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ORIGINAL ARTICLE

The association of nutritional profile and prognosis of degenerative diseases associated with carbohydrate and lipid metabolism at high altitude of district Ziarat, Pakistan

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KEYWORDS

Nutritional profile;
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Abstract *Objective:* In the present study the physiological parameters, their comparative analysis with carbohydrate and lipid metabolism were studied. This study suggests life style, environmental and genetic adaptations in the studied population.

Method: One hundred and ninety eight subjects were selected from different towns of District Ziarat. General characteristics of the population according to their nutritional habits including, age, body mass index(BMI), systolic blood pressure, diastolic blood pressure, glycemia, triglycerides, serum low density lipoprotein (LDL), high density lipoprotein (HDL), very low density lipoprotein (VLDL), triglycerides (TG) were measured.

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Results: Mean cholesterol, LDL, VLDL and triglyceride values were significantly higher in men than women and the values increased with increasing age in both men and women. HDL and glucose values were significantly higher in females than males. In men with various nutritional groups such as A, B and C, the mean cholesterol ($P < 0.001$), LDL ($P < 0.014$), VLDL ($P < 0.031$) and triglyceride ($P < 0.025$) levels were significantly observed among comparable groups. However, in women with various nutritional groups such as A, B and C, the mean age ($P < 0.047$) and triglyceride values ($P < 0.033$) display statistically significant results.

1. Introduction

About 140 million persons reside at high altitudes over 2500 m, mainly in North, Central, and South America; Asia; and eastern Africa (ward et al., 2000; Sherpa et al., 2011). Pamirs, Hindu Kush, Karakorum, Koh-e-Safaid and Great Himalaya are the mountain ranges located in Pakistan. Adjacent to these ranges are different cities and villages in which people reside permanently. In Balochistan the high altitude places are Ziarat, Zhob Harboi (Kalat District) etc., these towns are located adjacent to the Sulaiman ranges and Kirthar Mountain Ranges (Khan, 1991).

It is reported by the United States centers of disease control and prevention in Atlanta that about 400,000 deaths in USA are associated with less exercise and poor diet (Mokdad et al., 2000).

High HDL, triglycerides and low LDL concentrations are risk factors for cardiovascular diseases (Steinberger et al., 1995; Hokanson and Austin, 1996). Cardiovascular diseases (CVD) are the major cause of illness and death in both developing and developed countries, and the major responsible factors for CVD are the higher levels of low density lipoprotein cholesterol (LDS) and lower levels of the high density lipoprotein cholesterol (HDL) present in blood plasma (Fruchart and Duriez, 2002). Higher HDL levels in plasma impart defense against CVDs (Gordon et al., 1989). Shift in the body measurements like BMI and waist circumference is directly linked with the metabolic conditions e.g., type 2 diabetes, hypertriglyceridemia and hyperinsulinemia (Banu et al., 2014; Diwan et al., 2012; Nakao et al., 2002). Healthy life style and dietary measures can cure many cardiovascular pathologies, inflammatory disorders and obesity (Bravata et al., 2003; De Lorgeril et al., 1999; Layman et al., 2003). Obesity is a condition which is a direct result of modern nutrition and life style which are main sources of recent degenerative diseases. It can be measured by a formula known as body mass index (BMI). It is caused by a number of reasons which include disturbed substrate oxidation, higher intake of fats, high energy density in food intake and low energy utilization (Taubes, 2001). In the south Asian populations the trend continues with high triglycerides and low HDL levels in different ethnic groups (McKeigue et al., 1985; McKeigue and Marmot, 1988; Miller et al., 1988).

Hypoxia, severe cold, high winds, intense solar radiation and increased physical activities make high altitude (5000–11500 ft) places interesting for physiologists to study human adaptations. A lower mortality rate from heart diseases has been reported in populations living in high altitude areas (Morley, 1998; Ashouri et al., 1994). While high level of serum HDL was found in the population living at high altitudes (Sharma, 1990). Higher HDL levels were measured in the migrants from lower altitudes to higher altitudes areas (Atbeave et al., 1990). Very less data are available on variations in lipid profiles in Pakistani normal healthy adults due to age, sex, BMI and life style.

