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Effect on the Lipid Profile of Lifestyle, Diet and Exercise.

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Abstract : This is a clinical based correlation study to the associations between lifestyle, diet, exercise and the serum lipid profile. The study included retrospective analysis of history and investigation of participants comprising 200 men and women above 30 years of age from a disease-free population and included healthy subjects visiting the clinic at Bhopal MP, India.

Among the participants of the study, 25.3% of the males and 44.7% of the females had hypercholesterolaemia. Body weight was significantly associated with higher total cholesterol and low-density lipoprotein (LDL) cholesterol. Of the subjects studied, males had a higher mean calorie and fat intake than the females. A positive association was observed between waist circumference and both total cholesterol and LDL cholesterol. Waist circumference was also positively correlated with systolic and diastolic blood pressure and triglycerides. There was a significant difference in the total cholesterol levels of subjects who exercised and those who were not involved in any physical activity. There was a significant difference between the high-density lipoprotein (HDL) cholesterol values of the subjects based on exercise levels. High-density lipoprotein cholesterol levels were significantly higher in males than in females and this is corroborated by the finding of increased exercise levels in males. Duration of exercise had a significant impact on the total cholesterol levels. Our results confirm that diet and exercise significantly affect the serum lipid profile. Obesity and overweight constitute a risk factor for the development of hypercholestero-laemia and hypertriglyceridaemia.

Keywords : Low density lipoprotein (LDL), High density Lipoprotein (HDL), Cardiovascular disease (CVD), Coronary Artery Disease (CAD), Obesity

INTRODUCTION

The increasing prevalence of overweight and obesity constitutes a major health crisis in India because of the associated increase in risk of coronary heart disease. India and other developing countries have witnessed a rapidly escalating epidemic of cardiovascular disease (CVD). It is predicted that, by 2020, coronary heart disease will be the leading cause of death in adult Indians. (Yajnik CS, 2001)

Recent studies have indicated that the life expectancy of adults with severe obesity might be 15-20 years lower than normal individuals. A significant proportion of morbidity and mortality in obese adults are due to sudden cardiac arrest and congestive heart failure related to obesity (Gidding SS, 2004)

It has been reported that among others, smoking, dietary habits, and physical inactivity account for most of the risk of myocardial infarction, worldwide in both sexes and at all ages in all regions (Yusuf S, 2004). Correlation of anxiety and depression with loss of autonomic control of heart rate, impaired baro reflex sensitivity and emotional trigger influencing the presentation pattern of ischaemia and arrhytmias in coronary artery disease (CAD). (Gupta, 2013). The excess burden of CAD in Indians can be explain by insulin resistance syndrome. The higher serum uric acid positively correlates with a number. of components of metabolic syndrome with hypertension and obesity being the major determinants of hyperuricaemia. (Gupta et al., 2011). Physical activity and physical fitness have been identified as protective factors against the occurrence and progression of coronary heart disease and against premature mortality. Such associations among other factors have been related to improvement in the lipid profile.(Haskell WL, 1984).

Lipid abnormalities are a widely accepted risk factor for ischaemic heart disease (Pais P et al, 1996). A study of 150 normal healthy persons as controlled compared with 150 cases of established cases of CAD suggested that there is a significantly high prevalence of dyslipidamia in a healthy central Indian population and it is relatively higher in cases of CAD (Gupta et al. , 2002). Factors such as obesity, dietary changes and changes in exercise routines can influence adult lipid levels.(El-Hazmi MA et al, 2001). In addition Lp(a) levels had a graded association with CVD. (Gupta R et al, 1996). There is a need to look at the diet of individuals in combination with their actual food intake in order to apply interventions that are effective at controlling their serum lipid profile, which is one of the major risk factors of CVD. In patient undergoing coronary angiography, carotid intima media thickness is associated

with increasing severity of coronary artery disease. This association is independent of other conventional cardiovascular risk factors. (Gupta, 2013).

