Chapter 3
Obstructed Labour: The Classic Obstetric Dilemma and Beyond

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Lay Summary The obstetric dilemma (OD) theory proposes that walking on two feet (bipedalism) favours narrower hips, while the large human brain favours wider hips with a more spacious birth canal through which the baby's head can pass. These competing demands on pelvic size and shape were argued to have resulted in a tight fit between foetal head size and the maternal birth canal, causing a long, painful childbirth and high risks of obstructed labour in humans. While this 'classic' OD has been widely accepted among anthropologists and medical researchers as an explanation for the human pattern of childbirth, obstructed labour may not be an inevitable consequence of the OD. Rather, rates of obstructed labour may vary over space and time in relation to more recent changes in growth, diet, weight and health resulting from alterations to our environment (both natural and caused by humans). Importantly, this suggests that the modern burden of obstructed labour, which accounts for up to 14 % of maternal deaths in low- and middle-income countries, can be reduced by focussing on lifestyle factors. Changing the typical birth posture may also help, and a closer examination of parental and foetal body measurements may aid in identifying the mothers most at risk of labour complications.

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3.1 Introduction

The OD [1] suggests that humans have a uniquely protracted, painful birth with increased risk of obstructed labour (where mechanical problems such as a large foetal head, shoulder dystocia or malpresentation of the foetus prevent its passage through the birth canal [2]) because two key characteristics of our species place antagonistic demands on pelvic form [3–5]. Bipedalism was proposed to favour a narrow pelvis for efficiency [6], while the exceptionally large size of the human brain necessitated a larger pelvis with a more spacious birth canal, resulting in a tight fit between foetal head and maternal bony birth canal. The OD has become widely accepted in anthropology and medicine, and blamed for a variety of birth complications including cephalopelvic disproportion, shoulder dystocia, and rising Caesarean rates [7–9]. However, this classic notion of a persistent OD leading to birth complications among humans is increasingly being challenged. In this chapter, we briefly outline some recent challenges to the OD and then focus on the link between the OD and obstructed labour in contemporary population. Rather than seeing obstructed labour as an inevitable outcome of the OD, we evaluate how rates probably vary temporally and between populations as a result of the influences of lifestyle and environmental conditions on maternal and offspring phenotype. By providing insight into the causes of such problems, an evolutionary view offers novel perspective on appropriate strategies to manage and reduce their impact.

3.2 Research Findings

3.2.1 Pelvic Morphology, Parturition and Locomotion

Proponents of the OD argue that the close fit between neonatal head size and the birth canal led to the evolution of uniquely human prolonged and painful labour, necessitating a rotational birth mechanism, assistance during childbirth, and increasing rates of maternal and/or neonatal mortality due to obstructed labour [4, 10, 11]. However, the uniqueness of these characteristics is open to question, and more fundamentally, evidence for key assumptions underlying the OD has been challenged [12–14], as we review briefly here.

The existence of selective constraints of bipedalism on pelvic morphology is not well supported. The alternative proposal that a broader pelvis offers greater walking efficiency [15] has recently been supported by empirical studies (summarised in [14, 16]). In addition, while shorter individuals generally have smaller pelves, birth canal size is maintained among certain recent small-bodied populations despite an absolutely narrower pelvis, suggesting a wider birth canal is compatible with adequate locomotor efficiency [17, 18]. Furthermore, pelvic breadth is also under climatic selection [19–21]. If the heat-retaining benefits of greater pelvic breadth in cold conditions outweigh hypothetical penalties in locomotor efficiency, it makes

