ISSN 1596-3519

Volume 20 Issue 3 July-September 2021

www.annalsafrmed.org

Annals of African Medicine

Wolters Kluwer

Medknow

Original Article

The Relationship between Body Weight and Dietary Habits with Respect to the Timing of Puberty among Saudi Children and Adolescents

Mashael AbdulAziz Shahatah, Alaa Mubarak Jadkarim, Revan Zeiny Banjar, Yousof O. Kabli[1], Asmaa A. Milyani[1], Abdulmoein E. Al-Agha[1]

Department of Paediatrics, Ibn Sina National College, College of Medicine, [1]Department of Paediatric Endocrinology, King AbdulAziz University Hospital, Jeddah, Saudi Arabia

Abstract

Objective: The objective is to investigate the timing of pubertal onset as determined by the development of secondary sexual characteristics in relation to body weight and dietary patterns among Saudi females. **Methods:** Children/adolescents visiting general and endocrinology pediatric clinics in King AbdulAziz University Hospital were invited to participate in this study. Female subjects between the ages of 5 and 20 years were included in this study, and those with syndromic disease, chronic comorbidities, endocrinopathies, organic causes of precocious puberty, positive family history of early pubertal onset, and under chronic medication were excluded from the study. Data were collected through clinical interviews with the consent of the legal guardians, and physical examinations were conducted. **Results:** A total of 164 females were investigated. The mean age of thelarche, adrenarche, and menarche was 10, 11.3, and 12.2 years, respectively. We found a significant correlation between higher weight standard deviation and an earlier age of both thelarche and adrenarche. In addition, daily consumption of fast foods was significantly associated with an earlier menarchal age. Consumption of nonorganic poultry was linked to early thelarche. **Conclusion:** Efforts should be directed to increase public and community awareness that fast food consumption, inorganic poultry, and higher body weight are important modifiable factors that lead to an earlier onset of female puberty across different parameters: breast development, adrenarche, and menstruation.

Keywords: Body weight, diet, early puberty, fast food, nonorganic

Résumé

Objectif: Étudier le moment de l'apparition de la puberté tel que déterminé par le développement de caractères sexuels secondaires en relation avec le poids corporel et les habitudes alimentaires chez les femmes saoudiennes. **Méthodes:** Les enfants / adolescents visitant les cliniques pédiatriques générales et d'endocrinologie de l'hôpital universitaire King AbdulAziz ont été invités à participer à cette étude. Les sujets de sexe féminin âgés de 2 à 18 ans ont été inclus dans cette étude, et ceux atteints de maladie syndromique, de comorbidités chroniques, d'endocrinopathies, de causes organiques de puberté précoce, d'antécédents familiaux d'apparition pubertaire précoce et sous traitement chronique ont été exclus de l'étude . Les données ont été recueillies lors d'entretiens cliniques avec le consentement des tuteurs légaux et des examens physiques ont été effectués. **Résultats:** Un total de 163 femmes ont été étudiées. L'âge moyen de la larche, de l'adrénarche et de la ménarche était respectivement de 10, 11,3 et 12,2 ans. Nous avons trouvé une corrélation significative entre un écart-type de poids plus élevé et un âge plus précoce de la larche et de l'adrénarche. De plus, la consommation fréquente de fast-foods était significativement associée à un âge ménarché plus précoce. Une consommation plus élevée de volaille non biologique était liée à la croissance précoce. **Conclusion:** Des efforts devraient être déployés pour sensibiliser le public et la communauté aux habitudes alimentaires et au poids corporel en tant que facteurs modifiables importants qui favorisent l'apparition précoce de la puberté féminine, indépendamment de leurs effets les uns sur les autres

Mots clés: poids corporel; Puberté précoce; Fast food; non-organique; Régime

Access this article online

Quick Response Code:

Website: www.annalsafrmed.org

DOI: 10.4103/aam.aam_41_20

Address for correspondence: Dr. Abdulmoein E. Al-Agha, Department of Paediatric Endocrinology, King AbdulAziz University Hospital, P.O. Box 80215, Jeddah 21589, Saudi Arabia.
E-mail: aagha@kau.edu.sa

How to cite this article: Shahatah MA, Jadkarim AM, Banjar RZ, Kabli YO, Milyani AA, Al-Agha AE. The relationship between body weight and dietary habits with respect to the timing of puberty among Saudi children and adolescents. Ann Afr Med 2021;20:193-7.

