Dietary Habits, Physical Activity and Enviornmental Toxicology Role in Type-II Diabetes Mellitus

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Abstract

Objective: To correlation between life style, diet and environmental pollution in type 2 diabetes mellitus.

Material and Methods: It was a cross sectional study of comparative data analysis of glycemic levels among population regarding environment, diet and physical activity. Sample size calculated was 228.

Results: The study included 228 participants who were randomly sampled from Services Hospital Lahore including patients as well as the accompanying attendants coming in from urban and surrounding rural area of Lahore. The variables specified for research were diet and lifestyle of a subjects from both urban and rural setups. The final result showed that 64% (147 out of 228) participants were normoglycemic, 6% were Pre-diabetic and 36% (81 out of 228) were of type 2 diabetes mellitus.

Conclusion: Diet and physical activity were the main cofactors along with pollution scenario, having an etiological role in type II Diabetes Mellitus.

Keywords: Diabetes mellitus, pollution, organic diet, physical activity.

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Introduction

Environmental toxicology is one of the branches that deal with toxins in atmosphere and its deleterious effects on living beings.[1] Among this, polluted air that human beings breathe in, has most notorious effect in morbidity. It can be narrated as particulate matter in atmosphere which when exceeds maximum allowable concentration, is when it starts producing ill effects on human body.[2] Among one of such morbid conditions resulting from such toxic air levels is diabetes mellitus type 2.[3] It can be very safely argued that diabetes mellitus is a complex of metabolic disorders with a predominant hyperglycemic characteristic in lieu of either defective insulin productivity, reduced insulin action or coexistence of both factors, originating from autoimmune pathogenesis resultantly leading to destruction of pancreatic beta cells.[4] A continued high level blood sugar level plays an intense damaging role in multi-organ failure with predominance of ocular, renal, neuronal and cardiac dysfunction.[5] Outdoor toxic air levels play a critical yet under rated and under stated role in diabetes pathology. This environmental milieu in addition to highly processed food ingestion are one of the leading causative etiological factors in type 2 diabetes mellitus.[3]

Particulate matter especially air pollution caused by traffic automobiles and smog, has a major yet an indirect role in pathogenesis of type 2 diabetes

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mellitus. Two-fold mechanism enacting in causation of hyperglycemia is inclusive of pro-inflammatory mediators and oxidants which damage endothelium along with enhanced insulin resistance.[6] There is no evidence to suggest a direct linkage to pancreatic beta cell damage. The particulate matter damages functioning capacity of endothelium regarding nitric oxide synthase signaling. An elevation of C reactive protein, IL-6 and leucocyte count serves as pro-inflammatory factors which have an adverse effect on endothelial function. Increased insulin resistance due to pollution is yet again an indirect effect resultant to high fat diet exposure.[7]

Dietary habits of humans are based on choices from carbohydrates, proteins and fats. Metabolic processes of the gastrointestinal system are capable of digestion and breakdown of the food into readily available sources of energy supplies. This needs a meticulously designed system of catabolism, anabolism leading to final break down of complex carbohydrates, proteins and fats. Key factor playing a role in persistent hyperglycemic levels is high carbohydrates in diet. For this a carbohydrate directed analysis of digestive process is to be scrutinized in detail following catabolic stepwise digestion of these polysaccharides. Carbohydrates are a dominant exogenic dietary source of vitality in human body. This usually amounts up to 40-60% of total calories diet consumption. 1 gram of carbohydrates is responsible for 4 calories provision. Target digestive process leads to disintegration of complex carbohydrate molecule in to simpler disaccharides and finally into absorbable monosaccharide molecules. Dietary downsized adjustment of carbohydrate caloric intake can miraculously alter hyperglycemic levels to normalcy.[8]

Glycemic levels need to be addressed here in detail. These levels have evolved with time into a narrow range as compared to what they used to be in 1980s decade. Fasting glycemic levels were standardized by American Diabetes Association to be 140mg/dl with 2 hours post prandial levels were desirable to be below 200mg/dl. However, in 1997 and 1998 this diagnostic criterion was revisited and readdressed. It narrated that a fasting level of glucose in plasma were fixed between 110mg/dl to 126mg/dl. New measurable gold standard was decided in 2003 and is prevalent choice to date. This has fixed the fasting standard value to be 100mg/dl. Any value between 101mg/dl to 126mg/dl is considered to be pre-diabetic and fasting plasma value above 126mg/dl is a diagnosed diabetic patient. According to this scale post prandial values state that healthy glycemic levels 2 hours after a meal is 140mg/dl, any reading between 141mg/dl to 200mg/dl is considered to be pre-diabetic and blood sugar level above 200mg/dl is labeled as full blown diabetes mellitus.[9] The multifactorial versatile view of hyperglycemic scenario elucidates a multidimensional approach to understanding diabetes mellitus. It is governed by a number of factors including inherent aspect, autoimmunity destroying pancreatic beta cells, idiopathic etiology followed by iatrogenic induced by factors such as air pollution plus variability in dietary pattern like excessive carbohydrate intake leading to piqued hyperglycemia combined by high fat foods leading to enhanced insulin resistance. Further adding insult to the injury is increasing trend of urbanization, fast food, lack of physical activity which concomitantly are playing a significant contributing role in type 2 diabetes mellitus.[10]

