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Evaluation of Effects of High Fat Diets on Cardiovascular Disease Risk Factors in Albino Rats

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Abstract

The consumption of high fat diet (HFD) is considered a risk factor for development of coronary heart disease (CHD). In our study, 28 albino rats (99-113g and aged 10-12 weeks) were divided into four groups of seven (7) rats each. Groups one and two were male and female rats fed with HFD while group three and four were male and female (control) fed with low fat diet (LFD). LFD food contained 7% fats while HFD food contained 40% fats. The rats were fed for four consecutive weeks. After the feeding, serum total cholesterol (TC), triglycerides (TG), high density lipoprotein cholesterol (HDL-C), low density lipoprotein cholesterol (LDL-C), atherogenic index (AXI) and blood glucose were estimated using standard methods. There was statistically significant difference in weight gained from first to fourth week in rats fed with HFD compared to control ($p < 0.05$) fed with LFD. However, there was no statistically significant difference ($p > 0.05$) in blood glucose of rats fed with HFD compared to control fed with LFD. The TC, TG, HDL-C and LDL-C differed significantly ($p < 0.05$) between male and female rats fed with HFD (136.17±14.19 and 137.0±14.13; 183.17±17.71 and 177.33±16.89; 38.33±6.31 and 38.33±6.31; 62.33±11.57 and 70.5±8.55 and 1.68±0.45 and 1.89±0.45 respectively) and male and female control rats fed with LFD (99.0±10.46 and 104.84±6.99; 134.67±24.15 and 131.5±12.41; 61.67±3.44 and 58.33±6.31; 22.5±4.32 and 21.83±4.36 and 0.36±0.06 and 0.37±0.07 respectively). Our findings suggested that HFD increased circulating lipids, lipoproteins and weight which are all risk factors that predispose individuals to cardiovascular disease (CVD).

Key Words: High fat diet, low fat diet, cardiovascular disease, abnormal lipids

Introduction

Cardiovascular disease is a disease that involves the heart or blood vessels (arteries and veins) (McGill *et al.*, 2008), while the term technically refers to any diseases that affect the cardiovascular system. It is often used to refer to those diseases related to atherosclerosis and/or hypertension. The causes, mechanism, and treatments of those conditions often overlaps (Maton, 1993). Cardiovascular diseases remain the biggest cause of deaths worldwide over the last two decades. Cardiovascular mortality rates have declined in many high-income countries, while at the same time, deaths and diseases due to cardiovascular diseases have increased at an astonishingly fast rate in low and middle-income countries (Mendis *et al.*, 2011). Although cardiovascular diseases usually affect older adults, the antecedents of cardiovascular diseases, notably (atherosclerosis) begin in early life, making primary prevention effort necessary from childhood (Boon *et al.*, 2006).

Aging is an important risk factor in developing cardiovascular disease. It is estimated that 87 percent of people who die of coronary heart diseases are 60 years and older (Mendis *et al.*, 2011). Multiple explanations have been proposed to explain why age increases the risk



of cardiovascular disease. One of them is related to serum cholesterol level (Jousilahti *et al.*, 1999). In most populations, the serum total cholesterol level increases as age increases and this increase level off around the age 45 to 55 years in men, and 60 to 65 years in women (Jousilahti *et al.*, 1999). Men are at greater risk to heart disease than premenopausal women (Jousilahti *et al.*, 1999). However, once past menopausal stage, a woman's risk of cardiovascular disease is similar to men (Camm *et al.*, 2009). Among middle-age people, coronary heart disease is 2 to 5 times more common in men than in women (Camm *et al.*, 2009). A previous report indicates that gender contributes to approximately 40% of the variation in the gender ratios of coronary heart disease mortality (Jason, 2008).

In a study conducted on rats, it was suggested that the links between a diet high in sugar and saturated fat compared with a sugar-free, low fat diet lead to cardiac dysfunction, despite modest levels of obesity. In human, diets, low in sugar and high in polyunsaturated fatty acids are associated with reduced risk of coronary heart disease (William *et al.*, 2009 and Brunsell *et al.*, 2008). The main aim of this research is to study the effect of high fat diets, gender disparity on cardiovascular disease risk factors in albino rats. High fat diet remains the biggest challenge in the field of medicine and nutrition, and with accumulated data on the effect of gender in the development of disease. The current study was designed to evaluate how these factors can influence the development of cardiovascular disease. Modernization and affluent lifestyle exposes people in developing countries to these great medical challenges, hence the need to bring to light, certain biochemical parameters that can be used to forecast features of cardiovascular disease development.

Material and Methods

Experimental Animals

Twenty- eight (28) apparently healthy albino rats of both gender weighing 99-113g and aged 10-12 weeks were used in this study. The rats

were purchased from the National Institute for Trypanosomiasis Research (NITR), Vom, Jos. The animals were kept in the animal house in the Faculty of Medical Laboratory Science, Usmanu Danfodiyo University Sokoto.

