

## The Relationship between Xenoestrogen Exposure and Early Puberty among Young Females Living in Jeddah, Saudi Arabia

Abdulmoein E Al-Agha<sup>1,2\*</sup>, Duaa Aiash<sup>3</sup> and Bara'ah O Tatwany<sup>3</sup>

<sup>1</sup>Faculty of Medicine, King Abdul-Aziz University, Jeddah, Saudi Arabia

<sup>2</sup>Department of Pediatrics, Faculty of Medicine, King Abdul-Aziz University, Jeddah, Saudi Arabia

<sup>3</sup>Faculty of Medicine, Ibn Sina National College, Jeddah, Saudi Arabia

### Abstract

**Background:** Xenoestrogen (estrogen disruptors) are artificial estrogen compounds, which are found in the environment and in various synthetic chemical products. Xenoestrogen have been claimed to affect the process of puberty among young females.

**Purpose:** This study aimed to investigate the relationship between exposure to various xenoestrogen products and the factor of early puberty among younger females in Jeddah, Saudi Arabia.

**Method:** This cross-sectional study was conducted in Jeddah for the time frame of one month. The study selected 568 younger females from different areas of Jeddah. Pubertal staging was done using the Tanner staging. The relevant data was collected through a questionnaire. Pearson's Correlation Coefficient did data analysis.

**Results:** There was a significant association among the use of children toys, age of breast (p-value = 0.040), and pubic hair development (p-value=0.028). The consumption of children plastic bottles also showed a significant correlation with early pubic hair development (p-value=0.048). The increased frequency usage of water plastic bottles, plastic packaging materials, women cosmetics and food preservations showed an inverse effect on pubertal signs.

**Conclusion:** This study confirmed the association between using xenoestrogen products and early puberty in young females living in Jeddah, Saudi Arabia. The study has evaluated that different association between the use of xenoestrogen products and the occurrence of early puberty was observed among the selected population. Therefore, it is advised to decrease the use of products that contain xenoestrogen in the daily life.

**Keywords:** Early puberty; Xenoestrogen; Young females; Saudi Arabia pubertal staging

### Introduction

Xenoestrogen can be defined as artificial estrogens, which are present excessively in the environment, plastic products, pesticides, dry cleaning chemicals, industrial wasteland, and other products of the daily use. Xenoestrogen mimic the effect of endogenous estrogen after binding to estrogen receptors in the human body. Thus, xenoestrogen play a major role in initiating the process of puberty at the early age. Puberty refers to the natural process, in which a child develops physical characteristics. Appearance of secondary sexual development is another major indication of puberty. It has been described that the estrogen hormone usually induces the process of puberty. The release of estrogen in the human body is responsible for initiating the process of puberty naturally. On this basis, it is said that xenoestrogen might result in development of pubertal characteristics in early ages. Moreover, it is also said that xenoestrogen are directly associated with the development of other disorders related to the reproductive system [1]. There are several measures to avoid early puberty as much as possible. Some of the common approaches include replacement of plastic bottles with glass cups, storage of food in glass packaging materials rather than plastics, and avoiding to use canned food and natural cleaning products at home [2]. Not all of these facts and findings have been presented by the research studies, conducted in the population of Saudi Arabia.

### Purpose of the study

The study aimed to investigate the relationship of unusing various xenoestrogen products and the occurrence of early puberty among young females living in Jeddah, Saudi Arabia.

### Material and Methods

#### Study design

A cross-sectional questionnaire-based study design was used for the purpose of data collection and data analysis. A set of standardized data collection sheets entailing a series of questions with multiple answer choices were utilized. The study population was recruited in the study through random selection of the younger girls between the age of 6 and 14 years.