The aim of the present study was to investigate/assess BMI, Glycemia, Blood Pressure, Lipid Profile and specially the effect of HDL cholesterol on living population of high altitude such as Ziarat, to analyze the degenerative diseases and associated carbohydrate and lipid metabolism.

2. Materials and methods

2.1. Data Collection

The study of the adult population was carried out from March 2008 to March 2009. The visit to the area was arranged in collaboration with the local doctors and other medical staff of the DHQ Ziarat of Government of Balochistan.

Health/medical camps were set up at Kawas town and Ziarat town in District Ziarat of Balochistan, a randomized survey and sample collection was conducted. Healthy men and women volunteers from both towns were selected. Individuals were interviewed by a medical physician using a standard questionnaire (approved by local ethics committee of BUITEMS), having information on age, gender, marital status, family system, ethnicity, physical activity, nutrition and history of any previous disease such as hypertension, diabetes, cardiovascular disease, and osteoporosis.

Sampling sites were chosen so as to survey among the population keeping in view their nutritional profiles, disease rates and life style.

Subjects were questioned to fill a Performa to collect information on the various parameters. At least one hundred and ninety eight subjects of both the genders mostly ranging between ages 17–80 were sampled. Blood samples were obtained by venipuncture from all participants who attended the health center/medical camp. Blood sampling was done by the certified personals.

General characteristics of the population of Ziarat according to their nutritional habits including age, body mass index (BMI), systolic blood pressure, diastolic blood pressure, glycemia, triglycerides, total serum cholesterol, serum low density lipoproteins ((LDL), high density lipoproteins (HDL), very low density lipoprotein (VLDL and Triglycerides were measured. The correlations of various parameters were found out within the populations.

The male/female population of Ziarat is divided into three nutritional groups:

A. Beef and mutton daily. Vegetables, pulses, eggs, milk 3–5 times a week. Apple, cherry frequently. (Male $n = 12$, Female = 15).
B. Beef and mutton 3–5 times a week. Poultry in excess. Vegetables, pulses, Apple, cherry frequently. (Male $n = 65$, Female = 29).
C. Beef and mutton 1–2 times a week. Vegetables, pulses 3–5 times a week. Apple, cherry frequently. (Male $n = 61$, Female = 16).

2.2. General observations

2.2.1. Body mass index (BMI) and blood pressure

Body mass index was calculated by obtaining weight of the subjects in kg and height per square in inches. Each subject was weighed on a tested bathroom balance (Tanita, China) with a maximum range of 120 kg and sensitivity of 0.5 kg. Height was recorded in inches by positioning the subject parallel to a wall on which the measuring tape was mounted. Blood pressure was measured with manual mercurial sphygmomanometer (Yamasu, Japan) according to a standardized protocol. Systolic and diastolic blood pressure was taken.

2.2.2. Blood collection

Five ml of venous blood was taken from each subject. Before drawing blood, a tourniquet was tied on the arm of the subject and the area of needle prick was sterilized with disposable alcohol swabs (Kandall Health Care Company, USA). Blood was taken through sterilized disposable syringe (Nipro Corporation, Japan) from each subject and the blood was quickly transferred into a tube. The tubes were marked with the code assigned to the subject. The samples were quickly transported to the laboratory for further processing.

2.2.3. Glycemia estimation

The glucose level of each individual was measured by using glucometer (Accu-Check Active, Roche Company).

2.2.4. Processing of blood sample

The venous blood collected in the serum tube was allowed to clot for about three hours. Within this time the serum was separated, however, it was centrifuged for fifteen minutes at 1500 rpm to obtain the clear serum. It was planned that the sample collected will be analyzed the same day of the collection. Thus overwhelmingly the tests were carried out within six hours after the collection.

Serum pipetted out was labeled in a fresh test tube with the code and number allotted to the subject and corresponding to the tube code at the time of sampling. Immediately, the sample was placed in freezer at a temperature of −20 °C.

Total cholesterol, heavy density lipoprotein cholesterol (HDL), low density lipoprotein cholesterol (LDL) and Triglyceride were estimated by direct kit method using precipitant of Spinreact Co, Spain estimated in the sera of the samples.

