Nutrition and obstructed labor1–3

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ABSTRACT Obstructed labor is one of the most common preventable causes of maternal and perinatal morbidity and mortality in developing countries. Among the common causes are cephalopelvic disproportion, malpresentation, and malposition. Recognizing the causes of obstructed labor is important if the complications are to be prevented. Adequate prevention, however, can be achieved only through a multidisciplinary approach aimed in the short term at identifying high-risk cases and in the long term at improving nutrition. Early motherhood should be discouraged, and efforts are needed to improve nutrition during infancy, childhood, early adulthood, and pregnancy. Improving the access to and promoting the use of reproductive and contraceptive services will help reduce the prevalence of this complication.

KEY WORDS Obstructed labor, cephalopelvic disproportion, supplementation, intergenerational effects

INTRODUCTION

Nutrition is important in reproduction, including the safe delivery of infants. Philpott (1) and Moller and Lindmark (2) showed that failure to achieve a normal delivery was directly related to the height of the mother, which is influenced by nutritional status in childhood and adolescence. Flattening of the pelvis is generally associated with a height < 152 cm (3). Other factors that can cause poor or distorted pelvic growth are rickets in infancy and childhood and osteomalacia in adolescence and adulthood (4). Early studies of the African pelvis showed that although the brim of the pelvis has a normal female shape, it is markedly smaller in all its diameters, and the resulting disproportion between the fetal head and the maternal pelvis (cephalopelvic disproportion) is a major indication for cesarean delivery due to obstructed labor (5).

Obstructed labor occurs when the passage of the fetus through the pelvis is mechanically obstructed. When it is not diagnosed quickly, or when it is improperly managed, obstructed labor is associated with significant complications. It is a major cause of maternal mortality, accounting for 1–5 deaths/1000 live births (6–9). In Bangladesh, for example, obstructed labor was found to be the third most common cause of maternal mortality in one study (10) and the most important cause of mortality in another (11). In addition to its effects on maternal mortality, obstructed labor can be a significant contributor to infant perinatal morbidity and mortality (6).

The prevalence of obstructed labor varies from one country to another, but it is more common in developing countries (12) because of the lack of adequate health care delivery facilities, poor nutrition, poverty (13), and socioeconomic and cultural factors that oppose orthodox antenatal care and delivery (14). In developing countries, the incidence of obstructed labor is difficult to estimate, primarily because of poor data collection procedures and secondarily because most of the reported studies are based on data from large, tertiary hospitals. Nevertheless, reported incidences vary from 1–2/100 deliveries in Nigeria (6, 15) to 3/100 deliveries in India (16). Estimates of these incidences are independent of cesarean delivery rates because most obstructed labors in developing countries were (4)—and are still—being treated by destructive operative deliveries (see below) rather than by cesarean delivery (JC Konje unpublished observation, 1998).

In cultures where child marriage is common and pregnancy occurs soon after menarche, obstructed labor can be common because young adolescent girls may not have achieved their maximal growth potential and thus start childbearing with an inadequate pelvis (17). Obstructed labor can also occur in subsequent pregnancies in which maternal nutrient deprivation may result in a distorted pelvis, or in women prone to pelvic fractures and other acquired pelvic deformities (4). Nutrient deficiencies such as calcium, vitamin D, folic acid, iron, and zinc deficiencies interact in combination with various biological and biosocial factors to determine the prevalence of obstructed labor (4). This article discusses the potential role of nutrition in the origins of obstructed labor and possible preventive nutritional measures.

ETIOLOGY

The most common cause of obstructed labor is disproportion between the fetus head and the mother’s pelvis. Occasionally, however, obstruction is secondary to malpresentation, malposition, and fetal abnormalities, especially in women who deliver at home unattended, or with the help of an untrained midwife (6).

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The availability of ultrasound for detection of obstructed labor reduces the prevalence of malpresentation complications, but this is not often an option for most women in developing countries. Although there are many other causes of obstructed labor (18–23), their contribution is small compared with that secondary to disproportion, and they are non-nutritional in origin.

