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Original Article

Evaluation of the persistent organic pollutants association with type 2 diabetes: A prospective study from Karachi, Pakistan

Avaliação da associação de poluentes orgânicos persistentes com diabetes tipo 2: um estudo prospectivo de Karachi, Paquistão

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Abstract

The aim of this study is to determine the association between environmental organic pollutants with type 2 diabetes. This prospective study was conducted in Federal Urdu University of Arts, Science and Technology (FUUAST) Gulshan-e-Iqbal Campus Karachi in duration from January 2016 to June 2017. This study was ethically approved from the Institutional Review Board of FUUAST. The study included 50 male and female convenient subjects with type 2 diabetes. Subject with other type of diabetes was excluded. Consent was obtained by each individual. Self-structured questionnaire was used for data collection. The comparative results suggest that the maximum level of summation polychlorinated biphenyls (PCBs) mean value was found in age group 27-33 as 0.695 mg/kg in 73% having total individual eleven. Median (interquartile range) of pesticides levels among subjects with normal weight, over weight and obesity were 0.49 (0.26-2.13), 1.53 (0.60-2.65), and 1.60 (1.23-2.05) respectively. It was observed that Organochlorine pesticides (OCS) levels of subjects with overweight and obesity were almost similar (P-value > 0.05) but significantly higher as compared to subjects with normal weight (P-value < 0.05). No significant differences were observed between PCB levels of subjects in terms of body mass index (BMI). In present study we trace the important elements involve in the deposition of persistent organic pollutants and established an association between pollutants with etiology of diabetes and associated disorders such as obesity.

Keywords: persistent organic pollutants, association, type II diabetes.

Resumo

O objetivo deste estudo é determinar a associação entre poluentes orgânicos ambientais com diabetes tipo 2. Este estudo prospectivo foi conduzido na Universidade Federal Urdu de Artes, Ciência e Tecnologia (FUUAST), Gulshan-e-Iqbal, Campus Karachi, com duração de janeiro de 2016 a junho de 2017. Este estudo foi eticamente aprovado pelo Comitê de Revisão Institucional da FUUAST. O estudo incluiu 50 indivíduos convenientes do sexo masculino e feminino com diabetes tipo 2. Indivíduos com outro tipo de diabetes foram excluídos. O consentimento foi obtido por cada indivíduo. Um questionário autoestruturado foi utilizado para a coleta de dados. Os resultados comparativos sugerem que o nível máximo de soma de bifenilas policloradas (PCBs) valor médio foi encontrado na faixa etária 27-33 como 0,695 mg / kg em 73%, tendo total de 11 indivíduos. A mediana (intervalo interquartil) dos níveis de pesticidas entre indivíduos com peso normal, sobrepeso e obesidade foi de 0.49 (0.26-2.13), 1.53 (0.60-2.65) e 1.60 (1.23-2.05), respectivamente. Observou-se que os níveis de pesticidas organoclorados (OCS) de indivíduos com sobrepeso e obesidade eram quase semelhantes (valor P > 0.05), mas significativamente maiores em comparação com indivíduos com peso normal (valor P < 0.05). Não foram observadas diferenças significativas entre os níveis de PCB dos indivíduos em termos de índice de massa corporal (IMC). No presente estudo, rastreamos os elementos importantes envolvidos na deposição de poluentes orgânicos persistentes e estabelecemos uma associação entre os poluentes com a etiologia do diabetes e doenças associadas, como a obesidade.

Palavras-chave: poluentes orgânicos persistentes, associação, diabetes tipo II.

