INTRODUCTION

1.1 GENERAL INTRODUCTION

The age at menarche or first menstruation is an important maturity indicator for assessment of development status of pubertal female. Puberty is a very important development stage for females. It involves a complex process of biological, morphological and psychological changes that transform the body from that of child to adult. In females puberty is a slow process. During this time, female experiences their first menstrual bleeding known as menarche. A menstrual period consists of shedding of the endometrium as a result of hormonal changes in hypothalamus-pituitary-gonad axis. The axis is stimulated weakly by placental hormones in female fetus and it leads to secretion of gonadotropin releasing hormone (GnRH) in the neonatal period. This hormone decreases and remain minimal adolescence when the occurrence of first menstruation marks its rapid increase (Grumbach 2002; Speroff et al. 1999).

The onset of first menstrual period indicates full sexual maturity, although full biological and emotional maturity occurs much later.

Age menarche is a complex process and involves both genetic and external factors. The external factors include place of residence, physical, activity, body composition, nutritional pattern, body mass index, socio-economic status, stress, migration, ethnicity and chronic illness many of these factors are inter-related to each other.
1.2 SECULAR TREND

It has been observed that age at menarche has been reducing in the past few decades. The age at menarche has declined in developed countries and this decline has also been observed in developing countries during recent years. The age at menarche had declined four months per decade in Britain during the past century while in Norway, Germany and Sweden this age has decreased by 2.5, 3.5 years in last 100 years Tanner (1968), Bodzrar (1988). In India a decrease of 5-7 days per annum was observed in Bengali girls.

The secular trends has generally been attributed to decline in the frequency of illness, improvement in hygiene and housing conditions better nutrition, better health care facilities etc. (Evelveth 1986, Singh & Malhotra 1988). In most developed countries the trend of decreasing age of menarche now seems to have stopped that have occurred in past.

In Europe and North American countries where after rapid decline in age at menarche during late 18th and early 20th century by about a year or so, it got stabilized at around 13 years. (Evelveth 1986, Poppleton and Brown 1966, Tanner 1981, Sandler (1984)and Laseek et. al. 1985) The secular trend is still observed in developing countries due to continuous improvement in nutrition and health (Ghosh et.al. 1973, Sharma et al. 1989).
Age at menarche is clinically valuable since it forms a basis for diagnosing delayed puberty and pathologic and hormonal disorders. There are many health conditions that have strong links to an early age of menarche such as resulting in higher risk of diabetes and hormone related cancers (Chunyan et al. 2009, Karapanou & Anastabios 2010). An early onset of menarche is a risk for breast cancer and could be a result of longer exposure to estrogens associated with menses and pubertal changes (Osuch et al. 2010). Christopher Li and his co-researches found that early exposure to different sex steroids, at early menarche can be a risk for breast cancer later on in life (Li et al 2007). Other than cancer, the exposures to hormones can also affect bone density. If a girl has menarche at an early age, she will be exposed to these sex steroids (i.e. estrogen and progesterone) for a longer duration, which can result in a higher bone mineral density. Having a high bone density will lessen the risk of osteoporosis (Karapanou et.al 2010) Early menarche can correlate with having a shorter stature and being heavier. According to a study in France a girls who start menses early would tend to initiate in sexual behaviours earlier and perhaps other risky behaviour due to early physical maturity (Gaudineau et.al. 2010).

1.3 PHYSIOLOGY

Menarche is the major landmark of puberty for females. Puberty is the process of physical changes by which a child’s body matures into adult body capable of sexual reproduction menarche follows the
appearance of secondary sex characteristics. It is initiated by hormonal signals from the brain to the ovaries. Physical growth i.e. height and weight accelerates in the first half of puberty and is completed when the child has developed an adult body.

1.3.1 Adrenarche

Puberty is proceeded by adrenarche it occurs between ages 6-10 years making an increase of adrenal androgen production. The onset of puberty is associated with high G
\text{\textsubscript{n}}\text{RH pulsing}, which precedes the rise in sex hormones LH and FSH( which in turn act on gonads to secrete sex steroid progesterone and estrogens. G
\text{\textsubscript{n}}\text{RH} is released in pulsatile fashion with low levels during childhood, which increase at puberty.

1.3.2 Thelarche : This is second stage in which breast development starts occurring at about 10.5 years of age.

1.3.3 Pubarche : Pubic hair is often the second noticeable change in puberty, usually within a few months of thelarche.

In the two years following thelarche, the uterus, ovaries and follicles in the ovaries increase in size (Tanner1962)

1.3.4 Menarche : The first menstrual bleeding a referred to as menarche and typically occurs about two years after thelarche. Fat tissues increase in female body in breasts, hips, buttocks, thighs, upper arms and pelvis.
1.4 **Age at menarche and Body Composition**

Body composition refers to relative percentage of muscles, fat, bone and other tissue of which the body is composed. There is a significant relationship between body composition and age at menarche. Early biological changes that precede menarche include the initiation of breast development, pubic hair growth and a rapid increase in height that may begin as early as 9.5 years. The attainment of the most rapid longitudinal growth rate (peak height velocity) typically proceeds the onset of menarche 6 to 12 months (Taner JM 1962). By menarche the young woman has reached about 95% of her adult height. Pubertal girls do not reach peak rate of weight gain until approximately six months after peak height velocity has been attained and this can coincide with menarche. During the peak weight velocity girls gain around 5.5 / 10.6kg / year.