**Short stature**

Many studies that examined anthropometric measures as predictors of fetomaternal disproportion provided evidence that the shorter a woman is, the more likely is significant disproportion between the fetus and the maternal pelvis, which results in obstructed labor (24–31). Although maternal height can predict the risk of obstructed labor, it is also an index of a woman’s general health and nutritional status from her childhood, in which genetic factors play a major role. Thus, the obstetric significance of a particular height needs to be related to the patient’s own genetic background (2, 33). This is exemplified by the various cutoff points that have been identified in different studies as being associated with or predicting an increased risk of obstructed labor. For example, associations have been identified for heights ≤150–153 cm in Ghana (27, 33), <155 cm in Burkina Faso (29), <156 cm in Denmark (34), ≤150 cm in Kenya (35), <146 cm in Tanzania (36), and <140 cm in India (37); cesarean deliveries were predicted by a height <160 cm in Zimbabwe (38) and ≤157 cm in the United States (39).

**Calcium**

Even after growth in height has stopped, there is a continuous need to lay down calcium in bone to maintain bone structure and, therefore, the shape of the pelvis. Calcium deficiency affects the bony pelvis. Severe deficiency causes rickets in children and causes osteomalacia in adults. Unlike rickets, which affects bones before the closure of the epiphyses, osteomalacia causes decalcification of fully formed bones. Osteomalacia is seldom seen in first pregnancies unless rickets in childhood has been followed by persistent vitamin D deficiency in puberty (4). Osteomalacia can develop after several pregnancies and worsens without treatment (4). Osteomalacia in women is more common in rural and economically deprived areas where lactation by the already nutritionally deprived women is prolonged and, additionally, the interval between pregnancies is not long enough to allow for replenishment of calcium stores (4). Although Bruunvand et al (40) reported that vitamin D deficiency, which can cause osteomalacia and subsequent maternal pelvic deformities, is common in Karachi, it was not associated with obstructed labor. What is uncertain is the severity of vitamin D deficiency in these communities. Mild deficiencies alone are not enough to cause osteomalacia.

Defective calcium absorption or poor bioavailability are causes of vitamin D deficiency and, therefore, osteomalacia (41), which may cause pelvic deformities and subsequently obstructed labor. In fact, Chaim et al (42) observed a few cases of pelvic deformities of the osteomalacia type in Bedouin women who consumed large quantities of raggif, an unleavened bread with a high content of phytic acid. Insufficient dietary intake of vitamin D compounded by inadequate exposure to sunlight, which reduces the synthesis of vitamin D from cholecalciferol in the skin, are other factors that can cause osteomalacia. Vitamin D deficiency often occurs in situations in which calcium intake or bioavailability is also precarious because this enhances the metabolic inactivation of vitamin D (43).

**Macronutrient intake and weight gain in pregnancy**

The demand for both energy and nutrients is increased during pregnancy. For well-nourished women, only a small amount of additional energy is required because the body adapts to the increased energy demands and becomes more energy efficient by reducing physical activity and lowering the metabolic rate. It is only during the last trimester of pregnancy that average-sized, well-nourished women require an extra ~489 kJ/d (44). Research on pregnancy weight gain in women with normal prepregnancy weight showed that high gestational weight gain increases birth weight (45). Studies of white and Asian women, who are at a high nutritional risk in the West Midlands, England, and in Indonesia, showed that protein-energy supplementation during pregnancy did not significantly affect birth weight and length (46, 47). Similarly, Kramer (48) concluded that prenatal protein-energy supplementation proffered little benefit to either mothers or infants. Other studies, however, have shown that protein-energy supplementation of pregnant women at risk of delivering a low-birthweight infant enhanced intrauterine growth (49–53).