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1. Introduction

Type 2 diabetes has become as a major health problem of public and its pandemic cause burden for health care professionals throughout the world (Onyango and Onyango, 2018). This disease has impact on quality of life and activities of an individual that leads towards an increased morbidity and mortality of individuals (Ramtahal et al., 2015). Currently, focus has increased on diabetes related deaths in people less than age of 60 years (Alotaibi et al., 2017). Elements including unhealthy diets and sedentary lifestyles, resulting in elevated Body Mass Index (BMI) and fasting plasma glucose are considered for these circumstances (Lone et al., 2017). Particularly, individuals with elevated Body mass index are prone to have type 2 diabetes (Mahanta et al., 2013). Unless these traditional risk factors evidence on the contribution of environmental contaminants to the prompt rise in the incidence of type 2 diabetes (Wolf et al., 2019).

Persistent organic pollutants (POPs), are group of environmental pollutants, that involved to enhance quality of some products commonly used in our daily living, but their properties of being bio-accumulated in environment induce unexpectedly harmful effects to human health (Yang et al., 2017). To overcome the strategy the National Toxicology Program (NTP) at the National Institute of Environmental Health Sciences (NIEHS) conducted a workshop in the month of January year 2011(Taylor et al., 2013). They examine the associations between certain chemicals and obesity along with diabetes. A wide variety of chemicals were included in the POPs category. The relation between persistent organic pollutants (POPs) and the development of type 2 diabetes had shown for over ten years, additionally many reviews and one meta-analysis of epidemiological studies combined the findings validating the initial statements (Wolf et al., 2019).

Few from previous studies reported environmental pollutants are responsible for dysfunction of energy metabolism in adipose tissue (Grün and Blumberg, 2006). Moreover, there are substantial differences in phenotypic characteristics and profiles of diabetes related complications in patients with diabetes worldwide, suggesting the possible contributions of environmental factors, including pollutants, on top of genetic factors, which add to the complexity of the understanding of diabetes (Kong et al., 2013). The aim of this study is to determine the association between environmental organic pollutants with type 2 diabetes.

2. Materials and Methods

This prospective study was conducted in Federal Urdu University of Arts, Science and Technology (FUUAST) Gulshan-e-Iqbal Campus Karachi in duration from January 2016 to June 2017. This study was ethically approved from the Institutional Review Board of FUUAST. The study included 50 male and female convenient subjects with type 2 diabetes. Subject with other type of diabetes was excluded. These individuals were selected conveniently from the general residents of Karachi city of Pakistan. Consent was obtained by each individual. Self-structured questionnaire was used for data collection (Ahn et al., 2007). Obesity was defined as BMI (kg/m^2) which were categorized as follows: normal weight (18-22.9 kg/m^2), overweight (23.0-24.9 kg/m^2) and and obese (≥25.0 kg/m^2).

2.1. Sample site areas

We select the samples from industrial areas where use excessive harmful substances and due to less sufficient facilities found a lot of environmental contamination. The use of unusual resources, and continuously destruction of environmental resources causes harmful effect to unban productivity.

Collection of blood samples: Blood collection was very simply, as blood drawn from inside the elbow vein. The phlebotomists insert the syringe slightly in this vein and draw small amount of blood (up to 10ml) collected in to airtight tube attached to the syringe needle and then remove the elastic band from the arm and then syringe from the vein. The blood samples were kept carefully in the ice flask and stored at minus 20°C in the deep freezer for further analysis.

2.2. Serum sepration

The blood samples kept in room temperature for few minutes until the sample become defrost then centrifuged the samples for 5 minutes at 3000 rpm. The separated serum collected from the blood by centrifugation then transfer into another vials and the rest of the blood is discarded carefully by covering in the polythene bags.

2.3. Extraction of pesticides from serum

The 5ml of serum from each sample were equilibrating at room temperature by adding 2ml of methanol and shake for 1 minute. After this 5ml n-hexane and diethyl ether (1:1 v/v) added and left the samples for 2 minutes and again centrifuge these samples for 5 minutes at 3000 rpm.

Following the centrifugation, the organic phase collects and aqueous phase remove twice with n-hexane, diethyl ether (1:1 v/v). After this the organic phase allows to evaporate until 1ml organic phase remain in a vacuum concentrator. Then 1ml concentrated H_2SO_4 added in organic phase, and shake well for 1 minute and centrifuged for 5 minutes at 2500 rpm.

