

Determination the Date of Menarche in a Sample of Girls in Karbala City

Najat Hamzah Hassan

Technical Institute of Karbala/ Al-Furat Al-Awsat Technical University || Iraq

Abstract: The aim of this study is to determine the mean age of menarche among girls in the Karbala city/ Iraq and find the relationship between this age and variables of the study sample. Methodology: Data were collected from 323 girls as a study sample selected randomly from February 2018 to March 2018 from primary and secondary school students. The questionnaire was designed to include two parts, the first part included BMI, educational level, family income. While the second part was specific to the menstruation, including (the first menstrual cycle, menstrual pattern, number of days of menstrual flow, and nature of the menstrual flow). Statistical analysis was carried out using the SPSS program to derive the results of the study (frequencies and percentages, mean and SD, the spearman correlation coefficient to find the relationship and the significance between age at menarche and other variables) Results: The mean age of the girls at menarche was (12.099 ± 1.390) years and most of them have normal BMI (59.8%), sufficient family income (61.3%), moderate in nature of the menstrual flow (54.8%) and regular menstruation pattern (75.2%). The days of blood flow (6 and above) day were (70.3%). There is a significant correlation at 0.01 between age at menstruation and BMI, educational level, family income, and a number of days of menstrual flow. While no significant correlation with the menstrual pattern and menstrual flow of the study sample. Conclusions: Age at menarche among girls in Karbala city is similar to that in other countries were (mean \pm SD) 12.09 ± 1.39 years, most of them have normal BMI and normal Menses characteristics. There is a significant correlation between age at menstruation and BMI, educational level, family income, and a number of days of menstrual flow. While no significant correlation with the menstrual pattern and menstrual flow of the study sample. Recommendations: The age of puberty, which is a manifestation of menarche is an important stage in the lives of girls so must be prepared by educating them about the importance of physical health, healthy diet, and exercise that contributes to improving their reproductive health.

Key words: Determination, date of menarche, sample, girls.

تحديد موعد الطمث لدى عينة من الفتيات في مدينة كربلاء

نجاة حمزة حسن

المعهد التقني كربلاء || جامعة الفرات الأوسط التقنية || العراق

المخلص: هدفت هذه الدراسة إلى تحديد متوسط عمر الفتيات عند أول حيض في مدينة كربلاء/ العراق وإيجاد العلاقة بين هذا العمر ومتغيرات عينة الدراسة. منهجية البحث: تم جمع البيانات من 323 فتاة كعينة دراسة تم اختيارها عشوائياً من فبراير 2018 إلى مارس 2018 من طالبات المدارس الابتدائية والثانوية. تم تصميم الاستبيان ليشمل جزأين، الجزء الأول اشتمل مؤشر كتلة الجسم، المستوى التعليمي، دخل الأسرة بينما الجزء الثاني خاصاً بالحيض، بما في ذلك (موعد أول دورة شهرية، نمط الحيض، عدد أيام تدفق الحيض، وطبيعة تدفق الحيض). أجري التحليل الإحصائي باستخدام برنامج SPSS لاستخراج نتائج الدراسة (التكرارات، النسب المئوية، المتوسط الحسابي، الانحراف المعياري، معامل ارتباط سيرمان لإيجاد العلاقة والدلالة المعنوية بين العمر عند أول حيض والمتغيرات الأخرى) النتائج: متوسط عمر الفتاة عند أول حيض كان (12.099 ± 1.390) سنة وأغلب الفتيات لديهن مؤشر كتلة الجسم طبيعي (59.8%)،