Frisch and Revelle (1971) and Frish (1970) proposed that increased percent of body fat underlies the initiation of menarche. Frisch proposed the weight hypothesis i.e. a critical weight triggers menarche. The weight dependency of menarche, irrespective of a causal relationship reduces variation in body size at maturity by delaying or advancing the age of sexual maturation as a compensation for environmental or genetic variation. Frisch concludes that a female must weigh a minimum of 48kg for menarche to occur regardless of her height and age and a minimum of 17% of body fat is necessary.
These are many studies that support Frisch hypothesis and many which conflict the weight hypothesis. Some investigates reported that chronic under nutrition decreases circulating levels of gonadotrophins, even short term periods of fasting suppress the secretion of these hormones. Again refeeding restores hormone levels before body composition is normalized, suggesting that energy intake may be more important that body fat or fat for resumption. Recent support for the Frisch hypothesis was provided by a report that leptin, an adipocyte-derived cytokine that regulates adiposity, accelerate maturation (Beunen et.al. 1994).

Some studies suggested that fat distribution is related to age at menarche. Girls with early menarche had more centrally distributed fat than girls with late menarche (Van lenthe et.al. 1996).

1.5 PHYSICAL ACTIVITY AND AGE AT MENARCHE

It has been found that strenuous physical activity tends to reduce the age at menarche. The female reproductive system is very intricate and highly sensitive to physiological stress. This increased stress level is often associated with several reproductive abnormities such as delayed menarche, primary and secondary amenorrhea and oligomenorrhea occurring in 6-79% of women engaged in athletic activity (Warren and Perlroth 2001).
The age at menarche is also dependent on the intensity and duration of exercise performed by a girl and also whether they have started exercising before or after menarche. The delay in menarcheal age is more significant in players who started playing before the onset of puberty than those who started after puberty (Sidhu & Grewal 1980). Warren (1980) postulates the hypothesis of energy drain. Warren relates the imbalance of energy intake and energy expenditure to the delay in age at menarche. An energy drain in athletes whose energy expenditure exceeds dietary energy intake appears to be the primary factor effecting GnRH suppression in athletes engaged in sports emphasizing learners; nutritional restriction may be an important causal factor in the hypoestrogenism observed in these athletes (Warren and Perloth 2001).

Some studies suggest that age at menarche is effected by stress from training in athletes Kabir (2005), Baker (1985), Drinkwater et.al. (1984). Sports which emphasize strength over leanness such as swimming and rowing, are not associated with low weight are not associated with low weight and restrictive eating patterns (Brooks-Gunn et.al. 1988) yet athletes in these sports are vulnerable to menstrual irregularities as well due to endocrine imbalance. A second view of the later age at menarche in athletes is that girls who are generally leaner and have low BMI are more inclined towards sports due to the benefit of small physique in some sports like gymnasts,
ballet etc. These girls attain menarche later due to low body fat percentages and small physiques (Malina 1973).

1.6 AGE AT MENARCHE AND NUTRITIONAL STATUS

Nutritional status is the most importance factor affecting age at menarche. All the other factors affecting age at menarche like Physical activity, Body composition and Socioeconomic status are directly or indirectly related to dietary intake. Nutrition has an important bearing on age at menarche. Adolescents gain 50% of adult weight and more than 20% of their adult height during this period. Menarche is attained earlier by well nourished adolescents.

Frisch (1971) explained that a minimum body fat percentage is necessary for the onset of menarche. Frisch & Mc Arthur (1974) that weight loss causes loss of menstrual function & weight gain restores menstrual cycles. So, dietary intake has an important role in attainment of menarche. The delay in menarche is mainly attributed to energy drain i.e. energy imbalance (Warren 1980). As nutritional status improves the age at menarche is lowered.

Some studies suggested that age at menarche age at peak height growth velocity were all associated with diet and body size much earlier in childhood (Berky et.al.). Some studies reported dietary composition is associated with age at menarche (Merzenich et.al. 1973) whereas other studies explained that dietary energy intake is
the only factor associated with age at menarche not dietary composition (Meyer et al. 1990). So Nutritional status has an important role in attainment of menarche, as nutritional status improves, age at menarche is lowered.

1.7 URBAN VS RURAL LIVING

Age at menarche is influenced by place of living. This factor is generally related to nutritional status and activity performed. Rural girls tend to mature later than their urban counterparts. Urban girls appears to be predisposed to early sexual maturation. This can be because of better nutrition improved hygiene, increased social or sexual stimulation and difference in physical activity performed. This phenomenon has been observed in many parts of the world over a long period. As early as 1610, Quarinsonices noted that Austrian peasant girls menstruated much later than the daughters of townsfolk or aristocracy. Wilson and Sutherland (1950.) reported that the mean age at menarche for girls in urban ceylon was 12.84 whereas in rural areas it was 14.39 year. In Southern India, Madhavan (1965) found that urban girls matured earlier than rural girls. Many recent studies also reported difference in age at menarche of rural and urban girls. (Mokha and kaur2006,Ray et al 2010,Rokade and Mane 2010).