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Dietary Intake of Acrylamide during Pregnancy and Its Relation with Birth Weight and Head Circumference of Newborns

Dalia I Tayel[1], Walaa MR El-Medany[2], Aly K Amin[3], Hassan H Hassan[4]

[1, 2, 3]Nutrition Department, High Institute of Public Health, Alexandria University, Egypt

[4]Paediatrics Department, Faculty of medicine, Alexandria University, Egypt

Abstract: ***Maternal diet during pregnancy is an important factor for a healthy growing newborn. A regular maternal acrylamide intake may affect the nutritional status of newborn. The study aimed to assess the dietary intake of acrylamide for Egyptian pregnant women and its association with birth weight and head circumference of their newborns. A cross sectional study was conducted on 200 pregnant women at 3rd trimester attending El-Shatby Obstetrics and Gynecology Hospital for delivery and their newborns as well. Data about socio-demographic characteristics and frequency of foods containing high levels of acrylamide consumption were collected from each pregnant woman. Birth weight and head circumference were measured for each newborn immediately after delivery. Dietary acrylamide intake was 41.8 µg/day. Birth weight and head circumference had a reverse significant association with high intake of acrylamide. The intake of acrylamide during pregnancy should be monitored along with checking any changes in the fetal weight during the antenatal visits. Awareness of the pregnant women should be raised about the acrylamide containing foods to decrease its consumption. Healthy diet should be eaten during pregnancy.***

Keywords: Acrylamide intake; Pregnant women; Pregnancy outcome; Birth weight.

1. Introduction

Acrylamide has been found to be formed in many cooked starchy foods. It was accidentally discovered in foods by scientists in Sweden (in April 2002) when they found the chemical in starchy foods, such as potato chips, French fries, bread, biscuits, breakfast cereals or crackers during frying, roasting, toasting, baking and grilling [1]. But it was not detected in foods prepared by boiling [2]. It is formed mainly by a reaction of reducing sugars with asparagine (amino acid found in potato, grains and nuts) when heating the food to >120°C. Acrylamide levels appear to rise as food is heated for longer periods of time and more of this substance is accumulated when preparation takes longer and/or occurs at high temperature [3-5].

There has been a worldwide concern about the potential health effects of dietary exposure to acrylamide as it has previously been recognized as a carcinogen in rodents and humans [6-7]. In pregnant women, the mean acrylamide intake among the 50,651 Norwegian pregnant women was 27.1 µg/day or 0.4 µg/kg body weight/day [8].

The US Food and Drug Administration (FDA) and health Canada estimated the exposure of adults to acrylamide in food was around 0.4 µg/kg body weight/day [9]. The joint FAO/WHO expert committee stated that average intake of acrylamide for general population is 0.001 mg acrylamide/kg body weight/day, and for high intake consumer is 0.004 mg acrylamide/kg body weight /day [10].

The tolerable daily intake of acrylamide for carcinogenic levels should be set at 2.6 µg/kg body weight to avoid the cancer risks and this would be equivalent to 182 µg for a 70 kg human. While the tolerable daily intake of acrylamide for neurotoxicity was found to be higher at 40 µg/kg body weight per day or 2,800 µg per day for a 70 kg body weight human. Both levels vastly exceed levels estimated by various national agencies [11].

Fetal exposure to acrylamide through the diet may start in utero as acrylamide has been found to cross the placenta barrier and so there has been particular concern of the health risk to the unborn child [12-14]. Maternal consumption of foods rich in acrylamide, such as fried potatoes, was associated with cord blood acrylamide adduct levels and with reduced birth weight and smaller head circumferences [15]. The Hb adduct levels measured in cord blood at the time of birth reflects the acrylamide exposure to the fetus during the third trimester. It was found that both the birth weight and the frequency of small for gestational age differed significantly by quartiles of acrylamide intake during pregnancy [16].

The aim of the study was to assess the dietary intake of acrylamide among Egyptian pregnant women to assert that dietary exposure to acrylamide during pregnancy and its association with reduction of the birth weight and the head circumference of their newborns as the outcome of pregnancy.

2. Subjects and Methods

2.1. Study Design and Sampling

A pilot study on 15 cases of pregnant women was conducted earlier in this study to calculate the sample size. Cross sectional study was conducted on pregnant woman at 3rd trimester attending Alexandria University Obstetrics and Gynecology Hospital (El-Shatby Hospital) for delivery and

their newborns. A total of 200 women were randomly selected including both the normal vaginal and the cesarean section delivery wards. Mothers with chronic diseases, gestational diabetes, pre-eclampsia, anemia during pregnancy, have newborns with known congenital anomaly, or with low birth weight were excluded from the study.

2.2. Data Collection

Data about socio-demographic characteristics (age, working status, residence, and income) and the awareness about the importance of proper nutrition during pregnancy were collected from the pregnant women by interviewing. Food frequency questionnaire (FFQ) method was used to estimate the dietary intake of foods expected to contain high levels of acrylamide commonly consumed during pregnancy such as fried potatoes (chips and French fries), Falafel, fried cereals (crisps, popcorn, bake rolls and breakfast cereals), bread, toast, fine bakery (cookies, pâté and croissant), roasted nuts, fried egg, fried chicken, chocolate, confectionary and coffee [17].