دخل الأسرة كاف (61.3%)، طبيعة تدفق الحيض كان متوسط (54.8%) ونمط الحيض منتظم (75.2%)، وكانت أيام تدفق الدم (6 وما فوق) اليوم (70.3%)، وهناك علاقة قوية بدلالة 0.01 بين عمر الفتاة عند أول حيض، مؤشر كتلة الجسم، والمستوى التعليمي، ودخل الأسرة، وعدد من الأيام من تدفق الحيض، بينما لا يوجد ارتباط مع نمط الحيض وطبيعة تدفق الحيض لعينة الدراسة. الاستنتاجات: العمر عند الحيض بين الفتيات في مدينة كربلاء يشبه العمر في البلدان الأخرى. كان الوسط الحسابي ± 12.09 السنة، معظمهن لديهن مؤشر كتلة الجسم الطبيعي وخصائص الحيض الطبيعية. هناك ارتباط كبير بين العمر عند الحيض ومؤشر كتلة الجسم، المستوى التعليمي، دخل الأسرة، وعدد أيام تدفق الحيض. في حين لا يوجد ارتباط كبير مع نمط الحيض وطبيعة تدفق الحيض من عينة الدراسة. التوصيات: يعد سن البلوغ والذي من مظاهره الحيض وهو مرحلة مهمة في حياة الفتيات، لذلك يجب إعدادهن عن طريق تثقيفهن حول أهمية الصحة البدنية والنظام الغذائي الصحي والرياضة التي تساهم في تحسين صحتهن الإنجابية.

الكلمات المفتاحية: تحديد، موعد أول حيض، العينة، الفتيات، كربلاء.

Introduction

The most important changes that occur during puberty are the occurrence of menstruation and puberty is the transition period between childhood and puberty where growth occurs, secondary sexual characteristics occur, and profound psychological changes in the individual.¹

The term puberty is used to determine the developmental process of physical changes as the body matures from childhood to adulthood. The development of natural puberty results from the continuous activation of the hormone-pituitary-pituitary (HPG) axis.²

Over the past decade, potential progress has been reported in the timing of puberty in the United States. In addition, it was observed in children, especially girls who emigrated to foreign adoptions in many Western European countries early development and increased rate of sexual speed, the potential role of endocrine agents from the environment was considered. These observations urge further studies of the onset of puberty as a possible potential early sign of interactions between environmental conditions and genetic susceptibility that can affect physiological and pathological processes. These observations raise the issues of current differences and secular trends in the timing of adulthood with regard to the ethnic, geographical and socio-economic background. The potential role of endocrine disruptors from the environment was considered.³

The specificity of sexual maturity in human species is the physiological variance of 4 to 5 years of age at the onset of puberty observed among ordinary individuals despite relatively similar living conditions. This discrepancy involves hereditary factors, as studies of genetics in childhood suggest, although molecular determinants have not yet been identified. Other factors such as race, nutritional status, and secular trends have been shown to affect the physiological range of age at onset of puberty.⁴ Researchers and governments have been interested in the age of menarche, where it is important to pay attention to public and social health to see when females in a given population are reaching maturity because of life changes with environmental and social changes. The first menarche of girls is usually a fairly general event.⁵

The age of puberty is a continuation of the evolution of the function of the gonads and the development of the genitourinary system - the pituitary gland from the fetus to full sexual maturity and fertility. During puberty, secondary sexual characteristics appear, and there is an increase in adolescent growth, leading to sexual deformity of mature individuals.⁶

There is wide variation in the normal onset and rate in which a child progresses through puberty, and there are many conditions that may affect this normal process. This variability involves genetic factors, as indicated by the studies on heritability of menarche age. Other factors such as ethnicity, nutritional conditions, and secular trends have been shown to influence the physiological range in age at the onset of puberty⁷. Secular trends appear to influence the physiological range in pubertal onset. The reasons for this secular trend relate to the decline in the severity and frequency of illness and to better health and nutritional status of the general population. These factors, in turn, are the result of improvements in medical care and socioeconomic conditions⁸.