This gives rise to the need to re-evaluate the standard diabetic threshold so that we can better manage global threat of diabetes. We need to adopt healthy eating habits and increase our participation in physical exercise. We need to analyze our food quality and our calorie count. Nutrition has a key role in the normal digestive metabolic process of body for maintenance of a normoglycemic profile. Processed Foods mostly have high Glycemic Index values whereas fiber, most vegetables and fruits have a low Glycemic Index value. Understanding the Glycemic Index and utilizing it to evaluate our diet can help in reducing Diabetes.[11] So far three main factors have been discussed regarding hyperglycemia. Inherent type 1 insulin-dependent diabetes mellitus; high glycemic index food and lack of physical activity leading to increased blood glucose levels causing type 2 diabetes mellitus. Urbanization especially air pollutant levels have a significant role in disturbing the normoglycemic index. Particulate pollutant matter is a cardinal causative factor in endothelial damage leading to increased insulin resistance and reduced peripheral glucose uptake.[10]

Material and Methods

A cross-sectional epidemiological type of study was performed about plasma glycemic levels. Simple random sampling technique was applied. Inclusion criteria were a random urban and rural population with age range of eighteen years and above apparently healthy with possibility of altered glycemic levels. Exclusion criterion was the population suffering from any other debilitating disease besides diabetes mellitus. After taken the approval from Ethical Committee Ref No. IRB/2022/972/SIMS dated: 26-05-2022. The study was conducted on a group of 228 subjects from various aspects of life in a time span of six months ranging from June 2022 till November 2022. A questionnaire was used to collect sample data from the study participants. Information about participant's age, gender, diet and exercise history, the demographic profile was collected. Diabetic and pre-diabetic participants were additionally asked about their disease and treatment history. The materials used for sample collection were Glucose Meter with test strips, disposable sterile blood lancets, and Alcohol Swabs. Two tests were performed on each subject that is, fasting blood glucose test and two hours' postprandial blood glucose test. The sample size was calculated using a statistical formula. IBM SPSS Version 20 was used for the statistical calculation of the obtained data.

Results

The study was conducted on around 228 participants from different walks of life, mainly categorizing into the urban and rural population. The questionnaire was well versed and meticulous. For the educated and literate population, it was self-explanatory, to others it was described in detail for information purposes. The diet and lifestyle of a subject were the significant variables that were considered to evaluate one's glycemic levels.

A total of 228 individuals were sampled as a randomized study, in an age range of 1year to 90 years. 109 were male and 119 were female candidates. It was a random study which included history and plasma glycemic levels of individuals visiting Services Hospital Lahore either as a patient or as an attendant. Of these 228 candidates 81 cases were diagnosed diabetics and 147 were found to be non-diabetic. Of the 81 cases 43 were on oral hypoglycemic medication and 34 were receiving insulin management. In this study 171 cases were from the Lahore city and 57 were from surrounding suburban rural areas. Of these 171 urban individuals assessed 91 were found to be non-diabetics and 35 out of 57 had normal glycemic levels belonged to rural population. This gives us the statistical value of 47% urban population being diabetic as compared to 39% diabetics in rural population. 10 out of 171 urban candidates as compared to 3 rural individuals were pre-diabetics **(table 1).** 14 urban cases were well managed with oral hypoglycemic agents whereas 6 out of 22 rural cases were established with good oral management. 17 versus 3 were the reported cases respectively belonging to urban and rural population poorly controlled diabetic control while been on oral medication. 10 cases were successfully managed on insulin in urban area, with 15 cases exhibiting poor glycemic control even while being on parenteral insulin therapy. 3 rural cases were on insulin treatment with good control. 4 each urban and rural cases were opted for no treatment as per their own choice. In an overall view 10% of the population exhibited pre-diabetic condition. 14% were diabetics with good control however 16.6% showed an uncontrolled diabetic condition even with medical management. 66 diabetics were only therapeutically

Table 1: *History Area of Residence Blood Sugar Levels Cross Tabulation*

Count					
Blood Sugar Levels			Area of Residence		Total
			Urban	Rural	
	History		1		1
		Total	1		1
Normoglycemic	History	Diabetic	2	1	3
		Non-Diabetic	91	35	126
		Total	93	36	129
Border Line Diabetic	History	Diabetic	2	0	2
		Non-Diabetic	14	7	21
		Total	16	7	23
Diabetic with Good Control	History	Diabetic	24	9	33
		Total	24	9	33
Diabetic with Poor Control	History	Diabetic	35	3	38
		Total	35	3	38
Newly Diagnosed with Borderline High Level	History	Diabetic		1	1
		Total		1	1
Newly Diagnosed with Severe Hyperglycemia	History	Diabetic	3	1	4
		Total	3	1	4
			1	0	0	1
Total	History	Diabetic	0	66	15	81
		Non-Diabetic	0	105	42	147
		Total	1	171	57	229