High performance liquid chromatography (HPLC) was used for acrylamide detection in foods [18]. The daily consumption from each food item collected by FFQ in g/day was multiplied by the content of acrylamide in each food item detected by HPLC in µg/g to get the daily intake of acrylamide in µg/day. Birth weight and head circumferences were measured for each newborn individually immediately after delivery according to the procedures of Gibson [19].

2.3. Statistical Analysis

Data management was conducted using the Statistical Package for Social Science (SPSS) version "17" software (Chicago, Illinois, US). Data were verified, tabulated and presented in the form of frequency, median, and range. Data were analyzed using Spearman correlation co-efficient (rho) to test the nature and strength of relation between two quantitative / ordinal variables. Multiple stepwise linear regression model was tested to determine factors which have significant association with dietary intake of acrylamide during pregnancy (µg/day). For all analyses, P value ≤ 0.05 was used to detect statistically significant difference.

2.4. Ethical Considerations

There is no any conflict of interest. This study was conducted according to the guidelines laid down for medical research involving human subjects and was approved by Ethics Committee of High Institute of Public Health, Alexandria University, Egypt. All data were collected following all privacy procedures and were kept confidential. A formal consent letter was obtained from pregnant women after they were informed about the study purpose and procedure.

3. Results

Table 1 shows socio-demographic characteristics of the studied sample of women. Forty percent of studied sample of women were at the age group less than 25 years. Working pregnant women contributed only 7% of the total studied sample of women. Women whose income was enough were more than those whose income was not enough. While women from urban areas contributed 89% of the total studied sample of women leaving only 11% from the rural areas.

Table 1 Socio-demographic characteristics of pregnant women

Socio-demographic characteristics	No (n=200)	%
Age in years		
<25	80	40
25-	60	30
30+	60	30
Working status		
Working	14	7
House wife	186	93
Income		
Enough	114	57
Not Enough	86	43
Residence		
Urban	178	89
Rural	22	11

Table 2 demonstrates the dietary intake of acrylamide during pregnancy and anthropometric measurements for newborns. With an estimated median dietary intake of acrylamide among the whole studied sample of 200 pregnant women was 41.8 µg/day ranging between 3.39-35.3 µg/day. Birth weight of newborns ranged between 2.25-5.90 kg with a median of 3.3kg. While the head circumference ranged between 31.50-39.0 cm with a median of 34.5 cm.

Table 2 Dietary intake of acrylamide during pregnancy and anthropometric measurements for newborns

Item	Median	Range
Dietary intake of acrylamide (µg/day)	41.8	3.39-356.3
Birth weight (kg)	3.3	2.25-5.90
Head circumference (cm)	34.5	31.50-39.0

Figure 1 summarizes the calculated percent contribution of consumed food items in daily intake of acrylamide during pregnancy. It was noted that bakery products represented the highest contribution in dietary intake of acrylamide followed by fried potato and white bread while, crisps had the lowest contribution.

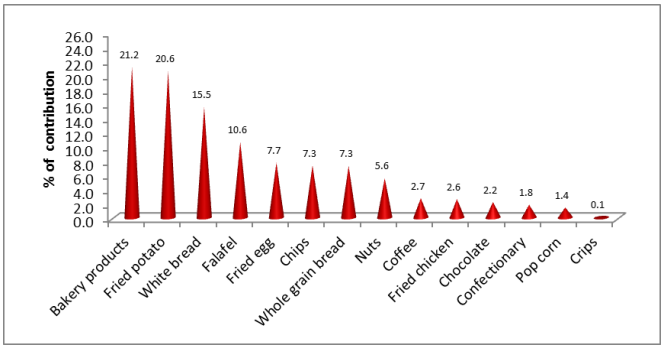

Figure 1 Percent contribution of consumed food items in daily intake of acrylamide during pregnancy

Figure 2 shows a reverse significant relationship between dietary intake of acrylamide during pregnancy in µg/day and birth weight of women's newborns. A direct significant

relationship was found between birth weight and head circumference of the newborns as shown in Figure 3.

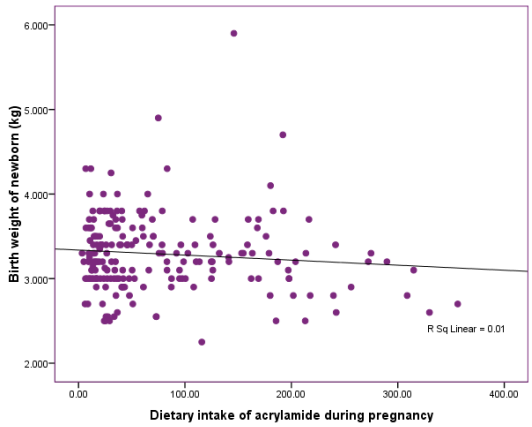

Figure 2: Correlation between dietary intake of acrylamide during pregnancy and birth weight of newborns

