Review on Childhood Obesity: Discussing Effects of Gestational Age at Birth and Spotting Association of Postterm Birth with Childhood Obesity

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Abstract:- Overweight and obesity in children and adolescents and its negative effects on health, including increased risks of long-term diseases like type II DM, CVD, dyslipidemia, stroke, hypertension, respiratory issues, gallbladder disease, sleep apnea, osteoarthritis, along with certain malignancies, which are already identified during the perinatal and prenatal period is one of the most important worldwide health concerns of the twenty-first century. To overcome the current epidemic of overweight and obesity, obstructing their risk factors is important in an effort to prevent the development of obesity and overweight. Multiple epidemiological research studies have shown a connection between BMI acquired later in life and birth weight; however, the results are constrained by the absence of information on gestational age. Majority of studies reported relation of childhood obesity with the preterm born children in study of relation with the gestational age. Although more likely to become obese in later adulthood, preterm and low birth weight born child are small and/or lean at birth, whereas post-term usually not and above all, children born postterm showed signs of a rapid weight gain that led to obesity decades early. Thus, the purpose of this review study is to determine the impact of the gestational age at delivery and to provide an overview of the evidence supporting the link between childhood obesity and post-term birth. Thorough systemic review conducted on online database Pubmed, Google Scholar and found only few studies on association with the postterm born children. Limited evidence necessitated the studying of additional adult post-term cohorts to accurately determine future risks to health and to investigate these potential metabolic alterations, as well as if the alterations in adiposity continue or get worse throughout adulthood, and how these correlations vary in adult born post-term in terms of pattern and amplitude.

Keywords:- Gestational Age at Birth (Postterm, Early Term, Full Term, Preterm); Childhood Obesity; Adiposity; Overweight.

I. INTRODUCTION

Obesity in children has emerged as a major worldwide public health challenges[1] and within the course of the last 20 years, its prevalence has sharply increased in many developed nations [2]. The rising prevalence of juvenile obesity and its connection to obesity in adulthood has turned into a worldwide health concern, with a prolonged obese condition raising the risks of consequences related to obesity [3, 4] such as increased incidence of adult obesity related risk of chronic diseases like cancer, cardiovascular disease and type II diabetes, which may precede premature mortality[5-8]. Due to high prevalence and risk of childhood obesity, it must be controlled with immediate and effective interventions with more studies and research required which must focus on providing insights into the underlying modifiable factors of obesity in children.

The term Childhood obesity is the accumulation of extra body fat and the proliferation of excess adipocytes [1]. Body mass index (BMI), which is determined from the individual’s height and weight measurements (BMI = weight/height (kg/m²)), is the recognised clinical reference for assessing overweight and obesity for children aged 2 years and up [9-13]. Generally, BMI provides a decent estimate of adiposity in the healthy paediatric population [14]. However, a significant percentage of children with decreased muscle mass from inactivity may have their adiposity undervalued due to overestimating of fatness in little children or those with relatively high muscle mass [15]. As such, BMI ought to be considered a proxy for obesity [16] and the weight for length is the recognised indicator of obesity and overweight in children under the age of two. With respect to age and sex, BMI varies substantially during early and late stage of life. Consequently, in contrast to adults, BMI cut-off points used to categorise childhood and adult obesity should be sex–age-specific [17]. In order to evaluate abdominal adiposity, waist-to-hip ratio and waist circumference could be the measurement of choice, however, skinfold thickness is useful in determining adiposity [9, 18-21].
The Following are BMI-based Classifications of Overweight and Obesity for Child and Adolescents Ages 2 to 20 Years [12]:

- **Overweight:** BMI more or equal to 85th to less than 95th percentile for sex and age
- **Obesity:** BMI more or equal to 95th percentile for sex and age
- **Severe obesity:** BMI more or equal to 120% of the 95th percentile, or BMI more or equal to 35 kg/m² (whichever is lower) [22, 23]. This correlates to about the BMI z score at or above 2.3 above the mean, or the 99th percentile [24, 25].