2.3. Statistical analysis

Data collected or estimated were spread on an Excel sheet for descriptive statistics. The difference between the value of different parameters of various populations, the correlations between various parameters within a population, correlations between different subgroups within populations were determined by statistical package of Sigma stat. The significance of the difference between comparing populations was taken at least = or $P < 0.05$.

3. Results

In this study a total of 198 subjects were selected between the age group 18–45 (138 male and 60 women were participated). Mean ages of males and females were 39.45 and 38.06, respectively.

Table 1 shows the mean values of age, BMI, systolic blood pressure, diastolic blood pressure, glucose, cholesterol, HDL, LDL, VLDL, and Triglycerides. Mean cholesterol, LDL, VLDL and triglycerides increased statistically significantly higher in men than women and values were increased with increasing age in both men and women. However HDL and glucose values were significantly higher in females than males. No significant differences were found in age, BMI, systolic and diastolic blood pressure because there values were close to each other in both males and females. The percentage of heart disease, hypertension and diabetic subjects are shown in Table 1.

Table 2 shows that in men with various nutritional groups such as A, B and C the mean age, BMI, Systolic blood pressure, diastolic blood pressure and glucose values indicate that there was no significant difference found among all different nutritional groups. However cholesterol ($P < 0.001$), LDL ($P < 0.014$), VLDL ($P < 0.031$) and triglyceride ($P < 0.025$) levels were significantly observed among comparable groups. Table 2 also indicates that LDL, VLD and triglyceride values among all nutritional groups were increased with increasing age and cholesterol level.

Table 3 shows that in women with various nutritional groups such as A, B and C, the mean age ($P < 0.047$) and triglyceride levels ($P < 0.033$) display statistically significant results. On the other hand mean values of BMI, systolic blood pressure, diastolic blood pressure, glucose, cholesterol, HDL, LDL and VLDL were not significantly different among all nutritional groups. While systolic blood pressure and cholesterol values were in close range in all nutritional groups.

The correlations of the various parameters were observed individually in all populations investigated in the study (Table 4). One parameter was taken as the constant factor and the relationship of other parameters was compared statistically for the significance of the correlations.

The correlations that were statistically significant were further analyzed among the specifically derived subgroups on the basis of the nature of each parameter within the population.

Highly significant positive correlations have been observed between age and Weight ($p < 0.0395$), BMI ($p < 0.00525$), diastolic blood pressure ($p < 0.0353$), and Glycemia ($p < 0.00671$). A highly significant positive correlation was seen between weight and HDL ($p < 0.0000037$), LDL ($p < 0.00000066$), and VLDL ($p < 0.0000000037$). It was observed that HDL, VLDL and triglycerides of the subjects increased with increasing weight.

A significant positive correlation was also seen between BMI and Glycemia ($p > 0.0354$), HDL ($p > 0.0000105$) LDL ($p < 0.00000043$), VLDL ($p < 0.0000022$). It was found

Table 1 General characteristics, age, BMI, systolic blood pressure, diastolic blood pressure, glucose, cholesterol, HDL, LDL, VLDL and triglyceride values in men and women.

Variable	Unit	Men $n = 138$	Women $n = 60$	*P* value
Age	Years	39.45 ± 12.89	38.06 ± 11.64	0.47
Height	Feet. Inch	5.70 ± 2.04	5.31 ± 0.25	0.16
Weight	kg	72.77 ± 12.98	64.60 ± 9.32	0.001*
BMI	kg/m^2	25.70 ± 4.89	24.31 ± 4.36	0.06
Systolic blood pressure	mmHg	125.27 ± 9.80	126.75 ± 12.88	0.38
Diastolic blood pressure	mmHg	85.92 ± 8.01	86.06 ± 9.99	0.91
Glucose	mg/dl	104.94 ± 33.48	119.30 ± 41.01	0.011*
Cholesterol	mg/dl	205.01 ± 48.51	179.20 ± 49.84	0.001*
HDL	mg/dl	53.30 ± 18.71	74.21 ± 24.87	0.001*
LDL	mg/dl	102.45 ± 30.28	71.09 ± 20.96	0.001*
VLDL	mg/dl	33.93 ± 13.30	27.50 ± 9.31	0.001*
Triglycerides	mg/dl	185.89 ± 54.73	134.41 ± 39.43	0.001*
Heart disease		7(5.07%)	3(5%)	
Diabetes		5 (3.62%)	3 (5%)	
Hypertension		4(2.89%)	4 (6.66%)	

$p < 0.05$ (significant).
* Significant.