Submitted: 16-May-2020 **Revised:** 14-Jun-2020
Accepted: 08-Sep-2020 **Published:** 17-Sep-2021

Introduction

Puberty is an interval period during which the reproductive axis is activated and secondary sexual characteristics begin to develop in order to achieve full reproductive ability.[1] It usually follows a sequence that begins in females with breast development (thelarche), followed by pubic (pubarche) and axillary (adrenarche) hair growth, and finally ends with the onset of menstruation (menarche). The current physiological age range for onset of puberty in females is between 8 and 13 years, with menstruation starting at about 15 years of age.[2] This is a dramatic decline in the age of puberty onset in comparison to the early 19th century, when the onset of breast development and menstruation averaged around 11 and 17 years of age, respectively.[3,4] The American Psychological Association has stated that an earlier onset of puberty that is within the lower limit of the physiological age range and not precocious was associated with more depressive disorders, substance use disorders, eating disorders, and disruptive behavioral disorders more prominent in females than in males.[5]

The role of several factors in the early onset of puberty has been investigated. Among these, environmental factors were found to be of significant contribution.[6] Examples of these environmental factors include the type of diet[7] consumed and exposure to pesticides.[6] Furthermore, childhood obesity is now considered an endemic struggle for the people of Saudi Arabia due to the predominantly sedentary lifestyle as a consequence of the high-temperature weather through most of the year. Outdoor activity is very limited, and there is high dependence on private transportation, as well as widespread, heavy, and frequent consumption of fast foods and nonorganic poultry. This in turn is precipitating an increase in female earlier-onset puberty, due to the association found between overweight/obesity and early onset of puberty in females.[8] Therefore, this study aimed to investigate the timing of pubertal onset in terms of developing secondary sexual characteristics in relation to body weight and dietary patterns as separate variables that are independent of each other.

Subjects, Material, and Methods

This is a descriptive, cross-sectional study that was carried out between May and October 2019. Ethical approval was obtained from the Research Ethical committee at King AbdulAziz University [refer to appendix A]. The sample included in the study was female children and adolescents between the ages of 5 and 20 years. Verbal informed consent was obtained from legal guardians/parents for the participation of their children in this study. The study adhered to the World Medical Association declaration of Helsinki on medical research involving human subjects.[9]

Sample recruitment was through random selection of patients attending general pediatrics and the pediatric endocrinology clinics at King AbdulAziz University. Data were collected by conducting clinical interviews with the parents/legal guardians, examining the children/adolescents, reviewing medical records, and questionnaires filled by the patients or the parents wherever appropriate. The data collected included a past medical and surgical history, medication history, family history, and age of thelarche, adrenarche, and menarche. Furthermore, a dietary history gathered information on the type of poultry consumed (local organic or nonorganic) and frequency of fast food intake (daily, 2–3 times a week, once weekly, or occasionally), which were the two dietary patterns investigated in this study. Children and adolescents underwent a general physical examination for the assessment of pubertal status. Puberty was evaluated according to the tanner scale.

The final sample size was 164 subjects that met inclusion criteria and were exempt from exclusion criteria and were therefore included in this study. Inclusion criteria were an age between 5 and 20 years, female gender, and Tanner stage of more than or equal to 2. Exclusions were investigated for through taking a comprehensive history and reviewing data present in medical records. They were determined based on factors that could interfere with the timing of pubertal onset. Children with syndromic disease, chronic comorbidities, endocrinopathies, previous exposure to cranial radiotherapy, positive history for sex hormone intake such as contraceptive pills, organic causes of precocious puberty (e.g., hypothalamic-pituitary tumors, hydrocephalus, meningoencephalitis and brain abscess, significant head trauma, and cerebral arteriovenous malformation) positive family history of early puberty, and incomplete data were excluded from the study.