Since hypertriglycerdaemia is often observed in association with small dense LDL phenotype, low HDL and other phenotypic features that characterize the insulin-resistance syndrome, it is difficult to ascribe the increased risk associated with hypertriglyceridaemia to any single metabolic abnormality (Gupta, 2004). The aim of this study was to evaluate the role of diet and other lifestyle-related factors in the prevalence of hypercholesterolaemia in Indians

MATERIALS AND METHODS

The study included retrospective analysis of participants comprising of 200 males and females above 30 years of age. The mean age of the subjects was 46 years. The study was carried out in outpatient clinic and consulting chamber in Bhopal, Madhya Pradesh in India with analysis of investigations. Healthy subjects visiting the clinic for health check-ups were chosen after obtaining their informed consent. Subjects with a history of Cardio vascular disease (CVD) or diabetes mellitus as well as those with alcohol consumption greater than 75 g/day or long-term medication use were excluded from the study. The subjects had an individual and relatives interview, anthropometric assessment and review of blood biochemistry reports. Participation in the study was voluntary with record analysis. Information on food habits and dietary pattern was obtained by using a detailed interview schedule. Information on physical activity, i.e. time spent on exercise per day was collected. The type of exercise indulged in, i.e. aerobics, walking, jogging, swimming, etc. was also ascertained.

Assessment of Body Mass Index, Weight, Height.

Weight was measured. Height (to the nearest 0.1 cm) was measured using a wall fixed stadiometer. The triceps skin fold thickness was measured. Waist circumference was measured with an inelastic tape used at the narrowest part of the torso at the end of expiration. Waist circumference of 290 cm was considered as the risk level for males and 280 cm for females. Body mass index (BMI) was computed and BMI of 23.0 was considered as the cut-off level for assessing the prevalence of overweight or obesity. The hip circumference was measured at the widest point of the buttocks by using an inelastic tape. The waist-hip ratio (WHR) was calculated. Blood pressure was recorded with a sphygmomanometer.

Biochemical Analysis

Review and analysis of blood samples were taken in the morning after a fasting period of 10-14 hours. Fasting serum total cholesterol and triglyceride were assayed enzymatically. Cholesterol concentrations were determined. Total cholesterol concentrations were measured enzymatically. Low-density lipoprotein (LDL) cholesterol in serum was measured. High-density lipoprotein (HDL) cholesterol in serum was measured with a diagnostic test kit by enzymatic clearance assay.

The triglycerides in serum were measured.

Dietary intake and physical activities

Information on family history, physical activity, food habits and dietary pattern was obtained by using a detailed interview schedule. The dietary intake was assessed by using the 24 hours recall method, which consisted of listing all foods and beverages consumed during the previous 24 hours using the standard cups developed by the National Institute of Nutrition, Hyderabad, India (Thimmayamma BVS, 1987). The dietary intakes obtained in terms of standardised cups were converted into quantities of raw food ingredients and the energy and fat content was then computed using the Indian food composition tables (Gopalan CB et al 1989). The subjects were asked about food choices, frequency of consuming sweets and desserts, monthly oil consumption, snack foods preferred and beverages.

Physical activity was assessed with two questions. In the first question, the level of leisure-time physical activity was measured with five alternatives which included walking, jogging, aerobics, swimming, and cycling. The frequency and duration of leisure-time physical activity was determined in a question with four response alternatives ranging from 0 to ≥60 min/session.

Statistical analysis

Descriptive statistics were computed for anthropometric measurements and indices like BMI and WHR. The association between calorie intake and BMI with lipid profiles was assessed by χ^2 test. Relationships between anthropometric measurements and lipid profile were assessed by correlation coefficients. Level of significance was considered as 0.05.

Table – 1
Variations in Lipid profile of the subjects studied

Parameter (mg/dl)	Prevalence (%)		
	Male	Female	P value
Total Cholesterol			
<190	74.5	55.83	0.013
>190	25.5	44.7	
Triglycerides			
<140	50.1	50.3	0.876
>140	49.9	49.7	
HDL Cholesterol			
<45	62.3	32.5	0.000
>45	37.7	67.5	
LDL Cholesterol			
<110	74.4	66.1	0.118
>110	25.6	33.9	

HDL: high-density lipoprotein,

LDL: low-density lipoprotein

Results

Majority of the subjects were in the age group of 30-60 years. Among the participants of the study 25.3% of the males and 44.7% of the females had hypercholesterolaemia (Table 1). 74.5% of men and 55.83% of women had cholesterol levels below 190 mg/dL. Majority of the subjects reported brisk walking as the predominant leisure-time physical activity. Brisk walking was found to be the predominant form of exercise preferred by males (52.2%) and females (39.4%) (P< 0.05). The duration of brisk walking ranged from 30 to >45 min/day. The subjects were divided into 2 groups-those who exercised regularly and those who did not.