The first menstrual bleeding is referred to as menarche.⁹ That's mean menarche is the onset of menstruation. The average age for menarche in the United States is now 12.8 years. Menarche is preceded by puberty-induced body changes that occur between ages 9 and 16 years. Age at which menstruation occurs is influenced by genetic and environmental factors. Early menses may occur with other conditions such as central nervous system tumors, hypothyroidism, and head trauma. Menarche may be delayed due to malnutrition, or exercise for high levels of exercise such as athletes or dancers, and many medical conditions, such as congenital heart disease, diabetes, and ulcerative colitis. Girls usually show an increase in length only from 2 to 3 inches after the onset of menstruation.²

Menarche typically occurs within 2–3 years after thelarche (breast budding), at Tanner stage IV breast development, and is rare before Tanner stage III development¹⁰ By age 15 years, 98% of females will have had menarche. An evaluation for primary amenorrhea should be considered for any adolescent who has not reached menarche by age 15 years or has not done so within 3 years of thelarche. Lack of breast development by age 13 years also should be evaluated.¹¹

Methods

Data were collected from 323 girls with the first menstrual period in the research year as a randomly selected sample from February 2018 to March 2018 from 8 primary and secondary schools students, in Karbala city, Iraq. Girls with a history of illness were excluded. The questionnaire was designed to cover two parts. The first part includes the level of education (primary and secondary), the family income (sufficient, no sufficient, and fairly sufficient) derived from the student card, and BMI by measuring the weight and height of the girl in centimeters after calculating them by using the formula of $(BMI = \text{weight (kg)} / [\text{height (m)}]^2)$ then the sample was divided into four categories (underweight: below 18.5, normal or healthy weight: 18.5 – 24.9, overweight: 25.0 – 29.9, and obese: 30.0 and Above). While

the second part was concerned with menstrual characteristics, including the age at menarche was divided into three categories (9- 11 years, 12-15 years, and >15 years), menstrual pattern (regular and irregular), number of menstrual flow days (2-3 days, 4-5 days, 6 and above), and menstrual flow nature (light, moderate, and heavy). Statistical analysis was carried out using the frequencies percentages, mean, SD, and the Spearman correlation coefficient was used to find the significance of the correlation between the age at menarche and the other variables by using SPSS program.

Results and Discussion

Table (1) Socio-demographic profile of the study sample (n = 323)

Item	Subgroup	Frequency	Percent
BMI	Less than 18.5	90	27.9
	18.5 to 24.9	193	59.8
	25.0 to 29.9	32	9.9
	30 and above	8	2.5
Educational level	Primary school	169	52.3
	Secondary school	154	47.7
Family income	Sufficient	198	61.3
	No sufficient	84	26
	Fairly sufficient	41	12.7

This table shows that the highest percentage 59.8% of girls have a normal BMI (18.5 to 24.9), 52.3%. The sample was almost equal in terms of educational level, with 52.3% primary and 47.7% secondary and, the family income for the sample was sufficient by 61.3%.

Table (2) Menses characteristics of the study sample (n =323)

Characteristic	Subgroup	Frequency	Percent
Age at menarche	9- 11 years	137	42.4
	12-15 years	170	52.6
	>15 years	16	5
Menstrual pattern	Regular	243	75.2
	Irregular	80	24.8
Number of days of menstrual flow	2-3 days	0	0
	4-5 days	96	29.7
	6 and above	227	70.3
Nature of the menstrual flow	Light	74	22.9
	Moderate	177	54.8
	Heavy	72	22.3

The highest percentage 52.6% of study sample were (12-15 years old), regular menstruation 75.2%, the menstrual flow days were 70.3% for 6 and above, and moderate in the nature of the menstrual flow 54.8%.

Table (3) A descriptive statistic of variables (age at menarche, number of days of menstrual flow, BMI of the study sample (n = 323)

	Minimum	Maximum	Mean	Std. Deviation
Age at menarche	11.00	16.00	12.09	1.39
BMI*	16.20	33.00	21.57	3.90
Number of days of menstrual flow	4.00	8.00	6.04	1.04

* BMI: Body Mass Index

This table shows the means and the standard deviation of age at menarche of girls were (12.09 ±1.39) years between the age of (11-16) years old, BMI (21.57± 3.90) Kg/(m)², and the number of days of menstrual flow (6.04±1.04) days.