Garner et al (54) suggested that interventions to increase birth weight could be hazardous to women because they could lead to more mechanical difficulties in labor in areas where access to the proper care might not be available. Few data are available to support this hypothesis. Prenatal supplementation (60 mg Fe and 250 μg folate, with or without 15 mg Zn) in Peru produced no effect on birth weight or head circumference (55). Goldberg et al (56), however, found that daily supplementation with 25 mg Zn in early pregnancy for women with relatively low plasma zinc concentrations was associated with greater infant birth weights (126 g; P < 0.03) and head circumferences (0.4 cm; P < 0.02). This effect was greater in women with a body mass index <26 (expressed in kg/m²), in whom birth weight was 248 g higher (P = 0.005) and head circumference was 0.7 cm larger (P = 0.007). Ceasay et al (52) found a small (3.1 mm) but statistically significant (P < 0.01) increase in head circumference with daily high-energy supplementation (4.3 MJ), which translated into an increase of only 1.5 mm in diameter, which is unlikely to increase the prevalence of cephalopelvic disproportion.

Secular studies of birth weight showed an increase across generations with no reported adverse effects (57), presumably because other secular changes in maternal proportions also occur and this increase in fetal size does not create cephalopelvic disproportion. Li et al (58) found that mean birth weights of infants born to Southeast Asian parents who were born outside the United States increased annually by ~18 g (95% CI: 11, 25 g) between 1908–1981 and 1986. A similar secular change of birth weight during the same period was not observed for infants of US-born Asian mothers. This, the authors suggest, shows that migration from their native countries to the United States had a positive effect on the birth weight of infants born to these mothers. Secular changes in birth weight were also observed in Asians living in England (59). Infants of migrant Pakistanis were 139 g heavier and those of migrant Indians 25 g heavier in 1978 than they had been 10 y earlier, reinforcing the concept that environmental factors play an important role in intrauterine growth.

Despite the absence of any negative effect of supplementation on obstructed labor, the situation may be different for women whose skeletal—and, therefore, pelvic—growth was restricted during childhood and early adolescence but whose general food intake increased later. Abitbol et al (60) reported that mothers born and raised outside of the United States (with narrow pelvic
dimensions) who eat a high-protein diet and receive adequate prenatal care after migrating as adults to the United States give birth to relatively large infants. This results in a marked cephalopelvic disproportion and severe dystocia, which frequently leads to cesarean delivery. Observations from the United Kingdom (JC Konje, unpublished observations, 1999) show that fetomaternal disproportion is more common in first-generation than in second-generation minority groups. These effects are more marked in women who are shorter and by inference more growth retarded.

CONSEQUENCES OF OBSTRUCTED LABOR

Once obstructed labor has been diagnosed, the obstruction must be relieved. The method of relief will be determined by various factors, including the state of the mother, the state of the fetus, associated complications, and the environment. The initial steps should be adequate resuscitation of the mother by rehydration and intravenous provision of fluids and energy, and, when infections are thought to have supervened, antibiotics. Immediately thereafter, the fetus must be delivered. When the fetus is alive, a safe delivery for both the mother and the fetus must be the option. When the fetus is dead, most women in developed countries will be offered a cesarean delivery. In developing countries, management should aim to reduce complications and simultaneously ensure that the woman and her family maintain some confidence in the health care facility. Often, this may mean a destructive operation rather than a cesarean delivery. This is important because women with obstructed labor often avoid hospitals in the first instance because of fear of cesarean delivery (3). Moreover, performing a cesarean delivery that does not result in a live baby will further reinforce a woman’s fears and result in her delivering at home in subsequent pregnancies, which increases the risk of uterine rupture and possibly maternal mortality (61).

If improperly managed, obstructed labor is associated with very severe complications. These are related to unrelieved pressure on the bladder, rectum, and lumbosacral trunk of the sacral plexus and to the method of delivery of the fetus. Some of the more common complications that can be considered nutritionally relevant are high perinatal morbidity and mortality (62), infections of the uterus and the urinary tract (6), maternal mortality (10, 11, 63–65), and secondary amenorrhea (66).

