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Shaping birth: variation in the birth canal and the importance of inclusive obstetric care

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Regional variation in pelvic morphology and childbirth has long occurred alongside traditional labour support and an understanding of possible normal courses of childbirth for each population. The process of migration and globalization has broken down these links, while a European model of 'normal' labour has become widespread. The description of 'normal' childbirth provided within obstetrics and midwifery textbooks, in fact, is modelled on a specific pelvic morphology that is common in European women. There is mounting evidence, however, that this model is not representative of women's diversity, especially for women of non-white ethnicities. The human birth canal is very variable in shape, both within and among human populations, and differences in pelvic shapes have been associated with differences in the mechanism of labour. Normalizing a white-centred model of female anatomy and of childbirth can disadvantage women of non-European ancestry. Because they are less likely to fit within this model, pelvic shape and labour pattern in non-white women are more likely to be considered 'abnormal', potentially leading to increased rates of labour intervention. To ensure that maternal care is inclusive and as safe as possible for all women, obstetric and midwifery training need to incorporate women's diversity.

This article is part of the theme issue 'Multidisciplinary perspectives on social support and maternal–child health'.

1. Introduction

Open almost any textbook on midwifery or obstetrics and you will find a description of childbirth that is modelled on what is considered to be the most common shape of the female pelvis. This shape, often called the gynaecoid pelvis, is characterized by a birth canal with a slightly transversally oval inlet that transitions into an antero-posteriorly elongated space at the middle and outlet of the canal. Owing to the changing geometry of the canal, the fetus rotates during labour to align the longer diameter of the head with the most spacious canal diameter at each level. This highly simplified model of childbirth does not account for the large variation observed in women's bodies and in the associated processes of childbirth.

In this article, I argue that this model is both misleading, in ignoring or minimizing the diversity of pelvic shapes and labour progression in women, and potentially dangerous. This standard model is based on studies of childbirth in women of largely European genetic ancestry, and is, in this respect, biased towards a specific population ancestry (see notes on terminology in electronic supplementary material for a distinction between ethnicity, ancestry and race). Pelvic shape varies geographically across human populations [1–3], and different shapes have been associated with different fetal rotations [4–6]. I will make the case that normalizing a model of childbirth based on a largely white sample of women might have led, albeit unintentionally, to discrimination in maternal care with detrimental effects on the health of non-white women and their

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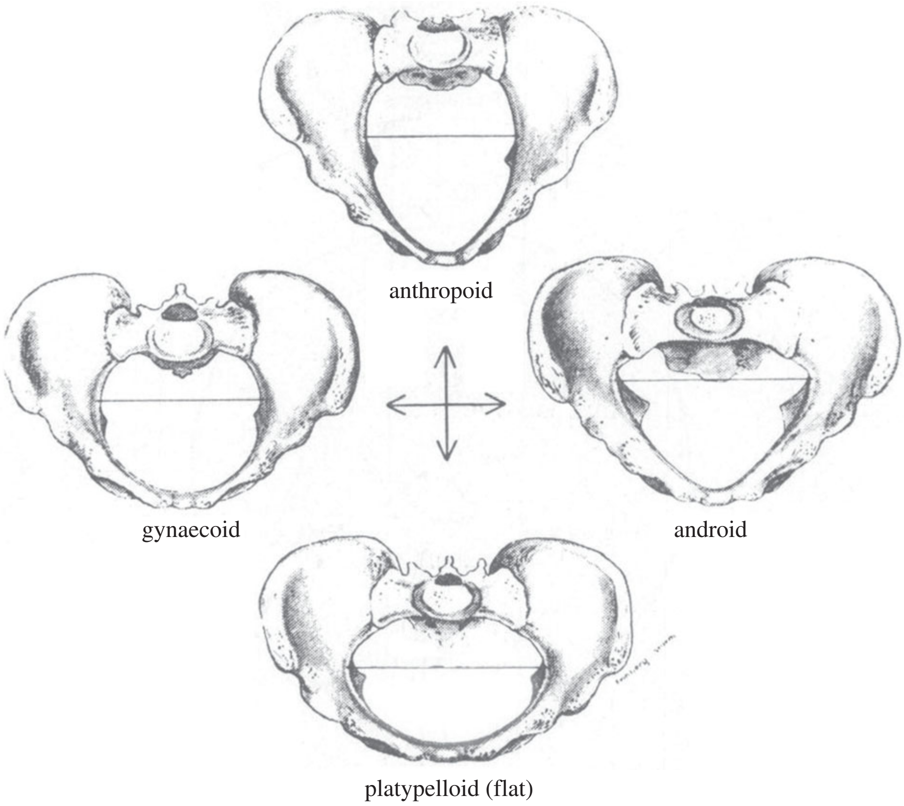