In relation to age at menarche, Menarche is the onset of menstruation in girls and occurs approximately 2.5 years after thelarche (mean age of onset is 12.6 years), with some variation depending on ethnicity, the average age of onset of menarche is 12.4 years.² The average age of menarche is 12.5 in the United States.¹² Anytime between 8 and 16 is normal. Most American girls experience their first period at 11, 12 or 13, but some experience it earlier than their 11th birthday and others after their 14th birthday. In Canada, the average age of menarche is 12.72,¹³ and in the United Kingdom, it is 12.9.¹⁴ Many studies have been shown that this result was close to the results of other studies that determined the age at menstruation in many countries where the mean age at menarche of girls were in Switzerland (13.4) years in 1983, Belgium (13.1) years in 1985, South Africa (13.2) years in 1990, Japan (12.6) years in 1992, UK (13.0) years in 1993, Finland (13.0) years in 1993, Italy (12.0) years in 1995, Sweden (13.2) years in 1996, Germany (13.5) years in 1996, Thailand (12.5) years in 1997, Hong Kong (12.4) years in 1997, Denmark (13.0) years in 1998, India (12.1) years in 1998, Iran (12.5) years in 1998, Greece (12.3) years in 1999, Cameroon (13.2) years in 1999, Venezuela (12.6) years in 2000, Netherlands (13.2) years in 2000, USA/NHANES (12.5) years in 2001, Spain (12.6) years in 2002, France (12.6) years in 2006.¹⁵ Other research conducted in Iraq on the mean age of menstruation was as follows: Iraq Baghdad (13.96) years in 1971¹⁶, Baghdad (12.61) years in 2002¹⁷, Iraq (14.0) years in 2008.¹⁸

In our current study and previous studies conducted inside Iraq or conducted in different countries, there is a difference in the means of the age at menarche and these differences are due to two reasons, first, the size of the sample whenever the sample size is large, Whenever the representation of society is properly represented and the other reason is the different factors associated with the age of girl's puberty on the difference of year and the country.

The exact reasons for changing the age at menarche are not specific and multi-factor. Age at menses depends on both genetics and social and environmental experiences. If the age of menarche was determined only by genetics, young girls everywhere will reach menstruation at the same age. However, it is clear that it is not. Thus, the environment and culture also have an impact on the menarche age. Although scientists do not know exactly what triggers puberty in humans, we know that the process begins in the brain with respect to the endocrine system.¹⁹

Steingraber in 2007 stated that the Hypothalamic Pituitary Ovarian axis is an internal monitor, which is very sensitive to disruptions, and can trigger the premature release of estrogen in girls. Therefore, the relationship between the brain and the external environment is a crucial element in the onset of puberty.²⁰ While Delemarre-van de Waal points out that environmental factors can outweigh the effect of genetics on the timing of menstruation, but a genetic predisposition to the timing of menstruation is still to be considered.²¹

Bielski and others suggested that even social factors affect the timing of puberty because children are socially sensitive to the availability and reliability of resources, both biological and emotional.²² It was noted that the average age of menstruation is gradually decreasing. Early-onset of menarche was a risk factor for breast cancer, ovarian cancer, and other diseases.²³ During the last century, there were secular (time-related) trends towards the early onset of menstruation in developed countries, with a decline of two to three months in the decade in Europe and the United States.²⁴ A general improvement in nutrition and health has been proposed to explain the downward trend. The onset of menstruation was seen earlier in developing countries.

Table (4) Correlation between Age at Menarche and BMI of the study sample

Correlations			Age at Menarche	BMI*
Spearman's rho	Age at Menarche	Correlation Coefficient	1.000	.143**
		Sig. (2-tailed)	.	.010
		N	323	323
	BMI	Correlation Coefficient	.143**	1.000
		Sig. (2-tailed)	.010	.
		N	323	323

* BMI: Body Mass Index

** Correlation is significant at the 0.01 level (2-tailed).

Through statistical analysis there was a significant correlation at 0.01 between Body mass index and age at menarche.