Experimental Design

A total of 28 albino rats of both gender weighing 99-113 g and aged 10-12 weeks were used for this study. The twenty- eight (28) albino rats were divided into four groups of seven rats each (group 1 were male rats fed with low fat diet, group 2 were female rats fed with low fat, group 3 were male rats fed with high fat diet and group 4 were female rats fed with high fat diet). The rats were given separate diet from the commencement of the study for a period of 4 weeks. Hygiene environment was maintained for all the rats, with food and water given *ad libitum*. The control low fat diet containing 7% fat was purchased from Grand Cereals Company Nigeria PLC. The high fat diet containing 40% fats, 38% carbohydrates, 22% proteins was prepared from palm oil, garri and dried fish as described by Oboh and Olumese (2010). Animals were grouped as follows:

- Group 1: Seven male rats fed with low fat diet (Control)
- Group 2: Seven female rats fed with low fat diet (Control)
- Group 3: Seven male rats fed with high fat diet
- Group 4: Seven female rats fed with high fat diet

Blood Sample Collection

At the end of the study, animals were anesthetized by dropping in a jar containing chloroform. Blood samples were collected through cardiac puncture and dispensed in a two (2) specimen containers (plain for lipid profile and fluoride oxalate for FBS). The blood sample in the plain container was allowed to clot and centrifuged at 3000 rpm for 15 minutes, while plasma from the fluoride oxalate container was used for plasma glucose estimation. Both sera and plasma were stored at -4°C in the deep freezer until processed.

Statistical Analysis

Statistical analysis was performed using SPSS version 20.0. Data are presented as Mean \pm Standard Deviation. Statistical comparison between groups was made using analysis of variance (ANOVA) with post hoc Bonferroni Multiple Comparison Test to identify differences in mean where appropriate. A p-value \leq 0.05 was taken as statistically significant.

Result and Discussion

Result

The mean \pm SD of weight gained from first to fourth week among the rats fed on high and low-fat diet (control) was presented in table 1. The result shows a statistically significant difference in weight ($p < 0.05$) between the groups fed with HFD (139.8 \pm 35.5 and 115.75 \pm 27.93g) for male and female respectively) and control fed with LFD (112.8 \pm 25.97 and 94.92 \pm 13.77g) for male and female respectively.

Table 2 shows the glucose and serum lipid profiles of rats fed with low and high fat diet. There was no significant difference ($p > 0.05$) in blood glucose level between the group fed with HFD and that fed with LFD (control). The total

cholesterol (136.17 \pm 14.19 mg/dl and 137.0 \pm 14.13 mg/dl for male and female respectively) among rats fed with high fat diet was significant higher ($p < 0.05$) when compared with the control mg/dl (99.0 \pm 10.64 and 104.83 \pm 6.99) for male and female respectively. The triglyceride levels (183.17 \pm 17.71 and 177.33 \pm 16.89) respectively for male and female rats fed with high a fat diet which was significantly higher ($p < 0.05$) when compared with the control male and female rats fed with a low-fat diet (134.67 \pm 24.15 and 131.5 \pm 12.4 respectively). The HDL-cholesterol levels (mg/dl) was 38.33 \pm 6.31 and 38.33 \pm 6.31 respectively among male and female rates fed with high fat diet compared to 61.67 \pm 3.44 and 58.33 \pm 6.31 mg/dl respectively among male and female fed with a low-fat diet ($p < 0.05$). The LDL-cholesterol levels (mg/dl) was 62.33 \pm 11.57 and 70.5 \pm 8.55 for male and female rats fed with a high fat diet compared to male and female control rats fed with a low-fat diet (22.5 \pm 4.32 mg/dl and 21.83 \pm 4.36) respectively.

The atherogenic index (mg/dl) was 1.68 \pm 0.45 and 1.89 \pm 0.45 for male and female rats fed with high fat diets compared to male and female control rats fed with a low-fat diet (0.36 \pm 0.06 and 0.37 \pm 0.09) respectively.

**Table 1: Weight gained from first to fourth week by rats fed with high and low-fat diets.**

Groups	1 st week (g)	2 nd week (g)	3 rd week (g)	4 th week (g)
Group I (n=7)	100.50±2-.0	109.62±22.0	115.83±27.93	118.0±34.39
Group II (n=7)	90.17±13.67	92.17±13.86	95.5±13.35	103.17±14.59
Group III (n=7)	104.67±20.80*	133.33±29.68*	150.67±29.25*	170.67±28.70*
Group IV (n=7)	93.0±14.85*	102.17±15.79*	123.5±21.58*	147.33±22.39*
p-value	<0.05	<0.05	<0.05	<0.05

Values are expressed as mean ± standard deviation and *=values differ significantly from control (p<0.05),

Keys: Group I = Male rats fed with low fat diet (Control)
 Group II = Female rats fed with low fat diet (Control)
 Group III = Male rats fed with high fat diet and
 Group IV = Female rats fed with high fat diet.

