associated with their relatively active life style when compared with the other groups.

Food consumption pattern and dietary habits in the Eastern Mediterranean have changed markedly during the last four decades. This was reflected on the increase in percapita energy and fat intake in all countries and the percentage of calories derived from animal foods. The contribution of sugar to energy intake was high and ranging from 9 -15% (Musaiger, 2011). Many different diets have been tried to treat obesity and weight loss occurs with all of them. However, there was no evidence that clearly supports a superiority of one macronutrient composition for diets used for weight loss (Bray., 2008).

Mokhtar, *et al*. 2001 reported a significant increase in body weight with the increase in total energy and macronutrient intake among Tunisian and Moroccan women. This is consistent with the results of this study which show that the total energy intake increased as the grade of obesity increased. However, the nature of the diet varied between overweight and obese females. The data show that grade 2 obese females derived a higher percentage of their caloric intake from sugar, fat and protein at the expense of a reduced intake from carbohydrates. In addition, they derived more calories from animal fat and protein when compared with overweight females. This food intake pattern contributed to the elevation of blood lipids among obese females (table4).

The impact of carbohydrate and sugar consumption on blood lipids is controversial. It was reported that carbohydrate consumption has been associated with lower HDL-C, higher triglyceride levels and high LDL-C levels (Liu *et al*., 2001; Welsh *et al*., 2010). Glycemic load was positively associated with total cholesterol and LDL-C levels and there was an inverse association between percentage of calories from carbohydrates and HDL-C levels (Ma *et al*., 2006). On the other hand when patients were fed a low fat diet, the concomitant increase in either simple or complex carbohydrates did not have an adverse effect on blood lipids (Saris *et al*., 2000).

The increase in total daily energy intake was positively correlated with total cholesterol, LDL-C, triglycerides and was negatively correlated with HDL-C. The data show that although the percent calories derived from Carbohydrates was lower among females with advanced grade of obesity when compared with overweight females, this change in the amount of carbohydrate intake was not correlated with the concentration of various blood lipids (table5). Sugar intake was significantly higher among obese females and was significantly correlated with all investigated blood lipids except HDL-C. When the percent energy derived from fat was increased as observed with grade 2 obese females, this was associated with a significant correlation with the concentration of total cholesterol and triglycerides and was negatively correlated with HDL-C.

The results show that the increase in percent of total fat consumed by obese females was associated with a significant increase in percent of animal fat consumed and a corresponding reduction in the consumption of vegetable fat, (Table4) The increased consumption of animal fat was positively and significantly correlated with the concentration of total cholesterol, LDL-c and triglycerides and negatively correlated with HDL-C. On the other hand the increased consumption of vegetable fats was negatively correlated with all blood lipids and was positively correlated with HDL-C. (table 5). The impact of animal fats on blood lipids has long been documented (Dawber *et al*., 1982). Replacement of saturated fat by polyunsaturated or monounsaturated fat lowers LDL cholesterol. However, replacement with a high carbohydrate intake particularly refined carbohydrates induced increased triglycerides and small LDL particles and reduced HDL cholesterol. (Siri-Torino *et al*., 2010).

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The consumption of a high protein diet was reported to lower triglycerides, increased HDL-C which was attributed to the reduction of carbohydrate intake. A high protein low carbohydrate diet is more effective in improving dislipidemia (Noakes *et al.*, 2005), however, the changes were not sustained during long term weight maintenance (Lyman *et al.*, 2009). The results of this study show that total protein consumption and animal protein consumption were positively correlated with all blood lipids and negatively correlated with HDL-C. On the other hand plant protein consumption was negatively correlated with all blood indices but was positively correlated with HDL-C. This may be attributed to fact that animal protein contain a high percentage of saturated fat which has been documented to increase total cholesterol, triglycerides and LDL-C. This suggests that vegetable proteins should be used when planning a high protein low carbohydrate diet to reduce body weight and lower blood lipids.

Conclusion:

Our results suggested that dyslipidemia is significantly affected by the grade of overweight and obesity. The blood lipid concentration is associated with age, educational level and occupation of adult females. Dietary factors such as total caloric intake, percent calories derived from sugar, type and quantity of fat and protein play a significant role in the development of dyslipidemia.

Conflict of interest the author has no conflict of interest.

Table 1: Impact of grade of obesity on blood, cholesterol, LDL-C, HDL-C in obese adult females.

Variables	Grade of Obesity						Total	
	Overweight (85)		Grade I (61)		Grade II (42)			
	No	%	No	%	No	%	No	%
Total Cholesterol (mg/dl)								
Less than 200	42	49.5	16	26.2	6	14.3	64	34.0
200 – 239	24	28.2	19	31.1	11	26.2	54	28.7
240 or more	19	22.4	26	42.6	25	59.5	70	37.3
$\overline{X}$ ± SD	199.3±41.6[a]		221.3±40.6[b]		235.2±35.66[b]		214.5±42.4	
	X^2 = 23.169, p = 0.00				F= 12.67 P= 0.00			
LDL cholesterol (mg/dl)								
Less than 100	26	30.6	10	16.4	6	14.3	42	22.3
100 – 129	27	31.8	13	21.3	14	33.3	54	28.7
130 – 159	24	28.2	24	39.4	7	16.7	55	29.2
160 – 189	5	5.9	6	9.8	8	19.1	19	10.1%
190 or more	3	3.5	8	13.1	7	16.7	18	9.6
$\overline{X}$ ± SD	121.0±31.67[a]		139.0±36.5[a,b]		142.14±40.2[b]		131.76±36.64	
	X^2 = 22.03, p = 0.004				F= 7.26 P= 0.00			
HDL Cholesterol (mg/dl)								
Less than 40	9	10.6	13	21.3	16	38.1	38	20.2
40-49	44	51.8	30	49.2	14	33.3	88	46.8
50-59	21	24.7	12	19.7	8	19.1	41	21.8
60 pr more	11	13.9	6	9.8	4	9.5	21	11.2
$\overline{X}$ ± SD	49.0±8.5[a]		46.8±8.9[a,b]		45.0±9.9[b]		47.4±9.0	
	X^2 = 13.77, p = 0.032				F= 3.10 P= 0.049			

[a,b] All means without a common superscript differ significantly at p<0.05

Table 2: Comparison of the levels of triglycerides in overweight, grade I and grade II obess adult female.