PREVENTION

Breaking the intergenerational cycle of growth failure

An intergenerational cycle of ill health and growth failure has been described in which undernutrition in childhood leads to small body size in adulthood. The critical periods are the intrauterine period, early childhood, and adolescence.

Intrauterine growth

Genetic and environmental influences affect maternal height and prepregnancy weight, both of which are important determinants of birth size (67). Malnourished women (ie, women who are short, underweight, do not gain sufficient weight during pregnancy, or are anemic) are more likely to deliver intrauterine-growth-restricted or low-birth-weight infants (68–70). Low birth weight and intrauterine growth restriction are not independent because birth weight is affected by intrauterine growth and gestation age; thus, both conditions need to be optimized to reduce the prevalence of low birth weight. Prentice (71) reviewed food-supplementation programs targeted at pregnant women and concluded that supplementation during late pregnancy can have a significant beneficial effect on birth weight in women who are genuinely at risk as a result of an inadequate home diet. The effect of food supplements will depend most likely on the nutritional status of the woman, which is multifactorial, and few good intervention studies have been conducted. Efforts to reverse intrauterine growth restriction have been disappointing and at times risky (72). Nevertheless, Strauss (72) agrees with Prentice (71) that energy supplementation in undernourished populations may be of significant benefit.

The concept of altering food and energy supplementation to influence intrauterine growth and therefore reduce fetal size and obstructed labor as proposed by Rush (73) is not justified. This is not only because of the multifactorial nature of fetal growth, but also because embarking on such a policy is not only unethical, it is also scientifically flawed. Having access to nutrition education during pregnancy is a fundamental human right and to not promote adequate food intake just because women are short, to theoretically reduce the risk of obstructed labor, is unacceptable in our contemporary world. There is epidemiologic evidence linking intrauterine growth and adult diseases such as diabetes mellitus, ischemic heart attack, and early death from stroke and hypertension (74). Deliberately withholding nutrition education or food supplementation during pregnancy may indirectly condemn offspring in future generations to these complications. There is insufficient justification on the basis of available evidence for such programmatic action.

Maternal micronutrient status may also affect the status of young offspring. A longitudinal study in Malawi among HIV-seropositive mothers showed that maternal vitamin A deficiency was related to linear growth of children after adjustment for confounding factors. At 1 y of age, children of vitamin A–deficient mothers were shorter than children of nondeficient mothers (75).

Ramakrishnan et al (76) examined the intergenerational effects of growth by using data from 14 studies of middle-class populations in developed countries. Overall, for every 100-g increase in maternal weight at the time of birth, child birth weight increased by 10–20 g. In a prospective analysis of data from Guatemala, Ramakrishnan et al (76) found that child birth weight increased by 29 g for every 100-g increase in maternal birth weight, which was almost double that reported for developed countries. Child birth weight increased by 53 g per 1-cm increase in maternal birth length, but this was reduced to 38 g/cm after maternal height and prepregnancy weight were controlled for, which the authors suggested was due to the intergenerational effects of maternal birth size. Child birth length also increased by 0.2 cm per 1-cm increase in mother’s birth length and by 0.1 cm per 100-g increase in maternal birth weight, although the former was not significant after adult size was controlled for.

Growth in childhood

The most striking effects of the intrauterine environment on childhood growth are seen in children with intrauterine growth restriction, who remain significantly lighter and shorter than their peers (72). There is some tendency for catch-up growth in low-birth-weight children, but the deficits can persist even up to 12–14 y of age (77, 78); children at greatest risk of long-term stunting were low-birth-weight infants who were also severely stunted during infancy. The potential for catch-up growth in a
cohort of Filipino children aged 2–12 y was greatest for children with greater growth potential, ie, those with taller mothers, longer length and lower ponderal index at birth, and less severe stunting during early infancy (78).