#### Data collection methods

The participants were recruited randomly by investigators from a number of shopping malls in Jeddah, Saudi Arabia and they were directed to an ambulatory clinic at King Abdul-Aziz University Hospital. The study took one complete month for deriving out effective outcomes. Medical doctors helped the investigators in the selection and recruitment of participants. The inquiries made pertained to the exposure of xenoestrogen products, adequacy of nutrition, history of early puberty in the family, and awareness of the topic. For the purpose of this research, the segments involving xenoestrogen

**\*Corresponding author:** Dr. Abdulmoein E. Al Agha, Faculty of Medicine, King Abdul-Aziz University, P.O. Box 80215, Jeddah 21589, Kingdom of Saudi Arabia, Tel: 966-505590459; E-mail: [aagha@kau.edu.sa](mailto:aagha@kau.edu.sa)

**Received** June 12, 2015; **Accepted** July 09, 2015; **Published** July 16, 2015

**Citation:** Al-Agha AE, Aiash D, Tatwany BO (2015) The Relationship between Xenoestrogen Exposure and Early Puberty among Young Females Living in Jeddah, Saudi Arabia. *Fam Med Med Sci Res* 4: 179. doi:10.4172/2327-4972.1000179

**Copyright:** © 2015 Al-Agha AE, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

products included plastic water bottles, children plastic bottles, children toys, plastic packaging materials, women cosmetics, food preservatives, pesticides, and some type of soaps and shampoos. In addition, the participants and their parents were asked about history of early menarcheal age in the family (mothers, siblings and/or aunts). The frequency of using identified products and their effect on early appearance of secondary sexual characteristics was assessed in young females. Data insufficiency in the questionnaires was the only factor for exclusion. Verbal and written approvals from females and their parents were obtained prior to filling questionnaire. Trained medical doctors at the ambulatory clinic collected anthropometric data. Height was measured using a wall-mounted stadiometer, with the children not wearing shoes and their shoulders in a relaxed position and their arms hanging freely. Weight was measured with a beam-balance scale, which was re-calibrated for every new subject. Subjects were weighed barefoot and wearing minimal clothing and BMI was calculated. Tanner staging was done by physical examination and palpating breast tissue of each individual.

This study has defined an early breast development, if has developed before age of 8, early pubic hair appearance before age of 9, and early menarche before the age of 10.

### Statistical analysis

Data entry and analysis was done using SPSS version 21.0. The data were completed from the collected questionnaires. SPSS was also used for the analysis. T-test, Mann-Whitney U test, and Kruskal-Wallis test were used for comparative evaluations of the selected participants. Furthermore, Chi-square test and cross tabulations were also applied for making a comprehensive analysis of the selected data. A p-value of <0.05 was further determined, which was statistically significant.

### Results

The total number of participants was 586, who were recruited in this research project. All of the participants were asked about the usage of the some xenoestrogen products. The findings of the study have mentioned that the percentage of participants who were using water plastic bottles was 92.3%. Out of the total, 78.3% of the sample used plastic packaging materials and 51.9% were using women cosmetics. Total percentage of participants who were adding food preservations was 78.3% (Table 1). All of the previous xenoestrogen products had inverse relation with signs of puberty after testing them with multiple linear regressions. Regarding the usage of children plastic bottles and children plastic toys, the percentage of those who were using them was 83.8% and 66.3% respectively. A significant relationship was present between their frequency usage and the age of pubic hair appearance after testing through chi-square (p-value=0.048), (p-value=0.028) respectively (Table 2). Moreover, there was a significant association between the usage of children toys and the age of breast appearance by using chi-square test (p-value=0.04). Additionally, the participants were asked about the usage of pesticides and certain types of shampoo and soap; 49.2% were using pesticides and 95.2% were using those types of shampoos and soaps at daily basis.

By using chi-square test, the study has found a significant relationship among the usage of children toys and early breast (p-value=0.04) and pubic hair development (p-value=0.028). Children plastic bottles also showed a significant relationship with early pubic hair development (p-value=0.048). This means that there is a decreased in the pubertal age; whenever, there is an increase in the usage of these xenoestrogen products.

As the breast development is the first sign of puberty in females,

the study also observed the relation between age of appearance and the usage of xenoestrogen products with linear regression analysis. The age of breast was kept as the dependent variable and the xenoestrogen products as the independent (Table 3). As shown in Table 1, if the frequency of children's toys usage increased, then the age of breast development will be decreased. The rest of the variables were not significant with the age of breast development; however, some of them have inverse relationship with its appearances. It was also evaluated that if the frequency usage increased, then the age of breast development will appear earlier.