Variables	Grade of Obesity						Total	
	Overweight		Grade I		Grade II			
	No	%	No	%	No	%	No	%
Triglycerides (mg/dl)								
Less than 50	61	71.8	34	55.7	13	31.0	108	57.4
150 – 199	17	20.0	18	29.5	17	40.4	52	27.7
200 – 499	4	4.7	5	8.2	7	16.7	16	8.5
500 or more	3	3.5	4	6.6	5	11.9	12	6.4
Total	85	100	61	100	42	100	188	100
$\overline{X}$ ± SD	144.4±105.1[a]		175.4±133.3[a,b]		231.5±160.5[b]		173.9±132.1	
	F = 6.48, p = 0.002							
	X^2 = 20.40, MCP = 0.002							

[a,b,c.] All means without a common superscript differ significantly at p< 0.05.

Table 3: Change in mean blood lipids among obsess adult female with age, educational level and employment status.

Variables	Blood lipids				Triglycericdes
	No	Total Choleterol	LDL-C	HDL-C	
Age (Years)					
Less than 30	24	194.9±27.6[a]	114.3±15.4[a]	51.6±8.9[a]	145.6±42.6[a]
30-	54	207.8±23.7[b]	126.2±17.2[b]	49.8±7.3[a]	159.8±51.9[a]

40-	63	217.1±28.3[b,c]	134.1±16.6[c]	46.9±6.1[b]	181.5±56.4[b]
50 or more	47	228.7±35.4[c]	146.9±15.1[d]	43.1±72[c]	199.4±46.3[b,c]
	F	8.55	25.19	10.64	8.15
	P	0.000	0.000	0.000	0.000
Educational level					
Illiterate/ primary	41	230.5±29.1[a]	148.2±19.3[a]	43.8±6.6[a]	193.1±39.6[a]
Middle level	68	190.6±26.8[b]	109.5±14.7[b]	52.9±9.2[b]	141.2±36.7[b]
University	79	226.8±29.4[a,b]	143.9±18.2[a,c]	44.5±9.3[a,c]	192.1±41.5[a,c]
	F	37.94	94.39	21.25	36.70
	P	0.000	0.000	0.000	0.000
Employment status					
Unemployed	59	228.7±25.6[a]	146.2±16.9[a]	43.5±5.9[a]	195.4±51.1[a]
Technical work	57	198.3±23.5[b]	117.3±143[b]	51.7±8.5[b]	147.8±45.5[b]
Administrative work	72	215.7±24.9[c]	133.2±13.8[c]	47.2±6.5[c]	176.9±41.1[c]
	F	22.08	54.06	20.15	15.96
	P	0.000	0.000	0.000	0.000

[a,b,c,d.] All means without a common superscript differ significantly at P< 0.05.

Table 4: Mean energy intake and percent consumption from macronutrients by adult female with different grades of obesity.

Daily intake	Grade of Obesity			ANOVA	
	Overweight	Grade I	Grade II		
	No = 85	No = 61	No = 42	F/Q	
Total energy (K. cal)	2781±141[a]	2994±167[b]	3427±235[c]	193.5	0.000
Carbohydrate (% of energy)	57.1±3.83[a]	51.6±3.74[b]	46.2±4.12[c]	116.5	0.000
Sugar (% of energy)	12.7±1.12[a]	13.3±1.24[b]	15.9±1.63[c]	89.5	0.000
Total fat (% energy)	29.3±1.83[a]	31.9±2.17[b]	36.1±2.91[c]	132.5	0.000
Animal fat (% of fat)	23.5±1.49[a]	29.2±1.62[b]	31.1±2.74[c]	289.8	0.000
Vegetable fat (% of fat)	76.5±4.11[a]	70.8±3.9[b]	68.9±5.18[c]	55.0	0.000
Total protein (% of energy)	13.6±0.81[a]	16.5±0.83[b]	17.7±1.13[c]	351.8	0.000
Animal protein (% of protein)	15.3±1.32[a]	16.1±1.12[b]	21.6±1.68[c]	324.5	0.000
Plant protein (% of protein)	84.7±7.21[a]	83.9±4.78[a,b]	78.4±5.46[c]	15.7	0.000

[a b c] All means without a common superscript differ significantly at p<0.05.

Table 5: Correlation between dietary intake variable and concentration of blood lipids.

Dietary variable	Total cholesterol	LDL-C	HDL-C	Triglycerides
Total energy (K.Cal)	0.251*	0.263*	-0.247*	0.275*
Carbohydrate (% of energy)	-0.051	-0.023	-0.003	0.012
Sugar intake (% of energy)	0.296*	0.279*	0.049	0.276*
Total fat (% of energy)	0.281*	0.103	-0.131*	0.231*
Animal fat (% of fat)	0.278*	0.291*	-0.303*	0.323*
Vegetable fat (% of fat)	-0.316*	-0.311*	0.296*	-0.295*
Total protein (% of energy)	0.172*	0.233*	-0.257*	0.177*
Animal protein (% of protein)	0.291*	0.283*	-0.225*	0.321*
Vegetable protein (% of protein)	-0.273*	-0.292*	0.334*	-0.319*

*Significant at p<0.05.

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