Serum triglyceride levels were similar in both men and women (P=0.876). Around 49% of the participants studied had serum triglycerides above the risk level of 140mg/dL. Information regarding food habits revealed that majority of the participants of the study was non-vegetarian (61.5% females and 64.3% males). A significantly higher number of females had HDL cholesterol levels <45 mg/dL.

Table 2 represents the association of biochemical parameters and BMI with calorie intake. A higher percentage of subjects whose calorie intake was inadequate had BMI below the cut-off of 23 kg/m2 (75.8%) compared to those whose calorie intake was adequate (17%). There was a significant difference (P=0.019) between subjects whose calorie intake was adequate and those whose calorie intake was inadequate with respect to BMI (Table 2). Significant association (P< 0.05) was observed between total cholesterol, HDL and LDL cholesterol with levels of calorie intake. There was no significant difference between subjects whose calorie intake was adequate and those whose calorie intake was inadequate with respect to triglyceride levels. Of the subjects whose calorie intake was adequate a higher percentage (63.7%) had total cholesterol levels >190 mg/dL than those whose calorie intake was inadequate (Table 2).

The association of biochemical parameters and BMI with physical activity is presented in Table 3. A lower percentage (36.4%) of subjects who exercised regularly had triglyceride levels above the risk level of 140 compared to those who did not perform any exercise (48.7%) but the difference was not significant. There was a significant difference in the total cholesterol levels of subjects who exercised and those who were not involved in any physical activity (P=0.047). Only 29% of the subjects who exercised regularly had total cholesterol levels over the risk level of 190 mg/dL (Table 3) compared to 62.3% of those who did not exercise. Although a lower percentage (72.1%) of subjects who exercised regularly had BMI above the Asian cut-off of 23, there was no significant difference between those who did not exercise (83.8%). There was a significant difference between the HDL cholesterol values of the subjects based on exercise levels (P=0.012). 62.3% of those who exercised regularly had

Table – 2
Biochemical parameters and with calorie intake

Calorie intake	Biochemical parameter		? ^{2}	P value
	Triglycerides (mg /dl)			
	<140	>140		
Inadequate	58.5%	41.5%	1.4	0.230
Adequate	50.9%	49.1%		
	Total Cholesterol (mg/dl)			
	<190	>190		
Inadequate	75.6%	24.4%	3.89	0.048*
Adequate	36.3%	63.7%		
	HDL Cholesterol (mg/dl)			
	>45	<45		
Inadequate	69.5%	30.5%	6.77	0.009**
Adequate	47%	53%		
	LDL Cholesterol (mg/dl)			
	<110	>110		
Inadequate	79.3%	20.7%	3.26	0.0007**
Adequate	31.2%	68.8%		
	BMI (Kg/m^2)			
	<23.0	>23.0		
Inadequate	75.8%	23.2%	2.89	0.019*
Adequate	17%	85%		

*p<0.05, **p<0.01. BMI: body mass index, HDL: high-density lipoprotein, LDL: low-density lipoprotein

HDL levels >45 compared to only 38.1% of those who did not exercise regularly (Table 3). Exercise did not result in any significant effects on serum LDL cholesterol levels.

The duration of exercise did not have a significant impact on triglyceride levels (Table 4). Total cholesterol levels were found to be lower in subjects who exercised regularly for >45min (P<0.01). 76.5% of the subjects who exercised for more than an hour per day had total cholesterol levels below the risk level of 190mg/dL compared to only 37.7% of subjects who did not exercise and 59.4% of those who exercised only 2-3 times/wk (Table 4).

A significant percentage (64%) of the subjects who exercised for half an hour to more than 45min daily had HDL cholesterol >45mg/dL compared to those who did not exercise regularly (Table 5). Our findings are similar to the results of Stein et al , 1990) who found that HDL levels rose significantly in groups training at higher intensity exercise when compared with a group training at lower intensity during 30-minute training sessions on a cycle ergometer performed 3 times per week. In our study duration of exercise had a significant effect on LDL cholesterol levels (P< 0.05). A higher percentage (70%) of those who exercised for half an hour or more daily had LDL cholesterol levels <110 mg/dL compared to those who did not exercise regularly (Table 5).