Statistical analysis

Data were checked for completeness, and errors were corrected. Descriptive statistics were used to present all variables. The one-way analysis of variance test was used to compare quantitative and qualitative variables, whereas the Chi-square test was used to compare qualitative variables. The participants were categorized according to weight standard deviation (SD) and were considered underweight if weight SD was below-1, overweight if the value was higher than +1, obese if higher than +2, and normal weight if the SD value was between −1 and +1 SD.[10] The analysis was performed using 95% confidence intervals, with $P < 0.05$ considered statistically significant. We employed the Statistical Package for Social Science, version 23.0 (IBM, Armonk, NY, USA).

Results

A table with demographic and clinical characteristics for our sample can be found in Table 1. A total of 164 females were investigated in this study, weight range was between 17 kg and 78 kg, with a mean weight of 40.6 kg ± 12.2 SD weight SDs ranged between −4.80 and +3.02, with a mean weight SD of −0.15. The weight pattern based on the age can be found in Figure 1. The age of thelarche ranged between 5 and 15 years with a mean age of 10 years ± 1.8 SD The age of adrenarche ranged between 6 and 16 years with a mean age of 11.3 years ± 1.8 SD. The age of menarche ranged between

Table 1: Demographics, clinical characteristics, and dietary outline of our sample

	Minimum	Maximum	Mean±SD	
Age (in years)	5.00	20	11.70±2.80	
Weight (kg)	17.00	78	40.60±12.20	
Height (cm)	111.00	176	141.90±11.00	
BMI (in kg/m^2)	11.70	37	19.80±4.40	
Age of thelarche (in years)	5.00	15	10.00±1.80	
Age of adrenarche (in years)	6.00	16	11.30±1.80	
Age of menarche (in years)	10.00	16	11.90±2.20	
	Daily	**2-3/week**	**Once/week**	**Occasionally**
Fast food consumption (%)	3.7	47.6	36	12.7
	Exposed		**Not exposed**	
Organic poultry (%)	56.1		43.9	