A number of studies have observed a relationship between increased body mass index (BMI) and the onset of puberty or menses in the United States and in Europe 2-5. The first association between lipids and preterm puberty does not appear in boys²⁵. There are two weight-related factors associated with age

at menarche: total body weight is measured as body mass index (BMI) and various measurements of fat distribution. The majority of studies supported the relationship between body mass index height in childhood, puberty, and previous age at menarche.²⁶

The Frisch-Revelle hypothesis essentially states that increasing BMI in childhood and adolescence is the most logical interpretation of early age at menarche.²⁷ Overweight in early puberty is associated with increased risk of gaining weight in adulthood. Obesity-related placements were found to have a greater effect on adolescents than adults²⁸. The determination of the leptin gene gave further support for the relationship between excess body fat and early sexual maturity at the molecular level. Leptin stimulates the release of the pulse of the thyroid hormone in the hypothalamus, which acts as a sign of the onset of menstruation.²⁹ The relationship between the early start of menstruation and increased body weight appears to be linked to the ability of leptin to stimulate the release of spring in GnRH. After being produced by fatty tissue, leptin in the hypothalamus is connected to the accumulation of a large amount of fat (about 16 kg) and can begin late puberty. The fact that age at menarche has a negative relationship with leptin concentration is evidence that supports the hypothesis of Fresh Revelle hypothesis.³⁰

It has long been found that body size factors, including height, weight, body mass index (BMI), and body fat percentage are strongly associated with the onset of menstruation. 1.6 Growth relationship in height and weight with menstruation has been studied for a long time.³¹

Table (5) Correlation between age at menarche and educational level of the study sample

Correlations			Age at Menarche	Educational level
Spearman's rho	Age at Menarche	Correlation Coefficient	1.000	.715**
		Sig. (2-tailed)	.	.000
		N	323	323
	Educational level	Correlation Coefficient	.715**	1.000
		Sig. (2-tailed)	.000	.
		N	323	323

** Correlation is significant at the 0.01 level (2-tailed).

In the current study, there is a high significant correlation at 0.01 between age at menarche and the educational level of the study sample. This result is logical because the sample was selected from the girls' students category and having the first menstrual cycle.

Table (6) Correlation between age at menarche and family income of the study sample

Correlations			Age at Menarche	Family income
Spearman's rho	Age at Menarche	Correlation Coefficient	1.000	.172**
		Sig. (2-tailed)	.	.002
		N	323	323

Correlations		Age at Menarche	Family income
		N	323
Family income	Correlation Coefficient	.172**	1.000
	Sig. (2-tailed)	.002	.
	N	323	323

** Correlation is significant at the 0.01 level (2-tailed).

Table (1) shows that approximately two-thirds of the sample (61.3%) belong to households with sufficient income and the table (6) shows that there is a significant relationship at 0.01 between family income and age at menstruation. This result can be explained by the fact that family income, when sufficient, will provide girls the necessary nutrition for the age of puberty because of the basic elements and components of the maturity of growth hormones and thus the onset of menstruation will be in normal time and that any imbalance in nutrition in terms of quantity or quality will lead directly or indirectly to the disturbance in the date of the first menstrual cycle, either be early or late.

Rigon, et al. (2010) said: "Nowadays, socioeconomic factors apparently become less significant for age at menarche as compared to the last centuries when the consistent nutritional deficit was a major problem worldwide".³² However, these factors are still important for low-income countries.

Table (7) Correlation between age at menarche and menstrual pattern of the study sample

Correlations		Age at Menarche	Menstrual pattern
Spearman's rho	Age at Menarche	Correlation Coefficient	1.000
		Sig. (2-tailed)	.
		N	323
Menstrual pattern	Menstrual pattern	Correlation Coefficient	.009
		Sig. (2-tailed)	.869
		N	323

No correlation between age at menarche and menstrual pattern of the study sample show in table (7). Menstrual cycles are often irregular during adolescence, particularly the first cycle to the second cycle. Most females bleed for 2–7 days during their first menses. Immaturity of the hypothalamic–pituitary–ovarian axis during the early years after menarche often results in anovulation and cycles may be somewhat long; however, 90% of cycles will be within the range of 21–45 days, although short cycles of less than 20 days and long cycles of more than 45 days may occur. By the third year after menarche, 60–80% of menstrual cycles are 21–34 days long, as is typical of adults.³³