Obesity in children is the result of a complicated interaction of several inheritable, ecological and socioeconomical variables, including the family, community, and school [16]. While earlier epidemiologic research focused at risk hazards for childhood and adulthood, current longitudinal research has brought attention to the vital significance of earlier experiences of life, encompassing those that occur prior to birth [26] or prenatal and perinatal variables. Various organ systems’ functional maturation, cellular differentiation and replication, and the rapid growth of the body occur throughout the time from conception to birth [27]. According to study of the literature, relationship among birth weight and birth length with childhood obesity has been documented in a number of research, the majority of which found a positive correlation of birth weight with childhood obesity [28]. However, limited studies have been reported focusing gestational age at birth as the predictors of childhood obesity. The majority of those investigations have demonstrated the correlation of low gestational age or children born preterm and term [29-31] with the childhood obesity with only few study reported association with post-term born children [26, 32-36]

Obesity and overweight and majority of their associated morbidity are preventable. Therefore prevention must be given top attention. Also because of the fact that obesity is notoriously challenging to manage, hence prevention alone is most important step to overcome that epidemic. Inspired by the concept that early life and perinatal environments can have a significant impact on long-term health, a new preventative paradigm has surfaced in the last few years [28]. A broad understanding of the effect of perinatal factors especially gestational age at birth on childhood obesity will aid in directing efforts at intervention and creating successful population-based initiatives and regulations to overcome the epidemic and morbidity related to childhood obesity. For this reason, the goal of this review study is to discuss effects of gestational age at birth and to analyse the association of postterm born children with the childhood obesity. In order to locate journal for this study’s review, a search was conducted using keywords as childhood, children, child, overweight, obesity, BMI, body mass index, adiposity, gestational weeks, gestational age at birth, post maturity and postterm on internet databases PubMed and Google Scholar.

II. EPIDEMIOLOGY OF CHILDHOOD OBESITY

In recent decades, there has been an increase in the prevalence of obesity and overweight among children and adolescents worldwide. [37]. The prevalence varies by age and gender and is highest in western and industrialised nations, but is relatively low in certain developing nations. [17]. As per WHO , the prevalence of obesity and overweight was higher in Americas and eastern Mediterranean areas (30-40%) than in the European region (20-30%), African regions, south-east Asian, western Pacific (10-20% in the latter three) [17]. According to the research, between 1980 to 2013, there is 47.1% increase in prevalence of overweight and obesity combined seen worldwide [38]. In 2013, the overall percentage of boys and girls with overweight or obese were approximately 12.9 and 13.4% respectively in developing nations, while 23.8 and 22.6% respectively were observed in developed nations [38]. An increase in childhood obesity was also observed in China [39, 40]. In China, an estimated 30.4 million people (or 5.1 and 9.9% of adolescents and school-age children, respectively) were overweight or obese in 2010. [41]. The percentage of overweight and obesity among Eastern and western Asia countries was 24.5% and 11.9% respectively [42]. In 2008, 170 million children under the age of 18 were assessed to be overweight or obese, and by 2030, it is predicted that 30% of all children will be affected [43, 44]. Trends in BMI for children and adolescence have accelerated in some parts of Asia and are no longer connected with those of adults, while they have plateaued in many developed nations, despite still being at high levels [45]. Asian countries had the greatest prevalence rate of adolescent obesity, according to a comparison study conducted across emerging nations. [46].

Furthermore, there is variation of prevalence of childhood obesity within nations across Asia: over 65% in the Maldives to 3.5% in rural Bangladesh [47], 30% in Saudi Arabia and Iran and approximately 12.5% in children of China [48]. According to a systematic review and meta-analysis research of Asian countries, the pooled prevalence (overall, girls and boys) of obesity in children aged 5 to 11 years was 5.8%, 4.8% and 7.0% respectively and 8.6%, 6.2% and 10.1% respectively for obesity in adolescents age 12–19 years. Additionally, the percentage of overweight children (overall, girls and boys) were 11.2%, 10.9% and 11.7% respectively; and for adolescents overweight, the percentage were 14.6%, 13.7% and 15.9% respectively [49].