BMI=Body mass index, SD=Standard deviation

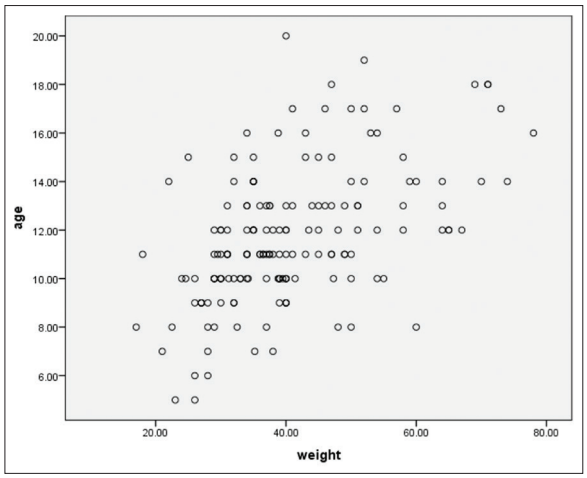

Figure 1: Pattern of weight across different age groups

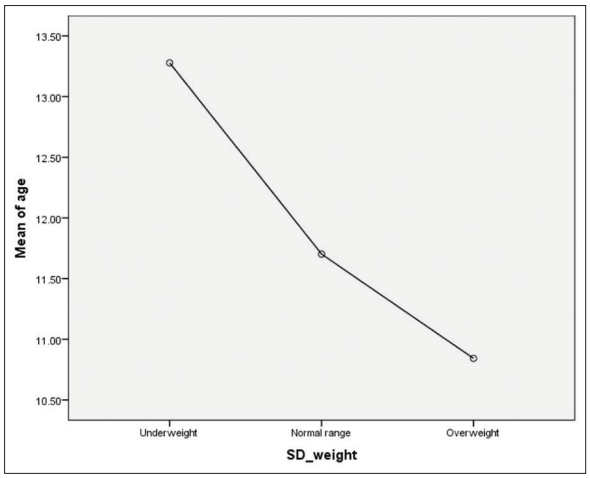

Figure 2: Mean age of each weight category adjusted to age and gender

10 and 16 years with a mean age of 11.9 years ± 2.2 SD. A significant correlation was established between subjects with higher weight SD and an earlier age of both thelarche and adrenarche ($P < 0.05$), whereas no relationship was found between weight SD and age of menstrual onset [Figures 2 and 3]. However, a significant correlation was established between daily consumption of fast foods and an earlier age of menarche ($P < 0.05$). In order to ensure weight SD and frequency of fast-food consumption were not confounding factors, we studied the relationship between fast food consumption and weight SD, and found no significant correlation between them in our sample ($P > 0.05$). This means that those who consumed fast-food daily did not have a high weight SD by means of statistical significance, and so results of earlier pubertal onset in both groups were independent of each other. A positive trend was found between consumption of nonorganic poultry and an earlier age of thelarche**,** but the relationship was not significant ($P > 0.05$).

Discussion

In terms of dietary patterns, we established a significant relationship between daily fast food consumption and an earlier mean age of menarchal onset and a positive trend between consumption of nonorganic poultry and an earlier mean age of thelarche.

Dietary pattern is an important modifiable factor to be considered in all aspects of child growth, development, and puberty. A previous study investigated the role of dietary factors in puberty and subsequently suggested a relevant association, besides that of obesity.[7] Consumption of animal protein has been proven to be significantly associated with an earlier-onset of puberty, whereas high vegetable intake is strongly associated with a later-onset of puberty.[11] One study showed that a diet devoid of chicken and beef significantly delays both the process of puberty and the onset of menarche in females, allowing more time for growth and the possibility to achieve peak height velocity.[12] Another study also yielded positive results on the relationship between animal protein consumption and age of menarche.[13,14] This was further reinforced by another study that suggested that the effect of animal protein on the onset of menarche is more noticeable when children consume animal protein between 3 and 7 years of age.[15,16] This might be explained due to the presence of steroid hormone residues in nonorganic

poultry consumed by children and adolescents causing breast enlargement at an earlier age than anticipated for physiological puberty.[17] Other authors have provided evidence that suggest a protein-mediated enhancement of growth factor expression as an explanation for the earlier pubertal onset experienced with higher animal protein consumption.[18,19]

Additional dietary factors were found to be significantly correlated with early development of secondary sexual characteristics, including the consumption of fried fast foods.[17] One study in China investigated 3 dietary patterns in relation to age of puberty: an unhealthy diet rich in soft drinks, fried food, and desserts; a protein diet rich in dairy products and protein powder; and the traditional diet rich in red meat, white meat, aquatic and sea food, vegetables, and fruits. An unhealthy diet was significantly associated with precocious puberty even after adjustment for age and body mass index.[7] This is in agreement with our findings, as children and adolescents who consumed fast foods more frequently were observed to have an earlier pubertal onset.

Overweight and obesity are believed to influence the age of pubertal onset through the development of insulin resistance, leading to a subsequent increase in circulating serum insulin and diminished levels of sex hormone binding globulin. This in turn increases the bioavailability of estrogen and promotes early thelarche.[20] In addition, the adipose tissue shows peripheral aromatase activity, which catalyzes the peripheral conversion of circulating androgens into estrogen, thus increasing its concentration. Adiposity is directly related to the degree of peripheral estrogen production, with higher concentrations in overweight or obese subjects. Adipose tissue is also regarded as the most predominant site of extra-gonadal estrogen biosynthesis.[21] Furthermore, high circulating levels of leptin are found in overweight and obese children. This is attributed to the degree of leptin-resistance expressed by individuals with high adiposity. Leptin plays a central role in the activation of the GnRH axis by signaling energy abundance through its interaction with kisspeptin, thereby facilitating the initiation of puberty. Children with high SD s of weight are prone to leptin-resistance and high levels of circulating leptin levels, placing them at risk of early puberty.[22] This is supported by the statistically significant ($P < 0.05$) finding in our study of an earlier age of onset of both thelarche and adrenarche in subjects with higher weight SD [Figures 1 and 4].