Once again organic phase collected and aqueous phase was extracted twice with 1ml of n-hexane. Obtain organic phase was evaporated and allow to dried completely in a vacuum concentrator. The dry residues were dissolved for cleanup purpose in 1ml of n-hexane (Frías et al., 2004).

Column chromatography (clean-up) of extracted samples: For recovery of pesticides the extracted samples were passed 2 to 3 times through the column during the column chromatography (Lopez-Avila et al., 1989).

2.4. Statistical analysis

Statistical analyses were conducted by using SPSS version 20. Demographic data was presented in percentage (%). Association between POPs and pattern of obesity presented in median (interquartile range). Mann Whitney U test was applied. Statistical significance was set at P-value < 0.05.

3. Results

Total 50 subjects were included in this study, out of which 46(92%) were males and 4(8%) females. Age was categorized into three groups 27-33 years (n=11, 22%), 34-40 years (n=20, 40%) and 41-47 years (n=19,38%). Majority of subjects have primary level of education, consumed both vegetable and meat also they were addicted of tea/ice-cream. Half of the study subjects shown family history of diabetes (Table 1).

The comparative results suggest that the maximum level of summation PCBs mean value was found in age group 27-33 as 0.695 mg/kg in 73% having total individual eleven. While the age group 34-40 having summation, PCBs mean value as 0.548 mg/kg in 95% present in volunteers slightly lower than previous age group and having maximum individuals of about twenty. However, the lowest mean value of summation. The trends of mean value of pesticides gradually decrease according to age as age increases. The greatest number of pesticides found in younger persons than older ones (Figure 1).

Median (interquartile range) of pesticides levels among subjects with normal weight, over weight and obesity were 0.49 (0.26-2.13), 1.53 (0.60-2.65), and 1.60 (1.23-2.05) respectively. Level of pesticides were significantly lower among subjects with normal weight as compared to subjects with overweight and obesity. While no significant difference was found between pesticides level of subjects with overweight and obesity (Figure 2).

Median (IQR) of OCS levels in subjects with normal weight, over weight and obesity were 0.38 (0.08-0.92), 1.12 (0.29-1.65) and 1.20 (0.73-1.60) respectively. It was observed that OC levels in subjects with overweight and obesity were almost similar (P-value > 0.05) but significantly higher as compared to subjects with normal weight (P-value<0.05) (Figure 3).

Median (IQR) of PCB levels in subjects with normal weight, over weight and obesity were 0.23 (0.08-0.92), 0.41 (0.22-1.05) and 0.40 (0.33-0.63) respectively. No significant differences were observed between PCB levels of subjects in terms of BMI (Figure 4).

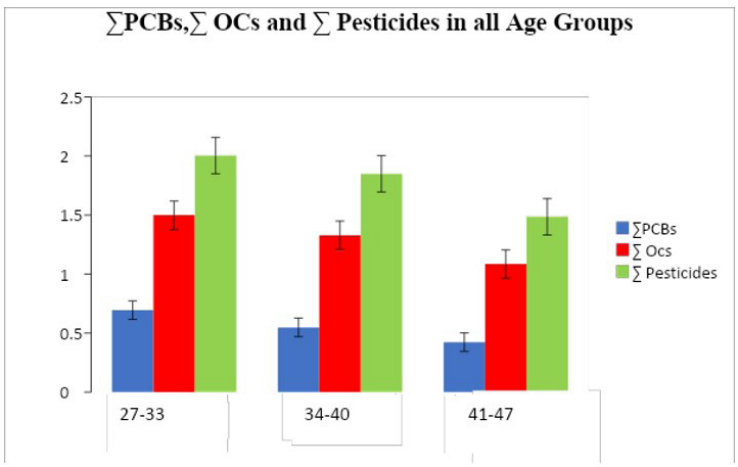

Figure 1. ∑PCBs, ∑OCs and ∑ pesticides means mg/kg in all type 2 diabetic age groups.