III. AETIOLOGY AND RISK FACTOR OF CHILDHOOD OBESITY

Over the past few decades, there has been a global rise in the prevalence of paediatric obesity. A deeper comprehension of the underlying causes of paediatric obesity is necessary to stop the trend through improved preventive and intervention techniques. [50]. Obesity is the result of complex interactions of multiple factors and the emergence of obesity is strongly influenced by both heredity and the environment. [50]. Pregnant mothers’ lifestyle, early nutrition for their child, and their upbringing environment
are all thought to be important factors in preventing childhood obesity. [51]. Environment, behaviour, genetics and biology which favour an unfavourable balance between an individual's energy intake and expenditure are among the factors that contribute to childhood obesity. [52]. However, there are also other relevant factors including intrauterine factors, physically active, dietary habits, duration of sleep and socio-economic condition [50]. Studies finding relation with maternal and paternal BMI study reported that childhood obesity is related to father’s BMI [53, 54]. The key role in the development of syndrome of metabolism, type II DM and obesity in the offspring is played by the intrauterine environment where the fetus grows [55, 56]. Figure 1 presents the conceptual framework of major risk factor correlated with childhood obesity.

IV. ASSOCIATION OF CHILDHOOD OBESITY WITH PRENATAL, PERINATAL AND POSTNATAL FACTORS

This is the crucial period of foetus and infant when programming of body composition occurs. Infant obesity develops as a result of both prenatal and early postnatal influences, such as intrauterine gain of weight or breastfeeding [57]. Prenatal and postnatal variables that cause excess adiposity in children also affect parental obesity and genetic variations of obesity-related genes in children and parents. [58, 59]. Various research and studies has been conducted till date correlating prenatal and postnatal variables linking emergence of newborn adiposity and obesity in children such as study of preterm and LBW [60-62], diabetes during pregnancy [63], gestational weight gain [64] and formula feeding to the infants [65]. Not only LBW or preterm born children develop adiposity but also term born children of large for gestational age (LGA) [66-68]and small for gestational age (SGA) [69] were affected by the increased adiposity. The overall determinants influencing the infant adiposity and childhood obesity is summarized in Table1.
V. EFFECTS OF GESTATIONAL AGE AT BIRTH ON CHILDHOOD OBESITY

Apart from the various epidemiological studies focusing on the adult and childhood risk factors, a number of recent research has mostly examined early life experiences, as well as perinatal events, such as foetal life. According to numerous studies in the literature, newborn adiposity is a stronger predictor of appropriate intrauterine growth and, as such, may be a better precursor of obesity in later life. A review of the literature revealed that most research observed a positive correlation among newborn weight at birth and childhood obesity, with number of studies examining the correlation of childhood obesity with birth weight and length. However, those studies have to deal with important limitation of incomplete data regarding gestational age.

Gestation is the critical period for human development. Neonatal body composition is influenced by gestation and perinatal factors. During study of infant within 4 days of life, it has been concluded that %BF (percentage body fat) increased significantly with gestational age and also reported in another study that greater adult weight and BMI were correlated with longer gestational age. Gestational age at birth was significantly correlated with child’s BMI in the first decade of life. Various definition of gestation used in the clinical practice in the past and categorized them into prematurity (<37 gestational weeks), term (37-42 gestational weeks) and post term (>42 gestational weeks). Within this 5-week gestational age range of term gestation, there is variance in the increased perinatal and neonatal morbidity especially respiratory disease in newborn which is related to morbidity encountered by both preterm and postterm born children. For this justification, it was believed that additional classifications would be assumed into early term (37 0/7 - 38 6/7 gestational weeks), full term (39 0/7 - 40 6/7 gestational weeks), and late term (41 0/7 - 41 6/7 gestational weeks). This 5-week span is also considered crucial as the foetal maturation pathway seems to be ongoing which is subsequently linked to the children’s short- and long-term morbidity.