The study has also tested the relationship between the age of menarche and the usage of xenoestrogen products with Multiple Linear Regression analysis. The age of menarche was kept as the dependent variable and the xenoestrogen products as the independent (Table 4). There was no significant connection due to lack numbers of females, who have had their menarche. It was also noted that there were 477 girls, who did not have menarche yet. The test has shown an inverse relationship between the age of menarche and the usage of these products (Table 5). Furthermore, we used chi-square to test the

Xenoestrogen product	Utilization percent
plastic bottles	92.3%
plastic packaging materials	78.3%
women cosmetics	51.9%
food preservatives	78.3%
children plastic bottles	83.8%
children plastic toys	66.3%
pesticides	49.2%
soaps and shampoos	95.2%

**Table 1:** Shows how many people utilize the common Xenoestrogen products in our population by percent.

Xenoestrogen Products	P- value	Relation
Plastic water bottles	0.299	Inverse relation with no significance
children plastic bottles	0.048	Inverse relation and significant
children plastic toys	0.028	Inverse relation and significant

**Table 2:** Shows the relation between Xenoestrogen products and early pubic hair development.

Xenoestrogen Products	(P. value)	Relation
plastic water bottles	0.583	inverse relation with no significant
children's plastic bottles	0.446	inverse relation with no significant
children toys	0.049	inverse significant relation

**Table 3:** The Relation between Xenoestrogen Products and Breast Development.

Xenoestrogen Products	(P. value)	Relation
plastic water bottles	0.583	inverse relation with no significant
children's plastic bottles	0.048	inverse significant relation
children toys	0.028	Inverse significant relation

**Table 4:** The Relation between Xenoestrogen Products and Pubic Hair Development.

Xenoestrogen Products	(P. value)	Relation
children's plastic bottles	0.966	inverse relation with no significant
plastic packing materials	0.351	inverse relation with no significant
women cosmetic	0.654	inverse relation with no significant
food preservatives	0.217	inverse relation with no significant

**Table 5:** The Relation between Xenoestrogen Products and Age of Menarche.

relation between siblings who had early menarche and the utilization of these Xenoestrogen products. The test showed a significant relation between history of early menarche in the family with using children plastic bottles, women cosmetics and some types of soap and shampoos. P-values are shown in Table 6.

In this research, we considered all essential factors in puberty onset such as height, weight, BMI, and nutritional status

The average height in centimeters is  $139.0 \pm 12.3$ , average weight in kilograms is  $37.71 \pm 13.9$ , and the average BMI is  $21.9 \pm 6.71116$ .

The nutritional status was assisted by asking the females and/or their parents about the consumption of certain foods such as chicken, beef, fish, fast food, french-fries, fruits, vegetables, dairy products, caffeine containing drinks and soft drinks. The percentages of these items are shown in Table 7.

## Discussion

Xenoestrogen are estrogen disruptors that mimic the effects of endogenous estrogen [3]. It has been evaluated that the occurrence of puberty is directly associated with the increased levels of hypothalamic gonadotropins releasing hormone. It is a major hormone, which plays a significant role in the secretion of reproductive hormones within human body. It is a fact that GnRH has the capability to trigger the secretion of two major reproductive hormones, which include luteinizing hormone (LH) and follicle-stimulating hormone (FSH). Both of these hormones are released from the anterior pituitary gland. There are various benefits of the release regarding these two hormones. It is because of these hormones that the ovaries start to secrete estrogen. It is also a fact that increased serum level of the estrogen is directly associated with the development of breasts among females [4,5]. After chronic exposure to xenoestrogen products, it has been observed that early signs of the pubertal development occurred without the normal release of gonadotropins [6].