Figure 1. Caldwell & Moloy's pelvic types [15].

babies. Given the persistent and still largely unexplained gap in maternal mortality and morbidity between white and black and minority ethnic women in the UK [7,8] and other countries in the Global North (e.g. [9,10]), it is essential that teaching materials and guidelines for maternal care professionals address the range of pelvic and childbirth variation in women of different ethnicities to ensure that maternal care is as inclusive, appropriate and safe as possible.

2. Geographical diversity in pelvic shape

Women's bony birth canals are remarkably variable in shape, more so than many other parts of their bodies [2,11], and during the nineteenth and early twentieth centuries, several authors devised systems of pelvic classification that could capture this diversity (e.g. [12,13]). Thoms [14] identified four shapes based on the relationship between the antero-posterior and transversal diameters of the superior entrance (inlet) of the bony birth canal: (i) dolichopellic, longer anterior–posterior diameter; (ii) mesatipellic, equal diameters or a slightly longer transversal one; (iii) brachypellic, longer transversal diameter; (iv) platypellic, transversal diameter substantially longer than the anterior–posterior one. The mesatipellic type was the most common shape in Thoms's sample of 450 white women [14].

Most midwifery and obstetrics textbooks today report the classification proposed by Caldwell & Moloy [15,16], which is based on the shape of the inlet of the birth canal as observed in X-ray images. Like Thoms, Caldwell & Moloy's classification describes four main pelvic types: (i) gynaecoid, slightly transversally oval inlet; (ii) platypelloid, more accentuated transversally oval shape; (iii) anthropoid, slightly anterior-posteriorly oval inlet; (iv) android, vaguely heart-shaped inlet resembling the male pelvis (figure 1). Caldwell & Moloy identified the gynaecoid shape as the most common pelvic type in their sample (around 42%; table 1), and considered it to be representative of the 'normal' female shape. The gynaecoid shape has since become the default model used to describe the 'normal' female pelvis in modern obstetrics and midwifery textbooks (e.g. [6,17–19]).

Table 1. Frequency (%) of pelvic types in Caldwell & Moloy's [15] study.

pelvic type	black American	white American
anthropoid	40.4	23.5
gynaecoid	41.2	41.4
platypelloid	1.7	2.6
android	15.7	32.5
sample size	121	147

The identification of a slightly transversally oval inlet as a defining characteristic of the female pelvis is remarkably consistent in nineteenth- and twentieth-century studies of human evolution and racial variation, despite clear evidence of large morphological diversity. In an influential 1886 paper, Turner compared pelvic measurements from several human populations to investigate racial differences [13]. He showed that pelvic shape varied across human groups, with some populations showing a rounder, or antero-posteriorly oval, pelvis with respect to the European predominantly transversally oval canal. He concluded that 'the Australian, Bush, Kaffir, and Andamanese present a closer approximation of the relative proportions of the parts found in the pelves of apes […] than is the case in the Negroes and in the Europeans. The pelvis, therefore, in those races shows a more degraded character—a less departure from the usual mammalian form—than is the case in the Europeans' [13, pp. 142–143].

