An overview of a difficult and unavoidable period in a girl's life: puberty

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Puberty begins in early adolescence and can take anywhere from two to six years to complete. Several consecutive growth processes referred to as “ Tanner stages” are involved in the following manner in girls: (a) breast bud formation; (b) the onset of breast development; (c) the appearance of pubic hair; and (d) finally, menarche (Cobb, 2010). Among these processes, menstruation is a vital stage in the pubertal maturation as it identified as the strongest indicator of maturity in females. It is a sign of the reproductive capacity of women. According to Ellis (2004), numerous researches have been revealed that the association between the early pubertal maturation in girls and a variety of negative health (e. g., unhealthy weight gain, breast cancer, the reproductive system cancer, teenage pregnancy, and low-birth weight babies) and psychological issues (e. g., low body image, depression, anxiety, aggression, and substance abuse). Given these detrimental associations, Ellis (2004) gave warning that it is positively necessary to understand the life experiences and pathways that place girls at risk for early pubertal maturation. Therefore, this paper aims at analyzing different researches conducted on the trend in age at menarche and the individual differences of various cultural cohorts in this age for the young girls.

Given numerous statistical data and literatures, adolescents grow faster and get into puberty at an earlier age today than they did in years past. This phenomenon of the downward tendency in the onset of puberty over generations has been said to reflect a secular trend. This trend has been found since the middle of the 18th century (Stattin & Magnusson, 1990), and it has been well documented that the age of puberty has declined significantly since the 19th and early 20th centuries in Europe and North

America. Menarche can be defined as the age at which the menses commence, and it is only a single event in the combination of physical development in puberty. Therefore, in most studies, mean or median age at first menstruation is considered as an easy, reliable indicator of pubertal development in girls (Danubio & Sanna, 2008; Tanner,###).

An overall declination in female pubertal timing that averaged 4 years in a century was observed (Parent et al., 2016). In Western Europe, the mean age at menarche settled at 12. 5-13. 0 years in all countries' data, and decreased by about 3-4 months per decade from 1830 to 1980 (Eveleth & Tanner, 1990). The established historical pattern of menarche in the United States also reveals that the mean age of menarche has decreased over the past one and a half centuries. During the 1800s, most girls had their first period between 14 to 16 years (Shelley, 2012). The age of menarche declined steadily until the first half of the 20th century. During this time, the average age of menarche declined from between 14 to 16 years in the 19th century to between 12 and 13 years. McDowell and his colleagues (2007) also found that puberty begins earlier than it has in previous years. According to them, mean age at menarche in the United States declined over time from 13. 3 years in the oldest age group, those born prior to 1920, to 12. 4 years in the youngest group, born between 1980 and 1984. It was also reported that this secular trend in all ethnicity groups as well as ethnic differences on mean age of menarche in the United States (McDowell et al., 2007). For example, Caucasian females in the United States experience their first period at the age of 12. 6 years whereas African American females experience their first period at 12. 1 years (Bjorklund, 2012). Similarly,

African American and Mexican American girls reached menarche earlier than European American girls (Casazza et al., 2008; McDowell et al., 2007).

In the 1990s, however, it was observed that menarcheal age has stabilized in some countries, such as Great Britain, Iceland, Norway, Denmark, Hungary, Belgium, Poland, indicating that the secular advancement in pubertal timing has leveled off (Danubio & Sanna, 2008; Parent et al., 2016). Even a slight inversion of the trend was found in Croatia (Prebeg et al., 1994). This recent static trend in menarche was consistent in populations in the United States (Herman Giddens et al., 1997; Malina, 1990; Wyshak, 1983) and Italy (Martuzzi Veronesi & Gueresi, 1994). The reason for this trend will be treated in the next paragraph. Particularly noteworthy is, most recently, that a new trend of changes has been observed in several countries such as the USA, Denmark, and Belgium. Specifically, the changes reflect heterogeneous, suggesting that advancement in age at onset of breast development and less or no change in menarcheal age (recited in Parent et al., 2016).

The secular trend has been attributed to many grounds. Among them the most generally accepted factor is the change of nutrition condition. According to Cobb (2010), a particular proportion of body fat is required for the onset of puberty so as to provide the necessary fat for the increasing metabolism and to provide the protein Leptin, necessary for maturity. In the worldwide, life expectancy changes have been attributed to not only better nutrition and hygiene but also easier and faster access to health care services, and overall improvement in standards of living. Many scholars began to compare the drastic decline in average age at menarche between

the 19th and the 20th century and these life patterns. For instance, Tanner (1978) suggested that improved nutrition and increased standards of living resulting in better health affected the phenomenon of earlier puberty in girls. Furthermore, he appended that this secular trend was reflected by the changes of parents' attitudes toward nurturing and better social, nutritional care of infants (Tanner, 1978; ##### book, 1990). Studies on comparison of age at menarche between industrialized countries and developing countries (or rural vs. urban) as well as their measurement of body mass index (BMI) have supported that the nutrition condition is associated with the age at menarche, indicating the secular trend. According to Shelley (2012), the average age of menarche is lower in adolescents in industrialized nations than in non-industrialized nations. In industrialized nations, adolescents can access proper nutrition and spend most of their time in school or interact with electronics. Television and video-viewing make children vulnerable to obesity. In non-industrialized nations, girls engage in hard physical labor and lack access to proper nutrition. Thus, they experience their first menstruation at a later age. This revelation suggests that changes in body fat are the leading cause of the secular trend and the beginning of puberty. The obesity epidemic in the United States also contributes early pubertal timing. In other words, children with a higher body mass index experience earlier puberty than those with lower BMI. According to Nielsen (2011), children from urban areas who are more exposed to the fatty foods receive their menses much earlier than the rural girls who mostly have not yet fully adopted the fat plenty diet. According to a study by Dossus et. al (2012),

girls who experienced an early onset of their periods were more likely to be overweight and obese.