Table 3
Biochemical parameters and body mass index and its allocation with physical activity.

Physical activity	Biochemical parameter		χ^2	P value
	Triglycerides (mg/dl)			
	<140	≥140		
No exercise	51.3%	48.7%	0.289	0.591
Exercise	63.6%	36.4%		
	Total Cholesterol (mg/dl)			
	<190	≥190		
No exercise	37.7%	62.3%	2.66	0.047*
Exercise	71%	29%		
	HDL Cholesterol (mg/dl)			
	≥45	<45		
No exercise	38.1%	61.9%	3.48	0.012*
Exercise	62.3%	37.7%		
	LDL Cholesterol (mg/dl)			
	<110	≥110		
No exercise	61.4%	38.6%	0.001	0.972
Exercise	71.6%	28.4%		
	BMI (Kg/m^2)			
	<23.0	<23.0		
No exercise	16.2%	83.8%	0.155	0.694*
Exercise	27.9%	72.1%		

*P < 0.05. BMI: body mass index, HDL: high-density lipoprotein, LDL: low-density lipoprotein.

Table 4
Biochemical parameters and body mass index and its association with duration of excersice.

Exercise duration	Biochemical parameter		χ^2	P value
	Triglycerides (mg/dl)			
	<140	≥140		
>45min/day	58.8%	41.2%	2.84	0.672
½-45min/day	48.6%	36.4%		
2 – 3 times/wk	62.9%	37.1%		
No exercise	51.3%	48.7%		
	Total Cholesterol (mg/dl)			
	<190	≥190		
>45min/day	76.5%	23.5%	2.96	0.006*
½-45min/day	70.1%	29.9%		
2 – 3 times/wk	59.4%	40.6%		
No exercise	37.7%	62.3%		
	BMI (Kg/m^2)			
	<23.0	<23.0		
>45min/day	17.6%	82.4%	0.896	0.925
½-45min/day	18.7%	81.23%		
2 – 3 times/wk	17.1%	82.9%		
No exercise	16.2%	83.8%		

Table 5
Biochemical parameters and its association with duration of excersice

Exercise duration	Biochemical parameter		χ^2	P value
	HDL Cholesterol (mg/dl)			
	≥45	<45		
>45min/day	64.7%	35.3%	4.67	0.052*
½-45min/day	64.5%	35.5%		
2 – 3 times/wk	45.7%	54.3%		
No exercise	48.1%	51.9%		
	LDL Cholesterol (mg/dl)			
	<110	≥110		
>45min/day	70.6%	29.4%	0.693	0.064*
½-45min/day	70.1%	29.9%		
2 – 3 times/wk	63.2%	36.8%		
No exercise	51.4%	48.6%		

*P<0.05. HDL: high-density lipoprotein, LDL: low-density lipoprotein.

Discussion

There is an increasing trend of total calorie intake and total fat intake with the increasing BM I. The prevalence of overweight and obesity in terms of BMI, waist circumference and waist-hip ratio was significantly higher in women compared to men. In our study weight and BMI were positively and significantly correlated with calorie and fat intake (Figure 1). More women than men were found to be overweight or obese. Analysis of the data also showed a significant correlation between waist circumference, hip circumference and total calorie and fat intake. Weight and BMI were positively and significantly correlated with calorie and fat intake (P< 0.01). There was no significant correlation between the waist-hip ratio and the total calorie or fat intake, which indicates that subjects with generalised obesity (high BMI) may not have central obesity (high WHR).(Chadha SL et al 1995)

In our study more women than men had hypercholesterolaemia (Table 1). Regarding serum cholesterol levels, it has been shown that both exercise and weight loss have a greater influence on lowering LDL cholesterol and raising HDL cholesterol levels in men than in women and in older or post-menopausal women.(Click M et al 1988) 25.6% of men and 33.9% of women had high LDL cholesterol levels (>110 mg/dL) but the difference was not significant (Table 1).