A significant number of studies were selected, which confirmed a positive relationship between using xenoestrogen products and environmental chemical pollutants [3-6]. It has been evaluated by the studies that Dichlorodiphenyldichloroethylene (DDE), phthalates (DEHP) and phenols have adverse effects on the initiation of puberty and appearance of secondary sexual development at early ages in young females. Forty one females in preschool classes have been investigated

in Italy, 34% of them had the onset of secondary breast development before the age of seven in relation to phthalates exposure [2]. In France, 15 girls with premature the larches were interviewed with their parents. 9 girls out of selected participants had an exposure to xenoestrogen products. Further investigations have found an increased level of estrogenic bioactivity in their serum, which may be related to the exposure to estrogen disruptors [7] Dichlorodiphenyldichloroethylene (DDE) is a chemical product found in various types of pesticides, and its effect on early puberty was investigated in several studies. Vasiliu et al., reported that menarche occurred one year earlier in females who were exposed to high amount of DDE [8,9]. A significant relation was confirmed between serum DDE concentration and early menarche before the age of eight in Chinese textile workers [10]. An Italian study reported 17 females with early pubertal signs in relation to synthetic estrogen (mycoestrogenzearalenone). 6 out of the selected participants were found to have elevated levels of this product without having any significant effect on early puberty. However, the study suggested other environmental factors herbicides and pesticides for the elevated levels of estrogen [11]. Moreover, numerous studies have shown the relationship between phthalates and early signs of puberty. One study was done in US, which selected 1151 females aged six to eight years. The girls were exposed to phthalates and phenols, which resulted in the early development of breasts and pubic hair [12]. Another study in China reported that females with early puberty had higher serum DEHP levels than females with onset of pubertal signs at normal age [13]. In a Danish study, females who live in greenhouse were compared to the normal population. It was identified that there was significant relationship between early breast development and pesticides usage [14].

In the current study, it has been found that higher exposure to some xenoestrogen products in early childhood will increase early pubertal signs appearance. It was also found that a significant relationship was present between the usage of children plastic toys and early breast development among 16.7% of the participants. Moreover, it further affects the early pubic hair appearance in 24.5% of the participants. The consumption of children plastic bottles also showed a significant relationship with early pubic hair development among 25.4% participants. The increased frequency usage of water plastic bottles, plastic packaging materials, women cosmetics and food preservatives showed an inverse effect on pubertal signs. Therefore, long time exposure to these xenoestrogen products may increase breast cancer incidence [15,16].

In addition, a significant relation was found between 27.9% of female siblings who had history of early menarcheal age and the use of some types of soap and shampoos. Also, 15.5% of siblings had an early menarche and was significantly correlated with the usage of women cosmetics. At last, we found a significant relation between 19% of siblings who had early menarche and the usage of children plastic bottles.

## Conclusion

The findings of the study has clearly indicated that the use of xenoestrogen products were directly associated with the development of puberty in early ages. Thus, it is advisable to avoid the use of xenoestrogen products in daily basis. Moreover, it was also evaluated that the continuous exposure to the xenoestrogen products will also affect the development of pubertal characteristics. Therefore, it is also recommended to replace plastic cups, plastic bottles, and plastic packaging materials with glasses and other elements. Furthermore, the population should decrease the use of cosmetics and pesticides; in

Xenoestrogen product	P-value
Children plastic bottles	.050
Women cosmetics	.038
Soap and shampoos	.019

**Table 6:** Shows the relation between siblings who had early menarche and utilization of Xenoestrogen products.

Item	Daily %	Weekly %	Monthly %	3/week %	2/month %	Not taking%
Chicken	47.9	21.0	1.1	27.0	.5	2.5
Beef	17.0	37.5	13.1	18.1	3.8	10.6
Fish	12.0	33.0	28.0	7.7	7.0	12.2
Fast food & french-fries	27.3	40.8	8.5	15.7	6.0	1.8
Fruits & veg.	53.2	19.9	7.4	11.8	1.1	6.7
Dairy products	76.4	9.9	1.4	8.8	.5	3.0
Caffeine	18.2	14.1	7.1	5.8	1.9	52.7
Soft drinks	29.0	27.0	7.4	11.1	1.6	23.9

**Table 7:** Percentage of Frequent Consumption of Certain Foods.

order to prevent the occurrence of early sexual development caused by exposure to high levels of estrogen disruptors.