The significance of this study centers on the detrimental psychosocial consequences that an earlier onset of puberty impacts female children and adolescents. While this was not one of the objectives that were investigated in this study, previous studies have proven a negative psychosocial impact of an earlier onset of puberty on female children and adolescents in particular.[5,23,24] One study has declared that females who have an earlier onset of puberty in comparison to their peers find it more challenging to adjust psychosocially and are more likely to experience negative adverse effects than their peers. These are in the form of depression, psychosomatic symptoms (inorganic abdominal pain, headache, breathlessness, palpitations, and sleep disturbances), eating disorders and body-image dissatisfaction, smoking and substance abuse, poor academic performance, and delinquency.[23]

The cross-sectional/observational nature of the study and the sample size used are some of the limitations of this research.

Conclusion

Our study demonstrates that daily consumption of fast foods and higher weight SD significantly contribute to an earlier onset of puberty in females whereas consumption of inorganic poultry is associated with an earlier mean age of breast development. Because these variables are modifiable, we recommend more efforts toward raising the community's awareness of the need to consume organic poultry, reduce fast-food consumption to an occasional frequency, and target overweight and obesity by promoting physical activity and healthier diets.

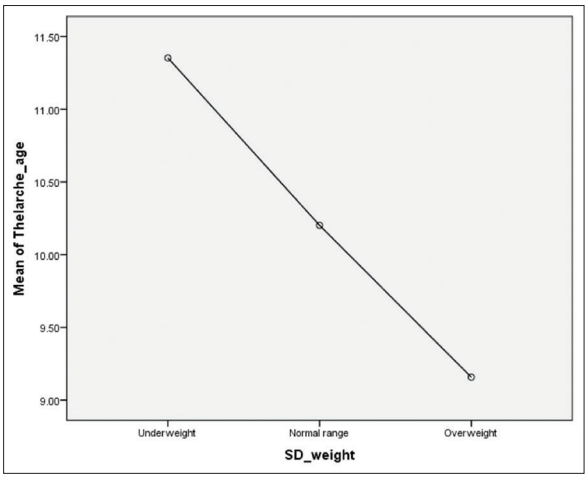

Figure 3: Mean age of thelarche onset across different weight categories in standard deviation

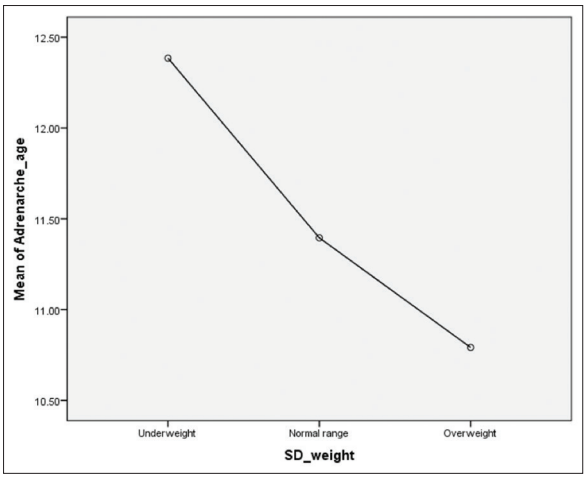

Figure 4: Mean age (in years) of adrenarche onset across different weight categories in standard deviation