Caldwell *et al*. [16,20] returned to the idea that some pelvic types might be more similar to the pelvis of non-human apes in the orientation of their canal. They defined their platypelloid (flattened oval) shape as an 'ultrahuman form' [16, p. 498], and suggested that pelvic variation could be seen as an 'evolutionary trend', with some pelvic shapes showing an 'arrest in evolution from the ape form, the true anthropoid, to the perfect human form which is characteristically flat' [20, pp. 486–487].

It is important to note that, while it is true that the inlet in the anthropoid pelvic shape has an antero-posterior orientation, the difference between the anthropoid pelvis and that of other apes is several orders of magnitude greater than is the difference between the anthropoid and the gynaecoid human shapes. Indeed, in 1913, Emmons wrote: 'less stress, I think, should in future be put by the anthropologist on those small differences seen in a few or even in a small series of pelves of separate tribes or races, but rather the close resemblances should be emphasized in contrast to the great differences noted between animals and man' [21, p. 46]. We must conclude that Turner's & Caldwell and Moloy's evolutionary interpretations of the gynaecoid pelvis as being more distinctly 'human' owe more to their prejudicial understanding of human racial difference than they do to any empirical evidence. For most of the eighteenth and nineteenth centuries, a belief in the racial superiority of white Europeans over other populations was widespread, and underpinned many studies of human variation [22], while increasing acceptance of human evolution led to the interpretation of European anatomy as 'more evolved'. While this understanding makes no sense from an evolutionary perspective, in that all living species and populations are equally evolved, it was an idea that resonated with the still-widespread neoplatonic concept of *scala naturae*, the great ladder of being that placed all living creatures in a divinely ordered hierarchy [23]. The focus on the gynaecoid shape as a model for women's anatomy can, therefore, be explained by a bias towards white women rooted in views of racial superiority, which saw the most common European pelvic type becoming the 'normal' or, indeed, 'ideal' human form.

Other pelvic shapes are, in reality, very common in our species, as shown by Caldwell and Moloy [15] (table 1). While the gynaecoid pelvis was most common in their samples of white and black American women (41%), the anthropoid shape was almost as frequent (40%) in black women, and the android shape was very frequent (32%) in white women. Between the 1930s and the 1950s, some authors started to use X-ray imaging to look at pelvic shapes and dimensions in a wider range of populations, such as Bantu [24], Mexican [25] and Indian women [26]. The increased understanding of the harmful effects of radiation exposure, however, meant that X-ray pelvimetry largely went out of use towards the middle of the twentieth century. At the same time, the horrors of racial persecutions during the Second World War provoked a reaction against racial typology. The investigation of human variation, both genetic and morphological, moved away from a typological approach and towards an appreciation of the clinal nature of geographical diversity in our species, finally disproving the existence of human races [27–30]. This shift was accompanied by a reluctance to study skeletal variation between populations, which felt too closely associated with earlier racial studies. The combination of this widespread reluctance and a lack of safe imaging tools that could be used on pregnant women meant that no progress was made in understanding birth canal variation across populations until the beginning of the twenty-first century.

In more recent years, Kurki [1] and Betti & Manica [2] restarted the investigation of human variation in the shape of the birth canal by looking at single populations instead of larger 'racial' groups. They found that the average shape of the pelvis varied among populations according to geographical location. Some population differences follow a latitudinal gradient [1,3], whereby high-latitude populations tend to have wider and more laterally flaring pelves as well as a larger body size. This trend has been previously explained as an adaptation for efficient thermoregulation: wider bodies have a lower surface-to-volume ratio that helps decrease heat dissipation in cold high-latitude environments, while narrower bodies help increase heat dissipation in hot low-latitude environments [31]. In addition to a latitudinal trend, geographically closer populations tend to show similar pelvic shape while populations from different continents tend to differ more substantially. This pattern is similar to what has been observed in human genetic variation [2,3] and can be explained by genetic drift, which led to the accumulation of small genetic and morphological differences among populations following the colonization of different regions of the world. Across our species, therefore, climatic adaptation and genetic drift have generated geographical variation in pelvic shape [32].