#### Acknowledgements

The authors are grateful for the essential cooperation and the major work that have been done by the statistical analyst Mrs. Ghiras Jamil Softah. We sincerely appreciate her patience and effort since this study would have not been possible without her amazing job. Also, we would like to express our gratitude to the family physician Prof. Fathi Al-jamal – head of family department at Ibn Sena National Collage for his valued revision and assessment of our study statistical analysis. The authors are also thankful to all of the participants and volunteers, who cooperated in data entry process during campaign.

#### References

1. Mueller SO (2004) Xenoestrogens: mechanisms of action and detection methods. *Anal Bioanal Chem*. 378: 582-587.
2. Colon I, Caro D, Bourdony CJ, Rosario O (2000) Identification of phtalate esters in the serum of young Puerto Rican girls with premature breast development. *Environ Health Perspect* 108: 895- 900.
3. Aksglaede L, Juul A, Leffers H, Skakkebaek NE, Andersson AM (2006) The sensitivity of the child to sex steroids: possible impact of exogenous estrogens” *Hum Reprod Update* 12: 341-349.
4. Kase NG, Speroff L, Glass RL (1994) *Clinical gynecologic endocrinology and infertility* (5<sup>th</sup>edn). Baltimore: Williams & Wilkins. 371-382.
5. Roy JR, Chakraborty S, Chakraborty TR (2009) Estrogen-like endocrine disrupting chemicals affecting puberty in humans—a review. *Med Sci Monit* 15: 137–145.
6. Massart F, Parrino R, Seppia P, Federico G, Saggese G (2006) How do environmental estrogen disruptors induce precocious puberty? *Minerva Pediatr* 58 : 247-254.
7. Paris F, Gaspari L, Servant N, Philibert P, Sultan C (2013) Increased serum estrogenic bioactivity in girls with premature thelarche: a marker of environmental pollutant exposure?. *Gynecological Endocrinology* 29: 788-792.
8. Vasiliu O, Muttineni J, Karmaus W (2004) In utero exposure to organochlorines and age at menarche. *Hum Reprod* 19: 1506-1512.
9. Krstevska-Konstantinova M, Charlier C, Craen M, Du Caju M, Heinrichs C, et al. (2001) Sexual precocity after immigration from developing countries to Belgium: evidence of previous exposure to organochlorine pesticides. *Human reproduction* 16: 1020-1026.
10. Ouyang F, Perry MJ, Venners SA, Chen C, Wang B, et al. (2005) Serum DDT, age at menarche, and abnormal menstrual cycle length. *Occup Environ Med* 62: 878-884.
11. Elsevier Health Sciences (2008) Environmental Toxins Linked To Early Onset Puberty In Girls, Study Suggests.
12. Wolff MS, Teitelbaum SL, Pinney SM, Windham G, Liao L, et al. (2010) Investigation of relationships Be Between urinary biomarkers of phytoestrogen, phthalates and phenols and pubertal stages in girls. *Environ Health Perspect* 118: 1039-1046.
13. Chumlea WC, Schubert CM, Roche AF, Kulin HE, Lee PA, et al. (2003) Age at menarche and racial comparisons in US girls. *Pediatrics* 111: 110-113.
14. Andersen HR, Wohlfahrt-Veje CV, Jensen TK, Grandjean P, Skakkebaek NE, et al. (2009) Prenatal pesticide exposure is associated with long term effects on endocrine function in children Poster presentation at Prenatal Programming and Toxicity. Florida: Miami Beach. pp. 7–10.
15. Russo J, Santucci-Pereira J, Russo IH (2014) The genomic signature of breast cancer prevention. *Genes (Basel)* 5: 65-83.
16. Roy JR, Chakraborty S, Chakraborty TR. (2009) Estrogen-like endocrine disrupting chemicals affecting puberty in humans—a review. *Med Sci Monit*, 15: 137-145.