Table 2: Glucose and Serum lipid profiles of rats fed with low and high fat diet

Parameters	Group I (n=7)	Group II (n=7)	Group III (n=7)	Group IV (n=7)
TC (mg/dl)	99.0±10.64	104.83±6.99	136.17±14.19*	137.0±14.13*
TG (mg/dl)	134.67±24.15	131.5±12.41	183.17±16.71*	177.33±16.89*
HDL-C (mg/dl)	61.67± 3.44*	58.33±6.31*	38.33±6.31	38.33±6.31
LDL-C (mg/dl)	22.5±4.32	21.83±4.36	62.33±11.57*	70.5±8.55*
AI (mg/dl)	0.36 ± 0.066	0.37±0.09	1.68±0.45*	1.89 ± 0.45*
Glucose	4.77±0.52	4.85±0.68	5.15±0.54*	5.52±0.77*

Values are mean±standard deviation, *=values differ significantly from control (p<0.05), MLFD- Male rats fed on low fat diet, FLFD-Female rats fed on low fat diet, MHFD - male rats fed on high fat diet, FHFD- female rats fed on high fat diet.

Keys: Group I = Male rats fed with low fat diet (Control),

Group II = Female rats fed with low fat diet (Control),
 Group III = Male rats fed with high fat diet and
 Group IV = Female rats fed with high fat diet.

Discussion

In this study, it was observed that rats fed with high fat diets showed evidence of lipid abnormalities when compared to control rats. This study showed increase in the triglyceride, total cholesterol, LDL-cholesterol, atherogenic index and HDL-cholesterol which are well known risk factors for coronary heart disease. These findings are in agreement with those reported by Lawes *et al.* (2008) and Lewis and Rader (2005) which showed abnormalities in lipid profile as a result of dietary changes. The atherogenic index is also increased in experimental rats as a result of increased LDL-

cholesterol and decreased HDL-Cholesterol when compared to control.

In this study, rats (male and female) fed with high fat diets showed significantly increased serum triglyceride (TG) (p<0.05) when compared to male and female rats fed with low-fat diets (control). This finding is in agreement with the findings of Lawes *et al.* (2008). In humans, triglycerides are a mechanism for storing unused calories, and their high concentration in blood correlated with the consumption of starchy and fatty food (Nelson and Cox, 2000).

This study also showed a significant increase in serum total cholesterol and LDL-cholesterol ($p < 0.05$) with respect to the corresponding control group. These findings are in agreement with those reported by Mozaffarin *et al.* (2006), which indicated that enriched fatty diet causes elevation of plasma total cholesterol and LDL-C which lead to development of atherosclerosis and later CHD. The consumption of dietary fat increases the risk of CHD by raising level of LDL-C and lowering levels of good HDL-C (Oboh and Olumese, 2010).

The rats fed with high fat diet showed significant weight gain as compared to control. The result shows that dyslipidaemia is directly related with body mass index, showing that with increased body mass index the trend of dyslipidaemia is raised in both male and female. This is in accordance with previous reports (Brown *et al.*, 2000; Malnick and Knobler, 2006; Must *et al.*, 1999). Our finding is also in agreement with the findings of Sebastian (1997) and Olson (1998) who reported that the serum concentration of TG, cholesterol and LDL-C are correlated positively with obesity.

There was no significant difference in blood glucose level between the groups fed with HFD compared with control. This is at variance with the work done by Parks (2002) who after 16 weeks of HFD feeding, reported that blood glucose increased in both gender as body weight increases.

Prevalence of dyslipidaemia was high in females than in male. The result revealed LDL-C, TC, and AXI values in females are slightly higher than the corresponding values in male. This finding is at variance with the work done by Must *et al.* (1999) and Malnick and Knobler (2006), who reported that the prevalence of dyslipidaemia was high in males than in female rats. Coronary heart diseases (CHD) which most commonly follows atherosclerosis is a worldwide life-threatening problem. Atherosclerosis in turn, is a diseases entity based upon hyperlipidaemia and hypercholesterolemia. These metabolic states are associated with multiple factors including

dietary habits. Thus, high intake of fats is considered to be among the risk factor for cardiovascular diseases development.

Conclusion

The lipid abnormalities such as raised total cholesterol, triglycerides, LDL-cholesterol, atherogenic index and decreased HDL-Cholesterol are the major risk factors for development of coronary heart disease. High fat diets showed significant increase in these parameters. It is therefore, recommended that combined life style therapies, that is enhanced by physical activity and dietary modification should be encouraged to decrease the risk of developing cardiovascular diseases.

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