Neuroendocrine immaturity causing approximately, half of the persistent symptomatic menstrual irregularity, whilst half is due to increased androgen levels. The former condition corresponds to a short/deficient luteal cycle phase, whilst the latter related to polycystic ovary syndrome.³⁴ Initial anovulatory cycles tend to be pain-free, but they can be associated with heavy menstrual bleeding³⁵ because estrogens, as opposed by progesterone, induce an unstable endometrial lining, the breakdown of which causes major uterine bleedings. The cycle length becomes more regular (lower prevalence of oligomenorrhea and irregular cycles) when regular ovulatory cycles commence, but often they become more painful due to increased levels of circulating prostaglandins. This corresponds to the growing prevalence of premenstrual and menstrual pain symptoms, with a higher prevalence of dysmenorrhea at older gynecological ages.

Table (8) Correlation between age at menarche and number of days of menstrual flow of the study sample

Correlations			Age at Menarche	Number of days of menstrual flow
Spearman's rho	Age at Menarche	Correlation Coefficient	1.000	..136*
		Sig. (2-tailed)	.	.014
		N	323	323
	Number of days of menstrual flow	Correlation Coefficient	..136*	1.000
		Sig. (2-tailed)	.014	.
		N	323	323

* Correlation is significant at the 0.05 level (2-tailed).

The results of table (8) showed a significant correlation at the 0.05 level between age at menarche and number of days of menstrual flow of the study sample and table (2) indicates that the menstrual flow days were 70.3% for 6 and above. This result agrees with previous studies which confirmed that most menstrual periods last between 3 and 7 days, and menstruation lasting more than 10 days is abnormal. Signs of maturation of the female body. Usually associated with the ability to ovulate and multiply. However, the appearance of menarche does not guarantee either ovulation or fertility.³⁶

Most females bleed for 2–7 days during their first menses. Immaturity of the hypothalamic-pituitary-ovarian axis during the early years after menarche often results in anovulation.³⁷ A previous study of cycle length and blood flow length showed that 2.5% of girls had cycles shorter than 21 days and 3.4% had longer than 35 days. Less than 4 days of bleeding (less than 4 days) was reported with 3.2% of the whole sample and a long bleeding period (> 6 days) of 19.6% of girls.

Table (9) Correlation between age at menarche and nature of the menstrual flow of the study sample

Correlations			Age at Menarche	Nature of the menstrual flow
Spearman's rho	Age at Menarche	Correlation Coefficient	1.000	.046
		Sig. (2-tailed)	.	.406
		N	323	323
	Nature of the menstrual flow	Correlation Coefficient	.046	1.000
		Sig. (2-tailed)	.406	.
		N	323	323

Through the statistical analysis, there was no association between age at menarche and nature of the menstrual flow as in table (9) and nearly half (54.8%) of the sample have moderate menstrual flow in table (2). This evidence that most girls of the study did not have any menstrual disorders, where about three-quarters of the sample had regular menstruation as shown in table (3), This is due to pituitary, hypothalamic, and ovarian hormones.

Menarche is the result of complex interactions between the pituitary, hypothalamic, and ovarian hormones. It also can be affected by the thyroid, adrenal, and pancreatic hormones. Thyroid hormones are essential for normal menstruation, and their deficiency or excess can interfere with menstruation or lead to a malfunction in current menstrual patterns. Adrenal androgens when abnormally elevated can affect the production of normal ovarian estrogen, as well as reduce the production of the natural pituitary gland for lutein. Low adiposity can lead to normal menstrual inhibition, and it is estimated that a minimum of 17% of body fat is necessary for menstruation, with 22% of body fat necessary to maintain normal menstruation. It seems that leptin plays a role in maintaining normal menstrual cycles as well. Stress and obesity seem to predict early menses.³⁸

Conclusions

Age at menarche among girls in Karbala city is similar to that in other countries were (mean± SD) 12.09 ±1.39 years, most of them have normal BMI, moderate and regular menstruation in the duration of (6 and above) days. There is a significant correlation between age at menstruation and BMI, educational level, family income, and a number of days of menstrual flow. While no significant correlation with the menstrual pattern and menstrual flow of the study sample.