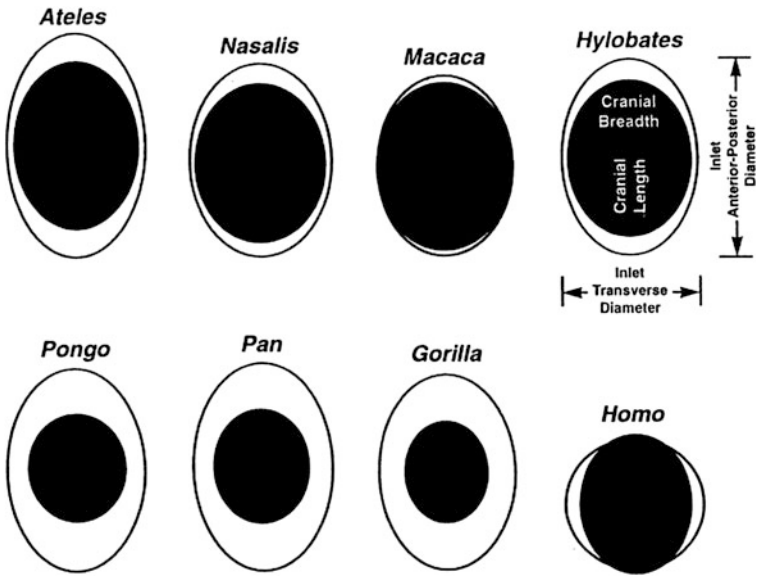

Fig. 3.1 The relationship between maternal pelvic inlet and neonatal head size in various primates, including our closest relatives the great apes (*bottom row*) (as redrawn in [4]). *Ateles:* spider monkey, *Nasalis:* proboscis monkey, *Macaca:* macaque, *Hylobates:* gibbon, *Pongo:* orang-utan, *Pan:* chimpanzee, *Gorilla*: gorilla and *Homo:* modern humans

little sense that pelvic dimensions could not increase to alleviate obstetric problems, which are likely under strong selection [22].

There also appears to be scope for natural selection to have decreased obstetric constraints on pelvic morphology. The relatively close fit between neonatal head size and maternal bony birth canal is not uniquely human [23] (Fig. 3.1). Some mammals have a much greater degree of disparity between neonatal and maternal pelvic canal size than humans, yet solutions to the problem have evolved in those species. For example, in free-tailed bats, the maternal intrapubic ligament stretches to $\sim$15 times its usual length during birth [24]. Significant increases in human bony birth canal size could be achieved with relatively small increases in diameter that fall within existing variation in humans, suggesting that the OD could have been relieved relatively easily by natural selection. A mere 3 % increase in maternal pelvic canal diameter would permit a 10 % increase in neonatal brain size and so reduce the OD substantially [25]. There is also evidence to suggest a degree of uncoupling between locomotor and obstetric features of the pelvis in our evolutionary lineage, allowing more independent evolution of these characters than in great apes [26]. Finally, the bony birth canal is as variable as other pelvic or limb bone dimensions [27] and as variable in males as in females [28, 29], which is inconsistent with female pelvic morphology being under particularly high obstetric constraint.

However, it is also worth noting that culture is a key adaptive response to a wide range of factors among humans, and some argue that childbirth assistance from other individuals ('midwives') may have evolved relatively early in the human evolutionary lineage [4, 10]. This could have reduced the selective pressure for biological adaptation to the tight fit between the birth canal and infant head.

3.2.2 *Cephalopelvic Disproportion and Obstructed Labour: The Consequences of an Environmentally Induced Obstetric Dilemma?*

The focus here is on the relationship of obstructed labour to the OD. Obstructed labour is a significant problem in contemporary agricultural and industrial populations, particularly in low- and middle-income countries where it accounts for 4, 9.5 and 13.5 % of maternal deaths in Africa, Asia and Latin America, respectively (though it is notable that post-partum haemorrhage and infections and hypertension actually account for more maternal deaths [30]). Rather than being an inevitable consequence of the OD, as some have suggested previously, obstructed labour may vary in frequency relative to social and environmental conditions, and understanding the relationship between the environment and obstructed labour is therefore relevant to trying to reduce its burden.

Short maternal stature is among the strongest predictors of obstructed labour and Caesarean delivery [31–33], so the long-term trends in height may also offer insight into the temporal origin of obstructed labour. Smaller women generally have smaller pelves and thus the greater risk of cephalopelvic disproportion (a form of obstructed labour where the infant's head is too large to pass through the mother's bony birth canal, necessitating Caesarean delivery) [32]. While size at birth is influenced by both maternal and paternal genetics [34–36], maternal phenotype (height and weight) is a primary determinant of foetal nutrition so that shorter, thinner mothers typically give birth to smaller, lighter babies [36–38]. In many populations, short female stature results from environmental conditions (poor diet, disease) in the current and preceding generations [39]. Although smaller mothers do have smaller and lighter babies, 'brain-sparing' growth may still increase the risk of cephalopelvic disproportion by preserving head (brain) size at the expense of other organs [40, 41].

The greater plasticity of height and weight compared with head size could mean that altered environmental conditions cause more rapid change in maternal body size than head circumference and thus elevate obstructed labour risk [12]. When small stature evolves over an extended period, the size of the birth canal is preserved [17, 18], but obstructed labour may be more frequent where maternal body size has decreased relatively recently and appropriate adaptations in pelvic

morphology are lacking [12]. Modern rates of obstructed labour could therefore have arisen with the adoption of agriculture in the last 10,000 years [12, 42], which was frequently associated with markedly decreased stature compared with preceding hunter-gatherer populations, probably due to increased rates of infection associated with living in settlements, nutritional deficiencies resulting from a less varied diet, and increased famine risk among agriculturalists [43, 44]. Alternatively, current obstructed labour rates could reflect more recent fluctuations in income and food security in low- and middle-income countries [12].