Poor food intake in early childhood is known to affect long-term physical growth (79, 80). The effects of single micronutrient supplementation on growth were also studied. Vitamin A supplementation had no effect on linear growth for preschool boys and girls in randomized supplementation trials in Indonesia (81), India (82), and the Sudan (83). The situation of linear growth with iron is equivocal. Among iron-deficient children (1.5–13 y of age), growth was improved after 8–15 wk of iron supplementation (84–87), although Gershoff et al (88) and Mgasena et al (89) did not confirm these findings. Angeles et al (87) attributed the improvement in growth to reduced morbidity after iron supplementation. Allen (90) suggested that these mixed results may reflect the short duration of the interventions. Alternatively, the treatment effect may occur only if the child was initially anemic.

Brown et al (91) conducted a meta-analysis of 25 zinc intervention trials of children 0–13 y of age (mean: 3.6 y). Zinc supplementation had a significant effect on height (0.22 SD units), and the effects were greatest for the children who were the most zinc deficient or the most growth stunted. A randomized, controlled trial among rural Zimbabwean schoolchildren, however, found no effect of zinc supplementation on growth (92). Only one study was found that looked at the effect of multiple micronutrient (ie, vitamins A, C, D, E, K, B-12, B-6, niacin, thiamine, riboflavin, folic acid, pantothenic acid, iodine, iron, zinc, copper, manganese, and fluoride) supplementation on the growth of children aged 8–14 mo in a double-blind, community-based, randomized trial (93). Treatment was administered under supervision 6 d/wk over 12 mo. Final length in the supplemented group was 0.6 cm greater than in the placebo group after background variables were controlled for. Nevertheless, the effect was lower than expected for catch-up growth, which led the authors to suggest that supplementation with more than the apparently deficient nutrients is required. Allen (90), in her summary of a review of nutrient deficiencies and linear growth faltering, noted that single nutrient supplementation has not had the effect on growth that would be expected if the nutrient were limiting. She too suggested that multiple—rather than single—growth-limiting nutrient deficiencies coexist in children.

Adolescent growth

Brabin and Brabin (94) looked at adolescence, which is an intense anabolic period during which requirements for all nutrients increase. They suggested that the process of catch-up growth may increase nutritional risk because it reduces stores of critical micronutrients such as iron and vitamin A. On the basis of studies showing improved growth after iron supplementation, Brabin and Brabin also postulated that iron is an essential nutrient for skeletal growth and that deficiency may limit growth during adolescence. Similarly, on the basis of data from Swedish adolescents that showed an association between serum retinol and puberty stage, they suggested that vitamin A is important for sexual maturation and that deficiency can cause menstrual irregularities, such as menorrhagia, and thus contribute to anemia. Illich-Ernst et al (95) performed a longitudinal study to look at, among other things, the simultaneous effect of growth and menarche on iron stores in adolescent girls. They found that the adolescent growth spurt and menstrual losses adversely affected iron stores in girls with low iron intakes (<9 mg/d). Delayed puberty has been reported in low-birth-weight children (96, 97), although Bhargava et al (98) documented an earlier onset of menarche in these children in a longitudinal study.

Pregnancy in adolescence imposes an even greater physiologic burden on girls, which is often worsened by poor dietary intakes and failure to use antenatal care optimally. Increased extraction from the adolescent parturient of nutrients (eg, iron, folic acid, and essential amino acids) when there are inadequate stores will result in deficiency and its consequent complications. Because adolescents are still growing, the implications of deficiency are restricted growth and fetopelvic disproportion that may result in obstructed labor.

Although a considerable amount of work has been invested in supplementing preschool children, few data are available to indicate whether food or micronutrient supplementation of girls during the rapid preadolescent growth phase can increase attained height, which could ultimately contribute to reducing maternal morbidity and mortality from obstructed labor.

Improved health

Growth in length is also compromised by common childhood infections, particularly diarrheal diseases in early childhood (99, 100). Infants with sustained Helicobacter pylori infection also grow less well than do children without the infection (101). Single and multiple helminthic infections have been shown to be associated with growth retardation (86) and catch-up growth has occurred in preschool-aged children after deworming (102, 103). Deworming school-aged children was also shown to improve physical growth (104). The adverse effects of chronic and acute infections on linear growth may result from micronutrient malnutrition or the induction of the acute phase response and production of proinflammatory cytokines that can affect long bone growth (99).