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

References

1. Delemarre-van de Waal HA. Regulation of puberty. Best Pract Res Clin Endocrinol Metab 2002;16:1-2.
2. Farello G, Altieri C, Cutini M, Pozzobon G, Verrotti A. Review of the literature on current changes in the timing of pubertal development and the incomplete forms of early puberty. Front Pediatr 2019;7:147.
3. Tanner JM. Trend towards earlier menarche in London, Oslo, Copenhagen, the Netherlands and Hungary. Nature 1973;;243:95-6.
4. Euling SY, Herman-Giddens ME, Lee PA, Selevan SG, Juul A, Sørensen TI, *et al*. Examination of US puberty-timing data from 1940 to 1994 for secular trends: Panel findings. Pediatrics 2008;121 Suppl 3:S172-91.
5. Weir K. The risks of earlier puberty. Monit Psychol 2016;47:40. Available from: https://www.apa.org/monitor/2016/03/puberty. [Last accessed on 2020 Oct 05].
6. Cardenas-Vargas E, Nava JA, Garza-Veloz I, Torres-Castañeda MC, Galván-Tejada CE, Cid-Baez MA, *et al*. The influence of obesity on puberty and insulin resistance in Mexican children. Int J Endocrinol 2018. doi: 10.1155/2018/7067292.
7. Lian Q, Mao Y, Luo S, Zhang S, Tu X, Zuo X, *et al*. Puberty timing associated with obesity and central obesity in Chinese Han girls. BMC Pediatr 2019;19:1.
8. Chung S. Growth and puberty in obese children and implications of body composition. J Obes Metab Syndr 2017;26:243-50.
9. World Medical Association. World Medical Association Declaration of Helsinki: Ethical principles for medical research involving human subjects. JAMA 2013;310:2191-4.
10. World Health Organization. WHO | Overweight and obesity. World Health Organization; 2018.
11. Atay Z, Turan S, Guran T, Furman A, Bereket A. Puberty and influencing factors in schoolgirls living in Istanbul: End of the secular trend? Pediatrics 2011;128:e40-5.
12. Rogers IS, Northstone K, Dunger DB, Cooper AR, Ness AR, Emmett PM. Diet throughout childhood and age at menarche in a contemporary cohort of British girls. Public Health Nutr 2010;13:2052-63.
13. 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.
14. Kaplowitz P. Pubertal development in girls: Secular trends. Curr Opin Obstet Gynecol 2006;18:487-91.
15. World Health Organization. Report of the Commission on Ending Childhood Obesity. Implementation Plan: Executive Summary. Switzerland: World Health Organization; 2017.
16. Ng M, Fleming T, Robinson M, Thomson B, Graetz N, Margono C, *et al*. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: A systematic analysis for the Global Burden of Disease Study 2013. Lancet 2014;384:766-81.
17. Lazzeri G, Tosti C, Pammolli A, Troiano G, Vieno A, Canale N, *et al*. Overweight and lower age at menarche: Evidence from the Italian HBSC cross-sectional survey. BMC Womens Health 2018;18:168.
18. Sheng MG, Ye JC, Ma J, Mi J, Sung RY, Xiong F, *et al*. Waist circumference reference values for screening cardiovascular risk factors in Chinese children and adolescents aged 7-18 years. Biomed Environ Sci 2010;23:21-31. doi: 10.1016/s0895-3988(10)60027-x.
19. Ong KK, Ahmed ML, Dunger DB. Lessons from large population studies on timing and tempo of puberty (secular trends and relation to body size): The European trend. Mol Cell Endocrinol 2006;254-255:8-12.
20. Li W, Liu Q, Deng X, Chen Y, Liu S, Story M. Association between obesity and puberty timing: A systematic review and meta-analysis. Int J Environ Res Public Health 2017;14:1266. doi: 10.3390/ijerph14101266.
21. Barakat R, Oakley O, Kim H, Jin J, Ko CJ. Extra-gonadal sites of estrogen biosynthesis and function. BMB Rep 2016;49:488-96.
22. Reinehr T, Roth CL. Is there a causal relationship between obesity and puberty? Lancet Child Adolesc Health 2019;3:44-54.
23. Mendle J, Turkheimer E, Emery RE. Detrimental psychological outcomes associated with early pubertal timing in adolescent girls. Dev Rev 2007;27:151-71.
24. Kim EY, Lee MI. Psychosocial aspects in girls with idiopathic precocious puberty. Psychiatry Investig 2012;9:25-8.