Table 2 General characteristics, age, BMI, systolic blood pressure, diastolic blood pressure, glucose, cholesterol, HDL, LDL, VLDL and triglyceride values in men.

Men	Unit	A $N = 12$	B $N = 65$	C $N = 61$	*P* value
Age	years	39.50 ± 14.33	38.75 ± 11.84	40.19 ± 13.83	0.823
BMI	kg/m^2	26.04 ± 04.10	25.72 ± 4.99	25.62 ± 4.98	0.967
Systolic blood pressure	mmHg	128.91 ± 13.29	125.00 ± 9.17	124.91 ± 9.84	0.418
Glucose	mg/dl	105.25 ± 29.50	104.09 ± 32.53	105.13 ± 36.26	0.984
Cholesterol	mg/dl	251.66 ± 40.52	205.36 ± 47.36	195.91 ± 46.44	0.001*
HDL	mg/dl	45.58 ± 13.99	52.56 ± 17.79	55.60 ± 20.20	0.217
LDL	mg/dl	126.58 ± 29.07	99.30 ± 26.42	101.06 ± 32.64	0.014*
VLDL	mg/dl	42.208 ± 16.32	31.61 ± 12.13	34.77 ± 13.33	0.031*
Triglycerides	mg/dl	226.66 ± 52.76	182.27 ± 57.90	181.72 ± 48.86	0.025*

$p < 0.05$ (significant).
* Significant.

Table 3 General characteristics, age, BMI, systolic blood pressure, diastolic blood pressure, glucose, cholesterol, HDL, LDL, VLDL and triglyceride values in women.

Variable Women	Unit	A $n = 15$	B $n = 29$	C $n = 16$	*P* value
Age	years	33.46 ± 9.67	41.79 ± 12.34	35.62 ± 10.35	0.047*
BMI	kg/m^2	24.90 ± 4.08	25.00 ± 4.97	22.56 ± 2.96	0.193
Systolic blood pressure	mmHg	124.66 ± 12.88	128.79 ± 13.34	125.00 ± 12.24	0.500
Diastolic blood pressure	mmHg	84.33 ± 10.15	87.931 ± 9.49	84.31 ± 10.75	0.383
Glucose	mg/dl	108.60 ± 37.61	119.86 ± 41.55	128.31 ± 43.25	0.414
Cholesterol	mg/dl	181.06 ± 68.10	178.82 ± 46.01	178.15 ± 38.55	0.986
HDL	mg/dl	73.20 ± 27.94	68.21 ± 24.21	86.03 ± 19.78	0.068
LDL	mg/dl	81.30 ± 28.32	69.97 ± 17.04	63.56 ± 16.43	0.055
VLDL	mg/dl	24.09 ± 7.49	28.466 ± 9.09	28.94 ± 10.89	0.263
Triglycerides	mg/dl	150.93 ± 45.50	136.65 ± 41.67	114.87 ± 15.91	0.033*

$p < 0.05$ (significant).
* Significant.

Table 4 Pearson correlation of general trends of all populations of Ziarat.

S. no	Variables	*P* value
1	Age	Weight (0.0395) BMI (0.0052) BP Diastolic (0.0026) Glycemia (0.0067)
2	Weight	HDL (0.00003) LDL (0.000) VLDL (0.000)
3	BMI	Glycemia (0.035) HDL (0.00001) LDL (0.000) VLDL (0.000)
4	Cholesterol	VLDL(0.000)
5	HDL	Triglyceride (0.000)
6	LDL	VLDL (0.00001)

$p < 0.05$ (significant).

that HDL, LDL, and VLDL, of the all the subjects increased with increasing BMI. A significant positive correlation was seen between cholesterol and VLDL ($p < 0.0000000039$). Highly significant positive correlation was found between HDL and Triglyceride ($p < 0.000000038$). A highly significant positive correlation was also seen between LDL and VLDL ($p > 0.0000196$).