In some societies, a large number of adolescents are sexually active, resulting in a high prevalence of sexually transmitted diseases (105), such as HIV (106, 107), syphilis, and chlamydia (108). Some of these diseases are more prevalent in undernourished and immunocompromised individuals. Improved nutrition may, therefore, enhance growth not only directly but also indirectly by improving the immunologic status of adolescents.

To improve the health of women of reproductive age, health care providers need to be trained to identify women at high risk of obstructed labor (and other pregnancy complications) and the factors that can diminish this risk. Improving the utilization of health care facilities during pregnancy, especially in areas with early adolescent marriage, and the introduction of nutrition education and supplementation programs could reduce the prevalence of obstructed labor.

CONCLUSIONS

Obstructed labor remains a common cause of maternal morbidity and mortality in developing countries. However, the prevalence and incidence rates are unknown. Even in developed countries, intervention often occurs before labor becomes obstructed; thus, it is difficult to determine true incidence and prevalence rates. Eliminating obstructed labor will be difficult unless adequate data on prevalence become available; to this end, a better definition of an acceptable international standard for the diagnosis is needed, probably under the auspices of the...
World Health Organization. For example, a clear distinction has to be made between prolonged labor (resulting from inertia) and obstructed labor (which is mechanical). In this regard, there is the need to reeducate midwives, physicians, and all health care personnel. Population-based studies in different geographic zones will provide the necessary data on the prevalence rate of this complication of pregnancy. This can be achieved only through cooperation among governments; voluntary agencies; and primary, secondary, and tertiary care providers. A more effective means of assessing prevalence may be hospital cesarean delivery rates for failure to progress in labor due to disproportion. Such data, however, are likely to be biased toward urban areas and possibly the middle and upper classes. Nevertheless, these data can help to improve the standardization of data collection and provide a better understanding of the magnitude of the problem for programmatic action.

A major cause of obstructed labor is fetomaternal disproportion. Intergenerational cycles of chronic undernutrition, which may include calcium deficiency, are responsible for this in a large proportion of cases. Because of this, it may take more than one generation to overcome the effects of childhood disadvantage; the most effective way to reduce the incidence of obstructed labor is, therefore, to adopt measures to improve the health and nutrition of children during their rapid periods of growth, i.e., infancy, early childhood, and adolescence. This means that an efficacious policy would be one that included effective interventions initiated from as early as infancy to beyond the conventional preschool years. Such programs must not only concentrate on nutrients that enhance skeletal growth but also aim to improve the general nutrition of the infant, child, and adolescent girl. Interventions should include infection control, the provision of hematins, and, in some situations, calcium supplements.

Efforts must be made to increase the awareness of the importance of good health, especially during the adolescent period, including the need for a balanced diet and the elimination of infections in early childhood that commonly exist in malnourished children. Such infections potentiate the effects of nutrient deprivation on growth. Policies that encourage formal education of young women, delay the age of marriage, and promote family planning and contraceptive use may result in the age of first pregnancy being delayed and, therefore, increase the chance of girls completing adolescent growth.

For women who are undernourished and who have not achieved their full growth potential (i.e., have a small pelvis), macro- and micronutrient supplementation may be important for fetal growth. Intrauterine growth can influence child and adolescent growth, and the effect is intergenerational. For this reason, it is likely to take a few generations to achieve secular changes in growth that will reduce and possibly even eliminate obstructed labor. There may be some justification in trading a transient increase in cesarean delivery for disproportionate to future reduction in stunted growth and thus the eventual elimination of obstructed labor. However, the theoretical fear of increased obstruction can be obviated by the inclusion of an education program that encourages women in rural communities to accept orthodox health care and by a simultaneous increase in the number in health care centers and personnel in such communities.

REFERENCES
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