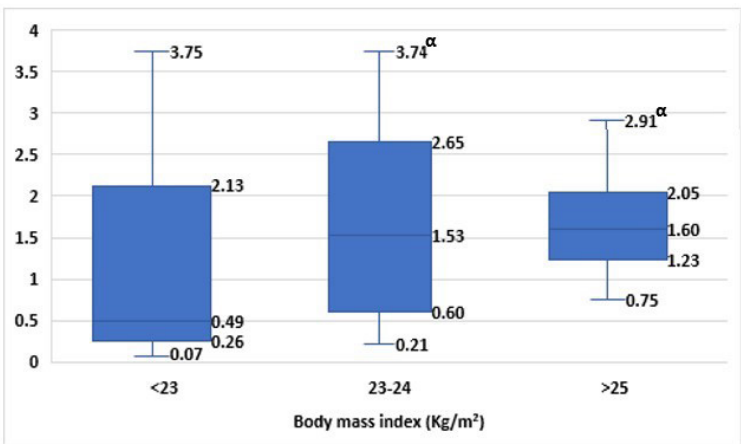

Figure 2. Association of pesticides with body mass index ᵅ significantly different from BMI<23.

Table 1. Baseline characteristics of study subjects.

Characteristics	Total	Percentage (%)
No. of Individuals	50	100%
Sex of Individuals		
Male	46	92%
Female	4	8%
Age (years)		
27-33	12	24%
34-40	20	40%
41-47	18	36%
Occupation		
Employee of chemical department	41	82%
Office worker / others	9	18%
Level of Education		
Primary	21	42%
Middle	12	24%
Secondary	08	16%
Intermediate	05	10%
Graduate	02	4%
Master	02	4%
Most Consumed Food		
Mostly Vegetables	15	30%
Mostly Meat (Chicken, Fish, Mutton or Beef)	10	20%
Both vegetables and meat	25	50%
Not specific dhal (split pulse)	20 to 30	40% to 60%
Sea Food Use		
Every day / Alternate days	02	04%
In week	18	36%
In month / In year	20 to 30	40% to 60%
Addict		
Smokers	30	60%
Smoking and tobacco users	19	38%
Pan with tobacco	16	32%
Smokers and wine users	08	16%
Tea/Ice-cream users	48	96%
Naswar addicter	20	40%
Pan parag users	12	24%
Sapari users	33	66%
Chaliya	24	48%
Drinking Water		
Mineral water	08	16%
Tap water	42	84%
Duration of Type II Diabetes		
1 to 2 yrs	12	24%
3 to 4 yrs	11	22%
5 to 6 yrs	19	38%
7 to 8 yrs	08	16%
Routine Work in a Week		
Little activities	10	20%
Medium activities	28	56%
High activities	12	24%
Activities Other Than Routine		
Walk	09	18%
Exercise	16	32%
Both	20	40%
Nothing	05	10%

Table 1. Continued...

Characteristics	Total	Percentage (%)
Family History of Diabetes		
Mother	4	8%
Father	13	26%
Siblings	08	16%
Nothing Family History	25	50%
Oil Proportion in Meals		
Low	19	38%
Middle	21	42%
High	10	20%
Dairy Products Consumption		
Yes	37	74%
No	13	24%
Socioeconomic Status		
Low	07	14%
Middle	23	46%
Better	18	36%
High	2	04%
Body Mass Index		
Normal weight	18	36%
Over weight	20	40%
Obese	12	24%

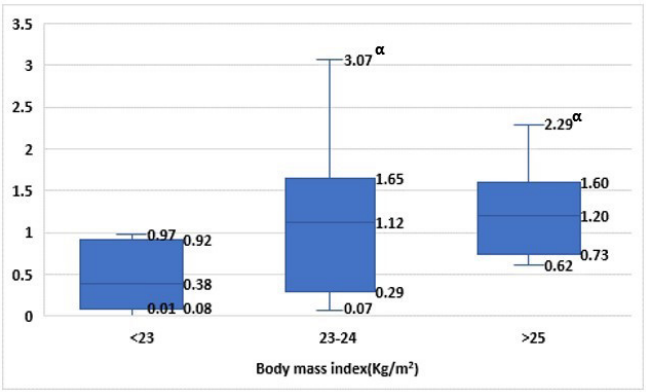

Figure 3. Association of OCS with body mass index [α] significantly different from BMI<23.

