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Xenoestrogen Exposure Affects Early-Onset Puberty Among Young Girls in Western Saudi Arabia: A primary cross-sectional study

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***Abstract*— Background: To investigate the correlation between xenoestrogen and the impact on early pubertal development among young girls in Western Saudi Arabia.**

Methods: This was a cross-sectional study of 794 young girls. Data were collected between June 5, 2016 and August 25, 2016 from the Pediatric Endocrine Clinic at King Abdulaziz University Hospital, Jeddah, Saudi Arabia. The clinical characteristics of the participants were recorded.

Results: The mean age of the participants was 10.87 years. The most common xenoestrogen products used daily included plastic packaging materials (n=353; 44.5%), pesticides (n=351; 44.2%), and plastic water bottles (n=311; 39.2%); the least common product used daily was food preservatives (n=101; 12.7%). There was a significant inverse relationship between the use of plastic packaging materials and age of breast (p=0.027) and pubic hair (p=0.005) development. Furthermore, there was a significant association between the increased use of pesticides and early development of pubic hair (p=0.044). A total of 516 participants were yet to experience menarche, which represented 65% of the total sample size for this study.

Conclusion: There was a direct relationship between the frequent usage of various xenoestrogen products and early development of breasts, pubic hair, and age of menarche among young girls living in Western Saudi Arabia.

***Index Terms*— Xenoestrogen, Early puberty, Saudi Arabia, Tanner scale.**

I. INTRODUCTION

Xenoestrogens are exogenous estrogen-like endocrine disrupting chemicals (EDCs). Xenoestrogens interfere with the synthesis, secretion, transport, metabolism, binding, and elimination of natural blood-borne hormones that are present in the body, and are responsible for homeostasis, reproduction, and developmental processes [1].

Xenoestrogens may exist in naturally occurring substances that are commonly found in various food products, including genistein in soy, or as synthetic compounds, such as pesticides [2]. Xenoestrogens are thought to be present in excessive quantities in the environment, and their harmful effects on humans have previously been demonstrated [3]. As artificial or synthetic compounds, xenoestrogens are found in the environment in the form of chemicals, such as polybrominated biphenyls (PBB), which are found in many domestic and consumer plastic products, including computer monitors and plastic toys for children. Other artificial sources of xenoestrogens in the environment include pesticides, chemicals used for dry cleaning, and landfill sites containing industrial wastes. Once xenoestrogens bind to estrogen receptors in the human body, they are able to exert effects similar to endogenous estrogen. Therefore, xenoestrogens likely have a major role in initiating early puberty.

Puberty is a natural process during which a child develops various physical characteristics that indicate sexual maturation and reproductive capacity [4, 5]. It has been suggested that the release of the estrogen in humans is responsible for inducing the natural process of puberty.

Considering the possible health effects of xenoestrogens exposure, we aimed to investigate whether xenoestrogen exposure influenced early puberty among young girls in Western Saudi Arabia.

II. METHODS

This was a cross-sectional study to collect data from the Pediatric Endocrine Clinic at King Abdulaziz University Hospital (KAUH), Jeddah, Saudi Arabia between June 5, 2016 and August 25, 2016. Data were collected through interviews with the participants. A random selection of young girls who were aged 6−15 years were selected. This study was approved by the Unit of Biomedical Ethics at KAUH (reference number 261-16). Verbal consent was obtained from all participants prior to data collection.

The data collection methods used for this study were similar to the methods used in a similar previous study conducted by Bordini & Rosenfield (2011). Four medical personnel were engaged to help recruit suitable participants for this study. These personnel also helped interview the participants. Mothers accompanied by their daughters within the age range of this study were also invited to participate in the study. The inquiries made by the data collectors included possible exposure of the young girls to xenoestrogen products, the side effects of early puberty, and related concerns.

In this study, individuals were included if they were young girls between the age of 6 and 15 years, healthy, and not known to have any medical illness that could interfere with puberty. Therefore, we excluded individuals with a family

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history of early puberty or who were known to have a medical illness, including a brain tumor, brain defect, congenital adrenal hyperplasia, or hypothyroidism. The age at menarche, breast development, and pubic hair growth was recorded for each participant.

The Tanner scale [6] (Figure 1) was used during the physical examination to categorize the age of onset of breasts development and pubic hair growth in addition to asking the mother for the age at which each pubertal milestone was attained in each participant.