We know little about past rates of obstructed labour, and estimating childbirth-related death rates in the past is difficult [12, 45]. While the archaeological record offers examples of deaths in childbirth, these are rare cases where the infant remains within the birth canal (reviewed in [12]). As humans were hunter-gatherers for over 90 % of our species' history, data from modern hunter-gatherers could offer some insight into past obstructed labour rates. Unfortunately, few relevant data are available and they may be problematic, especially for extrapolating to preagricultural societies [12]. Anecdotally though, birth is quicker and obstructed labour extremely uncommon in hunter-gatherer groups including small-bodied populations ('pygmies') [42, 46], suggesting greater coordination of height and pelvic canal dimensions in these populations.

The problem of mismatched maternal height and offspring head size may be further exacerbated by the current global obesity and diabetes 'epidemics' [12]. Maternal overweight, obesity, excess pregnancy weight gain and gestational or pre-existing diabetes are associated with foetal macrosomia [37, 47, 48] and negative birth outcomes including obstructed labour [48–50]. As obesity rates rise, foetal macrosomia and associated problems may become more common unless female pelvic size also increases. The relationships between height, overweight, obesity and obstetric dimensions are not well studied. Although external pelvic dimensions at least do not seem to increase in concert with secular trends in height [51–53], external dimensions do not necessarily reflect the obstetrically relevant dimensions of the birth canal. Theoretically, more frequent Caesarean sections may be reducing the selective pressure against cephalopelvic disproportion where women can access this procedure, but simultaneously further increase the obstructed labour rates [54], and thus the need for Caesareans in subsequent generations.

Contemporary mothers in low- and middle-income countries probably face the greatest burden of obstructed labour as they are more likely to be shorter due to their own poorer growth environment, and simultaneously at increasing obesity risk with westernisation [55]. Low birthweight and short adult stature are associated with increased risk of obesity and type 2 diabetes, especially in an obesogenic environment [40, 56, 57], potentially further increasing the likelihood of obstructed labour.

3.3 Implications for Policy and Practice

An evolutionary perspective suggests that obstructed labour does not result from the 'classic' OD, but is temporally and environmentally contingent. It has been particularly exacerbated by more recent lifestyle changes and environmental impacts on maternal and/or offspring phenotype [12]. This has important implications for healthcare policy and practice in that the OD is not an unavoidable feature of our species, but one that can be managed through nutrition and healthcare. While Caesarean sections offer an immediate solution, other strategies to reduce obstructed labour rates are preferable in the light of limited healthcare access in poorer communities, the financial cost to health services, associated health risks for mother and child [58–62] (although see [63]), and the potential consequent increase obstructed labour rates in subsequent generations [54]. Therefore, focussing on diet and lifestyle factors to reduce obstructed labour rates is highly preferable, especially considering the health benefits, such changes bring to the wider community and across the life course.

3.3.1 Promotion of Healthy Weight and Lifestyle

In low- and middle-income countries, ensuring adequate maternal and child nutrition and health, especially for girls, will help to reduce the incidence of short maternal height and associated risks [9, 64], as well as bringing more widespread health improvements. Conversely, the associations between maternal obesity, excess pregnancy weight gain, diabetes, foetal macrosomia, obstructed labour and other birth complications give further urgency to the need to promote healthy lifestyles, especially among reproductive age women [47, 65–67] Given debates concerning the definition of appropriate pregnancy weight gain [65, 68, 69], more research is needed to enable medical practitioners to offer evidence-based guidance. The promotion of healthy maternal weight gain will also have wider-reaching benefits for offspring health across the lifespan [67, 70, 71].

3.3.2 Maternal Stature and Reducing Obstructed Labour

The higher plasticity of maternal body mass index compared with stature and pelvic morphology, and the link between high maternal body mass index and neonatal size, suggests that obstructed labour rates may take multiple generations to decline [12]. Secular trends in stature in high-income countries occurred incrementally over multiple decades [72]; thus, the alleviation of obstructed labour by increasing maternal stature in low- and middle-income countries is likely to take several generations. However, faster increases in obesity rates may perpetuate and even