4. Discussion

Among the high altitude places of Balochistan; Ziarat located at 2560 meters height from the sea level and the main tribes living here are Pashtuns and Kakar. They have their own traditions and dietary habits. These people have a genetic set up well adapted to the local conditions, including the dietary characteristics and activity habits. Physiological and bio chemical characteristics of a group of individuals with common background reflect the outcome of the interactions between genetic setup and dietary habits, activity and other traditions. The prominent aspects of biochemical and physiological expressions are associated with nutrient metabolism. Carbohydrate, lipid and protein metabolisms are main ingredients of nutrient metabolism.

It was observed that total serum cholesterol level in male subjects 205.01 ± 48.51 48 were higher than women subjects that were 179.20 ± 49.84. It was also found that levels of HDL, VLDL and Triglyceride, increased with increasing total serum cholesterol in all subjects. The relationship was statistically significant in both males and females.

Significant positive correlations were also observed between age, weight, BMI, diastolic blood pressure and Glycemia. The level of Glycemia also increased with increasing age in all populations. The significant variation in age will affect the other comparisons such as the incidence of degenerative diseases with varied metabolic profiles increased in aged population (Elia, 2001; Flega et al., 1998).

A comparison of weight with other parameters shows that a highly significant Positive correlation between weight, HDL and VLDL. It was observed that HDL, VLDL and Triglyceride levels of all subjects increased with increasing weight. Weight and height are the main ingredients of index of BMI, therefore BMI was also calculated and correlation with other parameters was observed. A significant positive correlation was seen between BMI with glycemia, HDL LDL and VLDL of all the subjects increased with increasing BMI.

Vegetables and fruits are the main components of a normal healthy diet and these help in preventing many major disorders like CVD and some cancers of the digestive system (Taubes, 2001; McKeigue et al., 1985). There are many illustrated mechanisms by which these protective measurements may be mediated, including micronutrients (e.g. flavonoids, vitamin C, folic acid) and antioxidants. According to the world health report 2002, fruit and vegetable intake varies considerably among different countries and within countries due to economic, cultural and agricultural environments. While comparing nutritional habits of population of Ziarat District, it was found that the difference in food is present in meat, poultry, pulses and vegetables. Because of Cultural and agricultural environments of Ziarat District, fruits (apple and Cherry) were abundant and were eaten by the population in abundance.

While comparing populations according to their nutritional habits the male and female populations were divided into three nutritional groups A (Beef and mutton daily. Vegetables, pulses, eggs, milk 3–5 times a week. Apple, cherry frequently), B (Beef mutton 3–5 times a week. Poultry in excess. Vegetables, pulses, Apple cherry frequently) and C (Beef and mutton 1–2 times a week. Vegetables, pulses 3–5 times a week. Apple cherry frequently).

No significant difference was found in age and BMI when nutritional groups in male population were compared. While in female population the BMI was higher in A than in B, group C had lowest BMI, these results were however not significant statistically.

Glycemia of the nutritional groups A, B and C was found in close range in male populations. No statistically significant difference was found in nutritional groups in both males and females. Glycemia level was higher in female (147.68 ± 17.225) than the male (105.98 ± 3.814).

The serum cholesterol in men was higher in group A compared to group B and C. A statistically significant difference was found between all nutritional groups. In females serum total cholesterol was in close range in all groups. HDL level was high in all nutritional groups but in group C the mean HDL was higher than the rest of the two groups both in males and females. Similarly the LDL level was slightly high in group A than the rest of the two groups. In females there was no significant difference in HDL and LDL levels among three groups. Triglyceride level was higher in group A than Group B and C both in male and females and there was a statistically significant difference found among the comparable groups in male and females.

5. Conclusion

The life style and environment at high altitude has an impact on human life which is interpreted in phenotypic and genotypic characteristics. These changes are expressed as physiological and biochemical parameters in our body. The metabolic ingredients are directly affected by these changes.

Increased levels of lipid profile and glucose are observed in this study. This increases key risk factors for cardiovascular disease and coronary heart disease, such as hypertriglyceridemia, low HDL and obesity, in high altitude natives.

Conflict of interest

The authors declare that they have no conflict of interest.

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