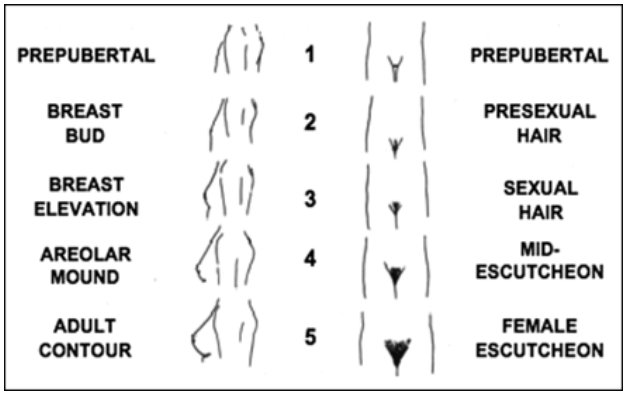

Figure 1. Tanner scale for categorizing pubertal breast development and pubic hair growth in young girls.

Statistical analysis, Data were entered, coded, and analyzed using the Statistical Package for Social Science, version 16. Simple descriptive statistics were reported as proportions for qualitative variables, such as the usage frequency of xenoestrogen materials. Spearman correlation coefficients for ordinal data were obtained, and the relationship between the age of breast development, menarche, or pubic hair growth and the independent variables, which included the usage frequency of various xenoestrogen materials (i.e., plastic bottles, plastic toys, pesticides, food preservatives, cosmetic products, soap, and shampoo), was evaluated. The results were considered statistically significant when $p<0.05$.

III. Results

A total of 794 young girls aged between 6 and 15 years were enrolled in this study; the mean age of the participants was 10.87 years. Of the 794 participants, 625 (78.7%) were of Saudi origin, while 169 (21.3%) were of non-Saudi origin.

While 516 (65.0%) participants had not attained menarche at the time of the study, 8 (1.0%), 93 (11.7%), 154 (19.4%), and 23 (2.9%) participants had attained menarche at an age of 5−7 years, 8−10 years, 11−13 years, and 14−16 years, respectively. Breast development occurred at an age of 5−7 years, 8−10 years, 11−13 years, and 14−16 years in 24 (3.0%), 230 (29.0%), 170 (21.4%), and 7 (9.0%) participants; 363 (45.7%) participants were in the pre-pubertal stage of breast development during this study. Pubic hair growth occurred at an age of 5−7 years, 8−10 years, 11−13 years, and 14−16 years in 19 (2.4%), 116 (14.6%), 168 (21.2%), and 24 (3.0%) participants; 467 (58.8%) participants were in the pre-pubertal stage of pubic hair growth during this study.

The descriptive statistics of the usage of xenoestrogen-containing materials (frequencies and percentages) are presented in Table 1. Notably, the majority of the participants used xenoestrogen-containing materials on a daily basis; 311 (39.2%) families used plastic water bottles daily, 334 (42.1%) children played with plastic toys daily, 353 (44.5%) used plastic packaging materials daily, 265 (33.4%) mothers used cosmetic products daily, 351 (44.2%) used pesticides, and 206 (25.9%) used soap and shampoo daily.

Significant inverse relationships between the use of plastic packaging materials and the age of breast development ($p=0.027$) and pubic hair development ($p=0.005$) were observed. Furthermore, there was a significant association between the increased use of pesticides and the early growth of pubic hair ($p=0.044$). The relationship between the usage of xenoestrogen products and early breast development and pubic hair growth is presented in Table 2.

Participants who did not achieve menarche or were during the pre-pubertal stage of breast development and pubic hair growth during the study were excluded, where applicable, from the subsequent analyses to determine the relationship between the use of xenoestrogen materials and the age of breast development, menarche, and pubic hair growth.

IV. Discussion

The aim of this study was to determine whether xenoestrogen exposure influences early onset of puberty among young girls in Western Saudi Arabia. According to the correlation coefficient analyses, there were significant inverse relationships between the use of xenoestrogen-containing materials and the age at menarche, breast development, and pubic hair growth. The age at menarche, breast development, and pubic hair growth decreased as the usage frequency of xenoestrogen-containing materials increased in young girls.