In our study increased calorie intake was positively correlated with total cholesterol levels (Table 2). It has been reported that dietary factors, particularly habitual dietary fat consumption and the amount and type of fat in a meal are major determinants of postprandial lipaemic response. .(Click M et al 1988, Berry SEE, 2005 and Chen et al 1992). reported that the magnitude of postprandial lipaemia within an individual is directly proportionate to the fat content of the meal. Among the subjects studied, a higher percentage (68.8%) of those whose calorie intake was adequate had LDL cholesterol levels >110 (P< 0.01). A higher percentage of subjects (69.5%) whose calorie intake was inadequate had HDL cholesterol levels >45 than those whose calorie intake was adequate (Table 2). It has been reported that excess weight gain tends to lower HDL cholesterol and raise LDL cholesterol.

A higher percentage of males were found to be performing exercise for half an hour or >45min daily than females (Figure 2). 58.7% of the women studied reported that they did not find time for exercise (Figure 2). There was a significant difference in the total cholesterol levels of subjects who exercised and those who were not involved in any physical activity (Table 3).

Only 29% of the subjects who exercised regularly had total cholesterol levels over the risk level of 190mg/dL (Table 3) compared to 62.3% of those who did not exercise. Our findings are similar to those of Lopez et al 2005 who reported a moderate effect of exercise on decreasing serum total cholesterol and a more marked effect on decreasing serum triglycerides in young individuals after a 7-week period of exercise.

High-density lipoprotein cholesterol levels were significantly higher in males than in females (Table 1) and this is corroborated by the finding of increased exercise levels in males (Figure 2). There was a significant difference between the HDL cholesterol values of the subjects based on exercise levels. About 62.3% of those who exercised regularly had HDL levels >45 compared to only 38.1% of those who did not exercise regularly (Table 3). The association between plasma concentration of HDL cholesterol and the incidence and severity of coronary heart disease has been well-recognised.(Raz I et al 1988). Our findings confirm the results of other studies which report that increased exercise significantly elevates plasma HDL cholesterol concentrations (Marrugat J, 1996) Total cholesterol levels were found to be lower in subjects who exercised regularly for >45min (P< 0.01). 76.5% of the subjects who exercised for more than 45min per day had total cholesterol levels below the risk level of 190mg/dL compared to only 37.7% of subjects who did not exercise and 59.4% of those who exercised only 2-3 times/week (Table 4).

In our study duration of exercise had a significant effect on LDL cholesterol levels (Table 5). A higher percentage (70%) of those who exercised for half an hour or more daily had LDL cholesterol levels <l10 mg/dL than those who did not exercise regularly.

Those who are overweight tend to have high total cholesterol and high LDL cholesterol partly on the basis of diet, which is usually high in saturated fats and cholesterol and partly on the basis of inactivity. In our study body weight was significantly associated with total cholesterol and LDL cholesterol (Figure 3). There was a negative association between weight and HDL cholesterol but this was not significant. Many studies have reported that obesity, as defined on the basis of BMI, is consistently related to increased blood pressure and unfavourable lipid profiles (Hu FB et al 2000). Waist circumference, however, may be a stronger predictor than BMI for the identification of metabolic and CVD-associated risk factors(Zhu S et al 2004). In our study, BMI was positively and significantly associated with systolic blood pressure (Figure 3). A positive association was observed between waist circumference and both total cholesterol and LDL cholesterol. Waist circumference was also positively correlated with systolic and diastolic blood pressure and tri-glycerides (Figure 3). It has been reported that a large waist circumference is significantly inversely associated with HDL cholesterol levels and significantly positively associated with LDL cholesterol levels and blood pressure. (Vijayalakshmi et al 2003)

Conclusion

Holistic approach of combining effects to improve diet with efforts to increase physical activity may be needed to

effectively reduce CVD risk. our findings provide support for the potentially beneficial effects of both diet and exercise on the serum lipid profile. The most important lifestyle factors which affect the serum lipid profile are diet composition, body weight and physical activity. The modification of blood lipid levels will be beneficial especially to those who are at higher risk of coronary heart disease. Screening for these abnormalities is essential and must be followed by active and effective interventions. Interventions may be more effective if they are targeted at specific socio-demographic sub-groups.

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