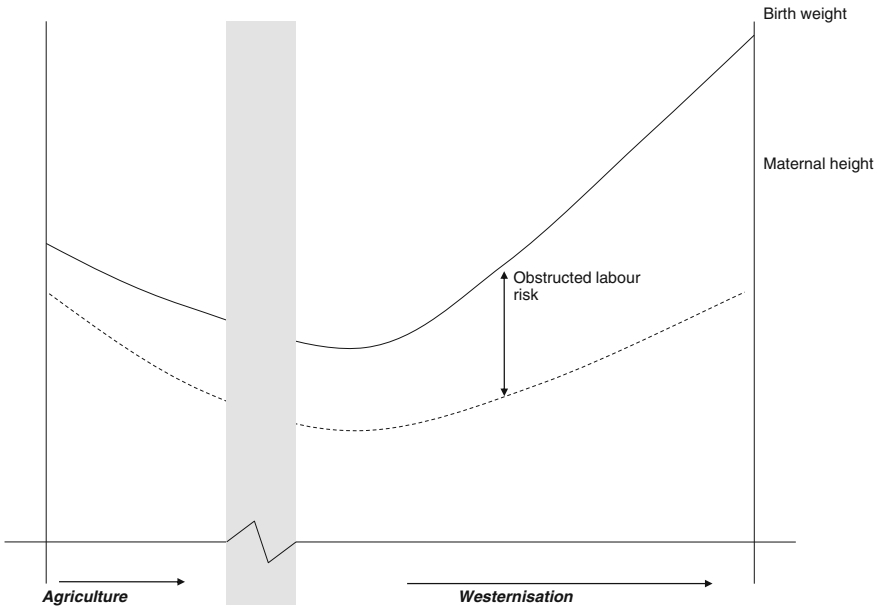

Fig. 3.2 Schematic representation of the relationship between maternal height, birthweight and obstructed delivery rates in low- and middle-income countries. After adopting agriculture, stature declined faster than birthweight and head circumference, and obstructed labour increased. With westernisation, maternal body mass index and diabetes increase rapidly, driving greater birthweight, while increased maternal stature takes multiple generations

exacerbate obstructed labour rates (Fig. 3.2). There is also evidence for a 'vicious cycle' of maternal and offspring obesity [73], potentially perpetuating and exacerbating obstructed labour across generations. Interventions during pregnancy to limit excess weight gain and regulate blood glucose can reduce foetal macrosomia and associated complications among overweight/obese mothers [69, 74, 75].

3.3.3 Childbirth Posture

In many traditional societies, childbirth positions were often upright, i.e. squatting, kneeling or sitting [4, 45, 76, 77], while the western supine or semi-recumbent position probably originated in the nineteenth- to twentieth-century medicalisation of childbirth [78, 79]. Upright birthing enlarges the bony birth canal by up to 28 % [80, 81] and may benefit both mother (e.g. reductions in pain, duration of the 2nd stage of labour, episiotomy, forceps assistance and perineal tearing [82–84]) and newborn (reduced incidence of abnormal heart rate, intensive care admissions [85]). However, some studies report increased maternal blood loss [85], and several report no difference in other neonatal outcomes with upright birth posture (e.g. Apgar

scores [82, 83, 86]). A recent Cochrane review [85] indicated that the current evidence is low quality; more research is needed as an upright posture has potential to offer a simple means of reducing obstructed labour [12].

3.4 Future Directions: Identifying Mothers at Risk to Target Birth Intervention More Effectively

While maternal height, body mass index, pregnancy weight gain, and pelvic and other measurements show significant associations with obstructed labour [32, 87, 88], they have limited predictive power and current UK guidelines warn against the use of maternal measurements to predict Caesarean for cephalopelvic disproportion [89]. Combining foetal and maternal characteristics may be more accurate [32, 90], but predictive power remains relatively low. Promising areas for investigation include identification of large foetal head circumference by ultrasound in late pregnancy [91] and disproportionately large foetal mass relative to head circumference in macrosomic infants [4, 92], and predicting cephalopelvic disproportion risk from the ratio of parental head circumference to height [33, 93].

Glossary

Cephalopelvic disproportion	The infant's head is too large to pass through the bony birth canal of the mother's pelvis, necessitating Caesarean delivery
Obstructed labour	Where labour fails to progress as a result of mechanical problems, e.g., cephalopelvic disproportion, shoulder dystocia or malpresentation of the foetus, which prevent its passage through the birth canal [2]
Phenotype	The physical characteristics of an individual, population or species. They represent the interplay of genetic and environmental influences on the body
Plasticity	The degree to which a given biological characteristic can be modified in response to environmental factors. Characteristics that are more responsive to the environment, and so less strongly genetically determined, are described as plastic
Shoulder dystocia	During labour, the shoulder is trapped behind the maternal pelvis (typically the pubic symphysis, or the sacrum) following passage of the head

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