In several prior studies regarding pubertal timing in girls worldwide, the proportion of girls who showed breast development at 7 and 8 years-of-age, particularly white girls, was greater than that reported from studies of girls born 10−30 years earlier [7]. For example, Herman-Giddens et al. [8] described a cross-sectional study of 17,077 young girls that was conducted by 225 United States-based practicing pediatric clinicians. According to this previous study, the participants developed pubertal traits earlier than that reported in published books. Furthermore, Hua-Mei et al. [9] performed a 2-year cross-sectional study in China to determine the prevalence and mean age of onset of pubertal traits in young girls in urban regions. In this previous study, it was found that the sampled young girls developed pubertal characteristics earlier than the norms. In addition, it was claimed that xenoestrogens were directly associated with the development of other disorders related to the female reproductive system [10]. Some researchers have shown that several chemicals, including dioxins (used in >90% of food and dairy products), DDT, phthalates (widely used in industrial products to achieve flexibility and resiliency), hexachlorobenzene, PCBs, endosulfan, heavy metals,

dichlorodiphenyldichloroethylene, and PBB, are EDCs, which impact pubertal timing [11-13]. Moreover, bisphenol A, which is used extensively in the plastic industry and beverage cans, has been detected in breast milk [14].

In a study of 31 Puerto Rican young girls who were clinically examined for the presence of EDCs or xenoestrogens, higher levels of phthalate esters were found in those with early breast development compared to the control group [15]. Phthalates are types of EDCs used to manufacture various cosmetic and sun cream and soften plastic products. Phthalates are also found in numerous domestic products, including nail polish, hair sprays, shampoo, deodorants, and perfumes [13]. These substances that exhibit xenoestrogen properties are thought to be capable of entering the human body [11]. In a French study of 15 young girls with isolated premature thelarche, parents were asked to provide information regarding EDC exposure. Young girls who were exposed to EDCs (n=9) had a significant increase in the total serum estrogenic bioactivity compared to those who were not exposed to EDCs (n=6). Based on these findings, early breast development might be related to an increased exposure to EDCs [16].

Another type of EDC is 2.5-dichlorophenol (2.5-DCP), which is one of the most commonly used pesticides worldwide. In a study conducted in the United States in 440 adolescents aged 12–16 years, there was a significant association between urinary concentrations of 2.5-DCP and early menarche [17].

The main limitation of this study was the analysis of the relationship between the usage of xenoestrogen products and early puberty in humans. However, this study is one of the few studies conducted in Saudi Arabia to investigate xenoestrogen and its relationship to early puberty. Other limitations included the minimal area covered (i.e., Western region), the relatively small sample size, and incomplete data for some of the participants.

In conclusion, several substances with xenoestrogen properties have been currently reported to influence pubertal development in young girls in Western Saudi Arabia. However, further cross-sectional studies with larger sample sizes are required for further investigation. To prevent early-onset puberty in girls, we recommend the use of ceramic and glassware instead of plastic products, the preservation of food items in glass rather than plastic containers, and the use of natural cleaning products instead of chemically formulated cleaning agents. In addition, the consumption of processed foods, especially canned foods, should be avoided.

Table 1. Usage frequency of xenoestrogen materials by participants.

	Usage frequency, n (%)				
Xenoestrogen material	**Never**	**Rarely**	**Weekly**	**Daily**	**More than twice a day**
Plastic water bottles	52 (6.5)	125 (15.7)	125 (15.7)	**311 (39.2)**	181 (22.8)
Children's plastic toys	40 (5.0)	119 (15.0)	143 (18.0)	**334 (42.1)**	158 (19.9)
Plastic packaging materials	24 (3.0)	85 (10.7)	164 (20.7)	**353 (44.5)**	168 (21.2)
Female cosmetics	23 (2.9)	150 (18.9)	253 (31.9)	**265 (33.4)**	103 (13.0)
Food preservatives	104 (13.1)	**304 (38.3)**	233 (29.3)	101 (12.7)	52 (6.5)
Pesticides	25 (3.1)	107 (13.5)	106 (13.4)	**351 (44.2)**	205 (25.8)
Soap and shampoo	148 (18.6)	189 (23.8)	162 (20.4)	**206 (25.9)**	89 (11.2)

Note: The most frequent responses are emboldened.

Table 2: Spearman correlation coefficients for the relationship between xenoestrogen material use and age at puberty.