After a study of the literature, majority of the studies for various endocrine and metabolic disorders in children and adolescence such as hypothyroidism, insulin insensitivity, overweight and obesity have listed preterm (<37 weeks of gestation) as a risk variable. As preterm children follow their childhood development into school age, their growth differs from that of children born fullterm. The entering phase of growth of preterm born infant adapts to extra uterine environment that could indicate an environment mismatch outside of uterus, resulting in changes to body composition as well as delivery methods. Additionally, the study found that within the first two years of life, extremely preterm (23–27 weeks of gestation) and very preterm (28–31 weeks of gestation) newborns usually experience postnatal growth failure followed by catch-up weight and length growth. Study on association of childhood obesity with entire category of gestational age at birth have reported that extremely rapid weight gain is observed in early term and late preterm born children in the initial 4 month of life which is the significant indicator for obesity tracking up to the age of 7 years. Similar predisposition of early term association was also observed in other study. There aren’t many studies available on the connection between childhood obesity and post-term births, with four studies displaying evidence of positive association with the childhood overweight and obesity, while remaining two studies shows no effect on children’s BMI or adiposity displaying negative association.

VI. ASSOCIATION OF POSTTERM BIRTH AND CHILDHOOD OBESITY

Even though post-term birth has no known long-term consequences, in addition to preterm birth and low birth weight, it has been linked to higher perinatal morbidity and death. Due to a poor foetal environment caused by insufficient nourishment or physiological stress, a prolonged gestation may result in long-term postnatal abnormalities in body composition and detrimental metabolic consequences. It has been proven that the observed metabolic and body composition abnormalities such as high blood pressure, increased fat mass and lower insulin sensitivity in post term children are comparable to small for gestational age (SGA) and preterm born children which was also supported by other studies reporting similar type of abnormalities in adults and children who were born SGA or premature.

<table>
<thead>
<tr>
<th>Table 1 Determinants of Childhood Obesity</th>
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<tbody>
<tr>
<td><strong>Prenatal factors</strong></td>
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<tr>
<td>Pre-pregnancy maternal BMI</td>
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<tr>
<td>Gestational weight gain</td>
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<tr>
<td>Paternal obesity</td>
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<tr>
<td>Gestational Diabetes Mellitus</td>
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<tr>
<td>Maternal malnutrition</td>
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<tr>
<td>Alcohol consumption during pregnancy</td>
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<td>Diet during pregnancy- high free sugar intake,</td>
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<td>less consumption of polyunsaturated fat</td>
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After searching for the association of post-term birth with childhood obesity, only few studies (six) on post-term born children has been found with smaller body of evidence with mixed results regarding their association with childhood obesity evaluating different outcomes in the study. While analysing anthropometry or BMI of children, one study reported that Post-term born children were heavier and had greater BMI than term born children and the marked differences were reported particularly among women born ≥43 weeks of gestation [32]. This finding was supported by other study, reported that post-term boys weighed 11.8 kg more than term subjects and that the overall prevalence of overweight and obesity was 47% in post-term boys and 13% in term boys (P < 0.01) as well as higher weight velocity among them at the age of 16 years.[26]. The only differences among both study was that earlier shows association in women but later had association with post-term born boys. Beltrand et al reported boys, but not girls, showed faster gains in weight in early years of life, increasing the risk of obesity in adolescence and also reported identical growth pattern and BMI in girls born term and postterm [26]. Likewise, on assessment of body composition and insulin sensitivity in postterm born child, revealed lower insulin sensitivity as well as lower FFM and more body fat, including increased central adiposity, truncal fat, and a greater proportion of androgenous to gynaecological fat at the age of 4 to 11 years in postterm children than control term children and also concluded that postterm children were found to be displaying other early marker of metabolic syndrome [33]. On examining the association between gestational age and BMI at different ages, smaller declines in average BMI compared to term infants(37-41 weeks of gestation) were observed among children born very early(<33 weeks of gestation) and early(33-36 weeks of gestation), while late-born children(42+ weeks of gestation) maintained a higher trajectory between 3 and 5 years of age. However, the differences observed in very early and early-born children at 9 months had diminished and were similar to term-born children by the age of 5 years [36]. In contrast, two studies on post term born showed evidence of either no effect on BMI or negative association with childhood overweight/obesity and adiposity. From a recent large-scale study focusing on preschool children which was conducted in China, found that post-term pregnancies not only associated with increased risk of thinness but also a lower risk of overweight/obesity, and overall lower growth parameters [35]. Similarly, research on post-term adolescence’s exercise ability and cardiac function found no appreciable variations in BMI and body composition between post-term and term control children and postterm adolescence was linked to decreased exercise capacity, possibly as a result of modifications to the peripheral vascular system, but no variations in core cardiac function were noted [34]. The various study on post-term born children and its association with childhood obesity is illustrated in Table 2.