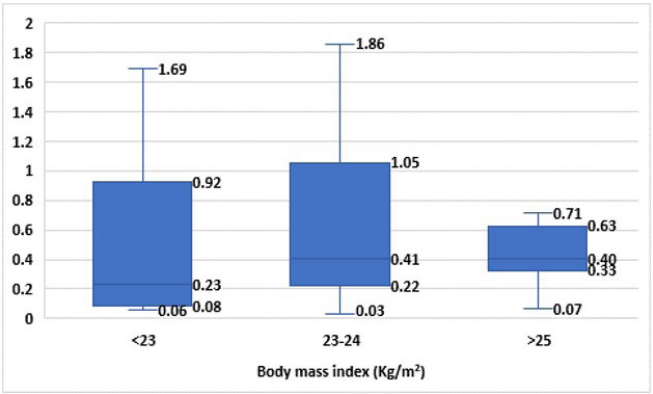

Figure 4. Association of PCB with body mass index.

4. Discussion

In present study we have observed the association between POPs in subject with type 2 diabetes with respect to age groups. Organochlorine pesticides (OCs) and polychlorinated biphenyls (PCBs) are present consistently in humans. It was found that higher exposure of all ∑PCBs, ∑OCs and ∑ Pesticides in younger age group as compared with others. Although inconsistent findings on the trend of POPs have been observed that increased with age increases in both sexes (Moon et al., 2014).

In this study majority of the subjects with type 2 diabetes were found with overweight that indicated the cause for the development of future metabolic disorders. This finding suggested the excess weight along with POPs in subjects contributed in the etiology of diabetes and other disorders. Lee et al study describes that obesity in the result of deformity in the production of pancreatic hormone, insulin resistance, and over production of insulin leads to diabetes (Lee et al., 2011). Even though the exposure of OC pesticides and PCBs were associated with insulin resistance and dyslipidemia in healthy individuals.

There were numerous components that contributing high accumulation of POPs which ultimately cause of different metabolic disorders. In current study we observed life style factors such as oil proportion in meal, sea food, vegetable, and meal consumption in their diet. The relationship between dietary habits and serum OCP and PCB levels were distinguishable that suggesting metabolic syndrome may alter the influence of food intake on POPs (Kim et al., 2018). In other studies analyses revealed that factor like age and meat intake had positive impact on serum total level OCPs that is consistent with our study results, while green leafy vegetables and beans intake had negative impact on OCPs level (Lee et al., 2007). Hence present study results describe that dietary intake found as an important factor for deposition of environmental pollutants.

The ability of pollutants to accumulate in human fat tissue cause a disruption in the endocrine system, which in turn increases body weight and waist circumference. Pesticides and OCS levels were found in association with BMI, but PCB levels found no significant differences in current study. In earlier studies the inverse association between BMI and PCB, whereas positive association with organochlorine pesticides were established (Ibarluzea et al., 2011). This may be due to high intake of fish meat. Weight gain was associated with Organochlorine whereas DDE neglected cause of lower concentration in the environment in previous study (Roos et al., 2012) .

5. Conclusion

Nevertheless, present study highlighted the important elements that are responsible for the deposition of POPs in the human body. Furthermore, association between pollutants with etiology of diabetes and associated disorders is established. Consequently, epidemiological studies on large scale required for validation of our findings and planning of preventive measures to minimize the harmful exposure towards populations.

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