Xenoestrogen materials	Age at first stage of breast appearance rho (p-value)	Age at pubic hair appearance rho (p-value)	Age at menarche rho (p-value)
Plastic water bottles	-0.147 (0.002)**	-0.217 (0.0001)**	-0.234 (0.0001)**
Children's plastic toys	-0.150 (0.002)**	-0.180 (0.001)**	-0.118 (0.049)*
Plastic packaging materials	-0.106 (0.027)*	-0.156 (0.005)**	-0.062 (0.305)
Female cosmetics	-0.133 (0.006)**	-0.176 (0.001)**	-0.084 (0.160)
Food preservatives	-0.097 (0.045)*	-0.219 (0.0001)**	-0.154 (0.010)*
Pesticides	-0.037 (0.438)	-0.111 (0.044)*	-0.046 (0.441)
Soap and shampoo	-0.003 (0.948)	0.081 (0.145)	0.114 (0.057)

**Correlation is significant at the 0.01 level; *Correlation is significant at the 0.05 level.

REFERENCES

[1] Roy JR, Chakraborty S, Chakraborty TR. Estrogen-like endocrine disrupting chemicals affecting puberty in humans-a review. Med Sci Monit. 2009;15:RA137-RA145.

[2] Thomson BM: Human health implications of exposure to xenoestrogens from food. PhD [thesis]. http://ir.canterbury.ac.nz/handle/10092/1391. Christchurch: University of Canterbury (2005).

[3] Wozniak AL, Bulayeva NN, Watson CS. Xenoestrogens at picomolar to nanomolar concentrations trigger membrane estrogen receptor-alpha-mediated Ca2+ fluxes and prolactin release in GH3/B6 pituitary tumor cells. Environ Health Perspect. 2005;113:431-9.

[4] Hayward C (ed.). Methodological concerns in puberty-related research. In: Gender differences at puberty. Cambridge: Cambridge University Press; 2003. p. 1-14. http://www.langtoninfo.com/web_content/9780521807043_excerpt.pdf.

[5] Golub MS, Collman GW, Foster PM, Kimmel CA, Rajpert-De Meyts E, Reiter EO, et al. Public health implications of altered puberty timing. Pediatrics. 2008;121:S218-30.

[6] Marshall WA, Tanner JM. Variations in pattern of pubertal changes in girls. Arch Dis Child. 1969;44:291-303.

[7] Biro FM, Galvez MP, Greenspan LC, Succop PA, Vangeepuram N, Pinney SM, et al. Pubertal assessment method and baseline characteristics in a mixed longitudinal study of girls. Pediatrics. 2010;126:e583-90.

[8] Herman-Giddens ME, Slora EJ, Wasserman RC, Bourdony CJ, Bhapkar MV, Koch GG, et al. Secondary sexual characteristics and menses in young girls seen in office practice: a study from the Pediatric Research in Office Settings network. Pediatrics. 1997;99:505-12.

[9] Ma HM, Du ML, Luo XP, Chen SK, Liu L, Chen RM, et al. Onset of breast and pubic hair development and menses in urban Chinese girls. Pediatrics. 2009;124:e269-77.

[10] Mueller SO. Xenoestrogens: mechanisms of action and detection methods. Anal Bioanal Chem. 2004;378:582-7.

[11] Diamanti-Kandarakis E, Bourguignon JP, Giudice LC, Hauser R, Prins GS, Soto AM, et al. Endocrine-disrupting chemicals: an Endocrine Society scientific statement. Endocr Rev. 2009;30:293-342.

[12] Abaci A, Demir K, Bober E, Buyukgebiz A. Endocrine disrupters-with special emphasis on sexual development. Pediatr Endocrinol Rev. 2009;6:464-75.

[13] Özen S, Darcan S. Effects of environmental endocrine disruptors on pubertal development. J Clin Res Pediatr Endocrinol. 2011;3:1-6.

[14] Rubin BS. Bisphenol A: an endocrine disruptor with widespread exposure and multiple effects. J Steroid Biochem Mol Biol. 2011;127:27-34.

[15] Colón I, Caro D, Bourdony C, Rosario O. Identification of phthalate esters in the serum of young Puerto Rican girls with premature breast development. Environ Health Perspect. 2000;108: 895-900.

[16] Paris F, Gaspari L, Servant N, Philibert P, Sultan C. Increased serum estrogenic bioactivity in girls with premature thelarche: a marker of environmental pollutant exposure? Gynecol Endocrinol. 2013;29:788-92.

[17] Buttke DE, Sircar K, Martin C. Exposures to endocrine-disrupting chemicals and age of menarche in adolescent girls in NHANES (2003-2008). Environ Health Perspect. 2012;120:1613-8.