Recommendations

Trends in menarche age should be monitored and time of sexual maturation and its related factors should be taken into account in strategies that aim to health education for girls about menstruation

before it occurs. Girls who are educated about menstruation and early menstrual patterns are less anxiety when they occur.

References

- 1- Rosenfield, RL, Lipton, RB, & Drum, ML. (2009). Thelarche, pubarche, and menarche attainment in children with normal and elevated body mass index. *Pediatrics*, 123:84–8.
- 2- Christopher, C, et al., (2013). Sexual Behavior of Pre-Pubertal Children. *Handbook of Child and Adolescent Sexuality*. University of Oklahoma Health Sciences Center, Oklahoma City, Oklahoma, page 145.
- 3- Anne-Simone Parent, et al. (2003). The Timing of Normal Puberty and the Age Limits of Sexual Precocity: Variations around the World, Secular Trends, and Changes after Migration. *Endocrine Reviews*, 24(5), 668–693.
- 4- Robert, G. (2007). Female Reproductive System. Elsevier's Integrated Physiology book. Pages 177-187.
- 5- M.E., Herman-Giddens (2007). The Decline in the Age of Menarche in the United States: Should We Be Concerned? *Journal of Adolescent Health*. 40,201–203.
- 6- Dennis, MS., & Melvin, MG, (2000). Physiology and Disorders of Puberty. *Williams Textbook of Endocrinology, Thirteenth Edition.*, Pages 1074-1218.
- 7- Parent, AS, Teilmann, G, Juul, A, Skakkebaek, NE, Toppari, J, Bourguignon, JP. (2003) The timing of normal puberty and the age limits of sexual precocity: variations around the world, secular trends, and changes after migration. *Endocr Rev*, 24: 668-693.
- 8- de Muinck Keizer, SM, & Mul, D. (2001) Trends in pubertal development in Europe. *Hum Reprod*, 287-291.
- 9- Tanner, JM, Davies, PS. (1985). "Clinical longitudinal standards for height and height velocity for North American children". *The Journal of Pediatrics*. 107 (3): 317–329.
- 10- Biro, FM, Huang, B, Crawford, PB, Lucky, AW, Striegel-Moore, R, Barton, BA, et al. (2006). Pubertal correlates in black and white girls. *J Pediatr*, 148:234–40.
- 11- Reindollar, RH, Byrd, JR, McDonough, PG. (1981) Delayed sexual development: a study of 252 patients. *Am J Obstet Gynecol*, 140:371–80.
- 12- Rosenfield, RL., (2013). Clinical review: Adolescent anovulation: Maturation mechanisms and implications. *J Clin Endocrinol Metab*, 98:3572–83.
- 13- ACOG Committee on Adolescent Health Care, ACOG Committee Opinion No. 349, (2006). Menstruation in girls and adolescents: Using the menstrual cycle as a vital sign. *Obstet Gynecol.*, 108:1323–8.