Another factor regarding the secular trend is increased environmental exposure to endocrine-disrupting compounds (EDCs) in household and personal care items (Louis et al. 2008). EDCs interfere with the endocrine system by mimicking hormones, altering their production and uptake, and deregulating their metabolism. These processes make cells unresponsive to hormonal signals. Subsequently, they interfere with hormonal signals that govern the onset of puberty. High estrogen levels can lead to premature breast budding in girls and early pubertal maturation (Buttke et al., 2012). Furthermore, evolutionary response to a person's environment may lead to early pubertal maturation. A person's body responds to ensure the survival of genes in stressful conditions making one mature early.

Even with the general declining trend, it has been noted there are also high variability in the age at which menarche occurs. This is because the multiple factors come synergistically into play in the onset of puberty. Behavior-genetic study helps to outline the basis of the differences in entry into puberty and menarche. Large twin's studies in the United States, Great Britain, Australia, Finland, and Norway have concluded that genotypic effects result in about 50-80 % of the variation in age at menarche whereas the other variance corresponds to non-shared environmental effects and measurement error (recited in Ellis, 2004). These results imply that the age at menarche not only depends on inherited factors (Gajdos et al., 2010;),

but to some degree, results in the specific environmental features, such as developmental condition(##), climate(##), and altitude (###)

In terms of genetic factors, Cobb (2010) noted that the best estimate of a girl’s menarche is given by knowing the age at which her mother had her first period. This statement means that individual differences reflect a strong genetic influence. What matter is the way in which it is challenging to identify genetic loci. According to Gajdos and colleagues (2010), much progress seems to have been identified genes underlying reproductive endocrine disorder (e. g., hypogonadotropic hypogonadism (HH) and Kallmann syndrome (KS)) and loci related to pubertal timing at 6q21 in or near LIN28B and at 9q31. 2. However, this is just beginning, and thus it needs to continue to identify other loci and other types of variants through large-scale GWA studies (Gajdos and colleagues, 2010).

Interacted with the genetic factors, certain environmental characteristics also are significantly important for the age at menarche. Even though todays, its impact plays less role in the menarche age, there was a deep conviction that climate determined the timing (Eliben and Mascie-Taylor, 2003). For example, South Korea, Indonesia, and Peninsular Malaysia were analyzed to identify the influence of climate on age at menarche. As a result, climate exerts a significant influence on the timing, suggesting that the relatively easy availability of food in the tropics increases energy intake while the absence of cold weather decreases energy expenditure on maintenance and activity as a reason (Sohn, 2016).

a warmer climate causes earlier pubertal onset, while high altitude, isolation, and a rural environment are contributed to delayed menarche (Celik, 2014; Danubio & Sanna, 2008). In addition, Parent and colleagues (2005) found that girls in more industrialized countries showed an early onset of puberty. The industrial emissions have an effect in altering the normal body functions thus affect the releasing of hormones which bring about puberty. In the following study, Parent et al (2016) pointed out the complexity of environmental influences on pubertal timing. For example, increase of environmental hormone (e. g., endocrine-disrupting chemicals) use is also involved in the environmental factors.

Finally, no less significant is the grounds that early life conditions in girls influence on the age at menarche. Early life factors include nutrition and health conditions, birth order, birth weight, body weight, socioeconomic conditions, the absence of father, parents' educational level, income and profession of parents, and psychological issues (recited in nubio & Sanna, 2008). Among these factors, it is very important that reaching a certain proportion of body fat is critical for menarche to occur (Frisch and Revelle, 1969). Bandini and colleagues (2007) described the role of body fat on menarche as follows: body fat plays a role in translating androgens into estrogens, and facilitates a supply of easily converted energy that the body needs, to support a pregnancy, if necessary. More to the point, fat cells secrete the hormone leptin, which triggers an increase in the production of kisspeptin, setting in motion the events of puberty. Furthermore, Lassek and Gaulin (2007) found that the distribution of body fat also contributes to be at least as important as its percentage, with a higher ratio of hip circumference

to waist circumference being associated with earlier menarche. Therefore, girls with higher BMI have been seen to receive their menses earlier and also develop other pubertal aspects at an earlier stage than those with a lower BMI (Nielsen, 2011). Kaplowitz and colleagues confirmed the hypothesis that the earlier onset of puberty could be attributable to the increasing prevalence of obesity in young girls in United States, indicating that whether obesity is an important contributing factor to the earlier onset of puberty in girls (2014).

In addition, a family with limited resources that cannot provide reasonable living in a given environment subjects children to poverty, lack of education, poor housing conditions, and dependency. These conditions delay the age of menarche and cause individual differences at menarche. High education levels among parents coupled with better nutrition and better care in raising children to hasten the growth and maturation of children (Newman, B. & Newman, P., 2009).

Physical activities (e. g., exercise) prevent early pubertal timing, whereas hard exercise delays puberty. Emotional stability also impacts the onset of a girl’s puberty. Maternal depression, poor parental support, the absence of a biological father in a home also contributes to early puberty (Barbaro et al., 2016). This is because that a girl without a biological father has fewer resources and less protection (O’Brien, 2015). Therefore, they reach maturation earlier than girls whose fathers care and provide for them.

In conclusion, an earlier onset of menarche is associated with many adverse health and social outcomes so that it must be understand the mechanism for

the changes of age at menarche. The variance in age at menarche is no longer to be considered under absolutely separate control by genetic and environmental determinants because all factors act synergistically on the onset of menstruation.