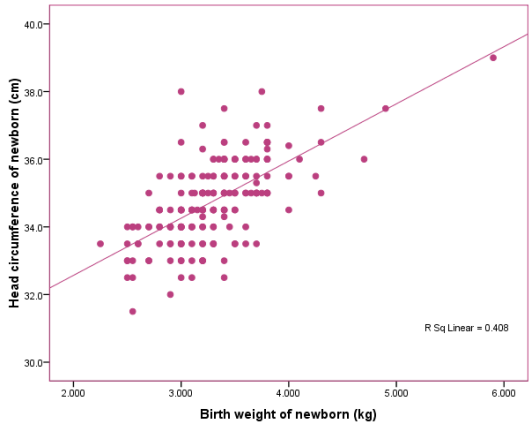

Figure 3: Correlation between birth weight and head circumference of newborn

Table 3 illustrates the results of multiple stepwise linear regression model. Awareness of the pregnant women about the importance of proper nutrition during pregnancy was found to be the most important factor that affects the dietary intake of acrylamide during pregnancy. Pregnant women who had a good awareness about the importance of proper nutrition during pregnancy were found to be less than others at dietary intake of acrylamide during pregnancy by 45.62 µg/day.

Table 3: Multiple stepwise linear regression for factors affecting dietary intake of acrylamide during pregnancy

Model	B	Std. Error	Beta	Sig.
Dependent variable: dietary intake of acrylamide during pregnancy	79.02	9.06	---	---
Awareness about the importance of proper nutrition during pregnancy	-45.62	21.11	-0.24	0.034
R^2= 0.06, F= 4.67; P = 0.034				

4. Discussion

The Joint FAO/WHO Expert committee on food additives reviewed the available data on the safety of acrylamide and concluded that its presence in food represents a healthy concern [10]. Acrylamide has been shown to affect the reproductive system in experimental animals. It also damages the genetic material and induces mutation [20]. An association between maternal acrylamide exposure and fetal growth changes were reported [16] and due to presence of acrylamide in a wide variety of food products which are regularly and heavily consumed by the community so it is important to monitor its levels in such foods as well as assessing its dietary exposure [21].

The purpose of this study was to assess acrylamide intake during pregnancy and correlate it with the birth weight and head circumference of the newborns. The obtained results showed that a higher maternal dietary acrylamide intake during pregnancy was associated with evident changes in birth weight and head circumference.

The dietary intake of acrylamide among the studied sample of pregnant women was in an average of 41.8 µg/day. A study in 2012 reported that the average acrylamide intake among pregnant women was 0.41 µg/kg body weight/day which is the same as our study in case that the pregnant woman weighed 100 kilograms [8].

The data showed a decrease in birth weight with the increase of dietary intake of acrylamide, a reduction of about 70 g between the highest and the lowest intake of acrylamide which also agrees with the findings from the cohort study in 2012 when they reported that birth weight of the newborns decreases monotonically with increasing quartiles of exposure to acrylamide with a reduction of 107 g between the highest and the lowest acrylamide intake [16].

A possible explanation for the reduction in birth weight and head circumference with the increase in acrylamide intake according to what was reported as the following: acrylamide and its metabolite glycidamide are reactive electrophiles that have the potential to react with nucleophilic sites in biomacromolecules. It could affect cellular processes of importance for growth and that it was evidenced that acrylamide-rich food is associated with a reduction in birth weight at exposure levels relevant for the general public [15,22,23]. According to the International Agency for Research on Cancer (IARC) in 1994 [24] about the ability of acrylamide to react with sulpfhydral and amino residues in proteins including enzymes, receptors and cytoskeletal proteins, so it can affect a multitude of cellular processes that was suggested to form the basis of some acrylamide toxic effects and contribute to birth outcomes observed in our study population.

A direct relationship between both the head circumference and the birth weight of the newborns was found in the study which was proved by a study in 2013 that a significant linear positive relationship existed between birth weight and head circumference of babies in Nigeria [25].

Women who had awareness about the importance of proper nutrition during pregnancy were of lower dietary acrylamide intake than those who had no awareness. It explains the role of healthy diet in lowering the intake of acrylamide during pregnancy. Nutrition education for pregnant women is necessary to control the high prevalence of low birth weight, length and head circumference in children as neonatal. Weight, length and head circumference at birth are important indices of newborn health which can show not only the quality of intrauterine growth of the fetus but also the quality of maternal prenatal care [26].

5. Conclusion and Recommendations

Dietary acrylamide intake of the studied pregnant women is 41.8 µg/day. Birth weight and head circumference of their newborns decreased with the increase of maternal dietary intake of acrylamide. Awareness about proper nutrition during pregnancy is important factor in reducing the dietary intake of acrylamide during pregnancy. The intake of acrylamide during pregnancy should be monitored along with checking any changes in the fetal weight during the antenatal visits. Appropriate nutrition education for pregnant women is necessary to raise the awareness of pregnant women about the kind of acrylamide containing foods to decrease its consumption.

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