- 14- Fraser, IS, Critchley, HO, Munro, MG, Broder, MG. (2007). Can we achieve international agreement on terminologies and definitions used to describe abnormalities of menstrual bleeding? *Hum Reprod.*, 22:635–43.
- 15- Karapanou, O., Papadimitriou, A. (2010). Determinants of menarche, *Reprod Biol Endocrinol.* 30; 8:115.
- 16- Shaker, A. (1971). The Age at Menarche in Girls Attending Schools in Baghdad, *Human Biology* , 43(2): 265-270.
- 17- Najlaa, F., et.al. (2006). Age of Menarche in a Sample of Iraqi Girls and Associated Factors, *Iraqi J. Comm. Med.*, 19 (2):108-112.
- 18- Hamed, Sh., (2009). Onset of Pubertal Growth in a Sample of Iraqi Female Adolescents, *Laboratory assistant Technical College Health and Medical.*
- 19- Dharmarha, N., Konda, A. (2018). A study of the factors affecting the receding age of onset of menarche in young girls, *Int J Reprod Contracept Obstet Gynecol.*, Jul;7(7):2813-2819.
- 20- Steingraber, S. (2007). The falling age of puberty in US girls: what we know, what we need to know. *Breast Cancer Fund: San Francisco*, 2011:72.
- 21- Delemarre-van de, Waal, HA. (2005). Secular trend of timing of puberty. In *Abnormalities in Puberty.* 8:1- 14.
- 22- Belsky, J., Steinberg, L., Draper, P. (1991). Childhood experience, interpersonal development, and reproductive strategy: An evolutionary theory of socialization. *Child Dev.* 62(4):647-70.
- 23- Kapoor, A.K., Kapoor, S. (1986). The effects of high altitude on age of menarche and menopause. *Int. J. Biometeor.* 30: 21.
- 24- Wyshak, G., Frisch, RE. (1982). Evidence for a secular trend in age of menarche. *N Engl J Med*, 306: 1033-5.
- 25- Biro, FM., Khoury, P., (2006). Morrison JA. Influence of obesity on timing of puberty. *Int J Androl*, 29: 272-277.
- 26- X., Guo, & C., Ji, (2011) "Earlier menarche can be an indicator of more body fat: study of sexual development and waist circumference in Chinese girls," *Biomedical and Environmental Sciences*, 24(5): 451–458.
- 27- Frisch, RE., & Revelle, R. (1971). "Height and weight at menarche and a hypothesis of menarche," *Archives of Disease in Childhood*, 46 (249): 695–701.
- 28- Den Hoed, M., Ekelund, U., Brage, S., et al. (2010) "Genetic susceptibility to obesity and related traits in childhood and adolescence: influence of loci identified by genome-wide association studies," *Diabetes*, 59 (11): 2980–2988.

- 29- Von Schnurbein, J., Moss, A., Nagel, SA., et al. (2012) "Leptin substitution results in the induction of menstrual cycles in an adolescent with leptin deficiency and hypogonadotropic hypogonadism," *Hormone Research in Pediatrics*, 77 (2): 127–133.
- 30- Blucher, S., & Mantzoros, CS. (2007). "Leptin in reproduction," *Current Opinion in Endocrinology, Diabetes and Obesity*, vol. 14: 458–464.
- 31- Marshall, WA., Tanner, JM. (1968). Growth and physiological development during adolescence. *Ann Rev Med*, 19:283- 300.
- 32- Rigon, FL., Bianchin, SB., et al. (2010). "Update on age at menarche in Italy: toward the leveling off of the secular trend," *Journal of Adolescent Health*, 46(3): 238–244.
- 33- Hickey, M., Balen, A. (2003). Menstrual disorders in adolescence: investigation and management. *Hum Reprod Update*, 9:493–504.
- 34- Metcalf, MG., Skidmore, DS., Lowry, GF., Mackenzie, JA. (1983). Incidence of ovulation in the years after the menarche. *J Endocrinol.*, 97:213–219.
- 35- McCartney, CR., Gingrich, MB., Hu, Y., Evans, WS., Marshall, JC. (2002). Hypothalamic regulation of cyclic ovulation: evidence that the increase in gonadotropin-releasing hormone pulse frequency during the follicular phase reflects the gradual loss of the restraining effects of progesterone. *J Clin Endocrinol Metab.*, 87:2194–2200.
- 36- Zhang, Z., Hu, X., Yang, C., Chen, X. (2019). Early age at menarche is associated with insulin resistance: a systemic review and meta-analysis. *Postgrad Med.*, Mar;131(2):144-150.
- 37- Flug, D., Largo, RH., Prader, A. (1984) Menstrual patterns in adolescent Swiss girls: a longitudinal study. *Ann Hum Biol*, 11:495–508.
- 38- Lacroix, AE., Langaker, MD. (2019). *Physiology, Menarche*. Treasure Island (FL): StatPearls Publishing, Available from: <https://www.ncbi.nlm.nih.gov/books/NBK470216/>.