<table>
<thead>
<tr>
<th>Authors (year)</th>
<th>No. of Participants</th>
<th>Observation</th>
<th>Final outcome</th>
<th>Evidence of association</th>
</tr>
</thead>
<tbody>
<tr>
<td>Derraik et al. 2016 [32]</td>
<td>Post-term (n = 27 153) Term (37-41 weeks of gestation; n=184245)</td>
<td>Weight, height, BMI</td>
<td>Women born postterm had a BMI 0.2 kg/m² higher and were 0.5 kg heavier than women born at term, considerably born very post-term (≥43 weeks).</td>
<td>Positive</td>
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<tr>
<td>Beltrand et al. 2012 [26]</td>
<td>525 children (including 17 boys and 20 girls born post-term)</td>
<td>Values of height and weight velocity, weight, height, and BMI</td>
<td>In post-term boys, weight velocity was higher (but not height) at ages 1.5-7 and again at 11.5-16 years of age.</td>
<td>Positive</td>
</tr>
<tr>
<td>Ayyavoo et al. 2013 [33]</td>
<td>36 born post-term (18 boys) and 41 (27 boys) born at term (38–40 weeks’ gestation).</td>
<td>Body composition from whole-body DEXA scan.</td>
<td>Compared to term controls, post-term children showed higher central adiposity with more truncal fat and a greater android to gynoid fat ratio, in addition to having more body fat and less fat free mass.</td>
<td>Positive</td>
</tr>
<tr>
<td>Jabakhanji SB et al 2018 [36]</td>
<td>Very early (&lt;33 weeks), early (33-36 weeks), on time (37-41 weeks), and late birth (42 + weeks); n= 10377</td>
<td>Height, weight and BMI at age 9 months, 3 and 5 years</td>
<td>Child born late had a higher BMI. Up to the ages of 3 and 5 years, late children continued on their higher trajectory.</td>
<td>Positive</td>
</tr>
<tr>
<td>Murali et al. 2018 [34]</td>
<td>48 adolescents (56% males) 25 born post term, 23 born at term (37-41 weeks’ gestation)</td>
<td>Whole body DEXA scan,</td>
<td>There were no variation in BMI, %body fat and fat-free mass.</td>
<td>No effect</td>
</tr>
<tr>
<td>Tang J et al. 2022 [35]</td>
<td>Post term children (&gt;42 weeks’ gestation); n=2369 post-term</td>
<td>Weight, height, BMI and BMI-for-age z score, weight-for-age</td>
<td>Children born at postterm had significantly lower BMI-for-age z score, weight-for-age z score, and</td>
<td>Negative</td>
</tr>
</tbody>
</table>
### VII. CONCLUSION

The prevention of childhood obesity is the topic of discussion nowadays because of its increasing incidence worldwide as well as long-term obesity related health consequences in later life. Also preventing and managing postterm pregnancy should be in consideration because of greater perinatal mortality and morbidity. This review study has found mixed result with comparatively more study stated that postterm birth is more prone to increase the risk of metabolic syndrome, overweight, obesity and insulin resistance in both male and female in adult life together with reduced capacity of exercise in postterm born adolescents. Further, the post-term born children showed evidence of exhibiting additional early metabolic syndrome indicators, such as increased body fat and central adiposity. Therefore, we speculate determining these associated variables may aid in identifying high-risk women who are pregnant and creating individualised therapies to lower the likelihood of postterm delivery. We discovered limited evidence of association of childhood obesity with post-term born children, which made it necessary to research more post-term cohorts in adulthood in order to accurately determine the long-term health hazards linked to longer gestation or postmaturity. Future research is required to investigate these potential metabolic alterations as well as whether the alterations in adiposity continue or intensify into adulthood, and the trend and strength of these relationships vary in adult post-term births.

### REFERENCES