TABLE:2 *Area of Residence Bloood Sugar Levels Management Crosstabulation Count*

Management			Blood sugar levels							
				Normoglycemic	Borderline Diabetic	Diabetic with Good Control	Diabetic with Poor Control	Newly Diagnosed with Borderline High Level	Newly Diagnosed with Severe Hyperglycemia	Total
	Area of Residence		1							1
	Total		1							1
Diet Management	Area of Residence	Urban					1			1
	Total						1			1
Oral Hypoglycemic	Area of Residence	Urban				14	17		2	33
		Rural				6	3		1	10
	Total					20	20		3	43
Insulin Treatment	Area of Residence	Urban		2	2	10	15	0	1	30
		Rural		0	0	3	0	1	0	4
	Total			2	2	13	15	1	1	34
Normal and Managed	Area of Residence	Urban		91	10					101
		Rural		36	3					39
	Total			127	13					140
No Management	Area of Residence	Urban			4		2			6
		Rural			4		0			4
	Total				8		2			10
Total	Area of Residence		1	0	0	0	0	0	0	1
		Urban	0	93	16	24	35	0	3	171
		Rural	0	36	7	9	3	1	1	57
	Total		1	129	23	33	38	1	4	229

managed via medication with a sedentary life style. 31 out of 80 had a good glycemic control with medication but were also actively involved in either physical activity, walk or active workout schedule reported from urban setup as compared to 9 out of 22 from rural background who had good diabetic control via treatment and physical activity **(table 2).**

Discussion

Diabetes mellitus has a prime significance in regards to not only the dietary habits and exercise but also environmental toxicological pollutants that have an impactful outcome in etiology. Normal physiology is dependent upon anatomically functional working pancreas which produces insulin to maintain biochemical activity. An overview of type 2 diabetes mellitus shows a lack of efficient glucose metabolism either due to deficient insulin as a result of reduced productivity or insulin resistance in response to hyperglycemia. Either way human body ends up in a state of raised blood sugar, accumulation of which causes deleterious multi-organ debility. Type 1 diabetes mellitus requires a parental homozygosis for disease manifestation. Type 2 diabetes mellitus has a much stronger correlation with family history. Despite a familial linkage, it is not that diabetes mellitus runs in families rather it is that nobody runs in family. It is a lack of physical activity that plays a vital role in causation of type 2 hyperglycemic response of human body in addition to intake of high glycemic index diet, primarily leading to obesity ending up in raised blood glucose levels permanently. Research in this article is based upon role of dietary intake, exercise and environmental pollution factors besides the established fact of molecular genetics, in development of type 2 diabetes mellitus.[12]

We hypothesized that organic rural diet plays a vital role in maintaining normal glycemic levels and controlling diabetes mellitus as compared to usual urban diet, as per which there should be a significant difference between the prevalence of diabetes in urban and rural areas. However, our results show that there is only a minor difference in the percentage of people with normal glucose levels living in urban and rural areas. In light of the result, we conclude that due to the rapid spread of urbanization in the rural areas and common use of insecticides in the crop has minimized the health effects of rural life.[13] Major

possible contributory factors can also be impurities in the organic diet and increasing environmental pollution. Excessive use of fast food is also a reason for a higher ratio of diabetes in urban areas. Yet minor difference between percentage of diabetic patients in urban and rural areas indicates that all in all organic diet is the main factor that maintains normal glycemic levels.[14]

The escalatory growth spurt, urbanizing trend set, industrialization along with excessive motor vehicles on the road all have drastically enhanced the air pollution leading to extremely poor air quality index to breath. This situation is further aggravated by the annual smog blanket hovering over the cities of Pakistan during fall season. All this hazardous air that is breathed in by population of Lahore is playing a major contributory role in pathogenesis of type 2 diabetes mellitus. Although this does not damage the pancreas directly however reactionary inflammatory process deteriorates endothelial function which resultantly increases insulin resistance eventuating into hyperglycemia.[15] Pakistan is one of the leading countries world-wide which has the poor air quality index with Lahore being one of the most effected cities of Pakistan.[16]

Conclusion

Taking into account the physical activity of a person, from results we observe that there are more diabetic patients in urban areas compared to the rural, as rural people have a more physically demanding and active lifestyle. We observed that people consuming an organic diet had good control over managing their diabetes while people who consumed urban diet showed a lower ratio of good control despite the regular physical activity.[17]

Conflict of Interest *None*

Funding Source *None*

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Authors Contribution

ARK: Conceptualization of Project

AFB: Data Collection

FT: Literature Search

KM: Statistical Analysis

FB: Drafting, Revision

KH: Writing of Manuscript