Kurki's [1] and Betti & Manica's [2] studies confirmed that, on average, European women have a transversally oval inlet (compatible with an android, gynaecoid or platypelloid shape). In many East Asian and sub-Saharan African populations, on the other hand, the average inlet is rounder and often oval in the anterior–posterior direction, compatible with an increased frequency of the anthropoid pelvic shape [2]. By highlighting a clear geographical pattern of birth canal variation across populations, these studies demonstrate that a model of pelvic anatomy based on the average European woman is not representative of women of other geographical ancestries. Moreover, these studies show that birth canal variation is very large even *within* each human population, and that using a single pelvic model based on a population's average or most common shape is inappropriate and potentially dangerous. Pelvic variation is continuous and does not fall into easily identifiable pelvic types, in the same way as people's stature falls across a smooth range and not in two distinct categories called 'short' and 'tall', and the gradual nature of variation among types should be made explicit in teaching material.

3. The link between pelvic shape, the mechanism of labour and childbirth complications

A good understanding of variation in the morphology of the birth canal is extremely important in obstetrics and midwifery. The shape of the birth canal has been linked to several aspects of labour, including the likelihood of complications, fetal position and rotations in the canal, and presentation at birth (facing forward or backward) [14,15,33,34].

A potential reason for these links between pelvic shape and the characteristics of labour is that human babies experience a very tight fit within the birth canal. This is partly owing to changes to the pelvic structure that occurred during the evolution of bipedalism, leading to a more compact pelvic girdle with respect to other apes [35]. Further, the evolution in our species of a particularly large brain [36], rigid shoulders [37] and larger neonatal fat deposits [38] all contributed to increasing the size of the fetus with respect to the canal, making human childbirth challenging. In order to navigate the tight canal, the fetus needs to align the longest dimensions of the head and shoulders with the largest diameters of the canal at the different levels (electronic supplementary material, figure S1), with a set of rotations called the mechanism of labour. In the gynaecoid pelvis, the inlet has a larger transversal diameter; as the neonatal head is longer than larger, most fetuses enter the canal with the head facing at least partially to the side. The midplane, on the other hand, is narrow with a longer antero-posterior diameter, requiring the fetal head to rotate to what is usually a backward-facing position (occipito-anterior position). The shoulders follow the head, rotating accordingly to the canal diameter but at a 90° angle with respect to the head, owing to their large transversal dimension (electronic supplementary material, figure S2).

This description of the mechanism of labour is used as a standard model of human birth in midwifery and obstetrics textbooks (e.g. [5,6,17,39]), in the same way as the gynaecoid pelvis is used as a model for 'normal' female pelvic shape. While this might be the most common mechanism in women of European ancestry, it is unlikely to serve as well as a model for other populations owing to geographical variation in canal shape. If the shape of the canal varies across human populations, we can expect that the mechanism of labour will vary too [1].

Alternative mechanisms of labour are sometimes mentioned in midwifery textbooks, especially in regard to the anthropoid pelvis (e.g. [5,6]). The inlet in the anthropoid pelvis (equivalent to Thoms's [14] dolichopellic type) has a longer antero-posterior dimension, which persists through the midplane and outlet. The fetus tends to enter the canal facing either backward or forward, and maintain this position until birth. While for the gynaecoid pelvis, most newborns emerge from the canal facing backward, forward facing is quite common for the anthropoid pelvis [33,34], estimated at around 19% [14]. In terms of fetal engagement, internal rotations and birth presentation, the 'normal' mechanism of labour for the anthropoid pelvis differs substantially from the model used in obstetrics and midwifery textbooks. As this pelvic type has been described in a substantial minority of women of European ancestry, and is common in women of other ethnicities [2,15,25], it is problematic that this alternative mechanism of labour is barely mentioned in the instructional literature, and is often ignored altogether (e.g. [18,39–41]).

The use of the gynaecoid pelvis as a model for 'normal' mechanism of labour can be partly explained by its association with a straightforward labour. In comparison, the platypelloid pelvis and the android pelvis have been associated with a higher rate of complications [15]. The anthropoid pelvis, however, is generally linked to an uncomplicated labour [14,42], so much so that Posner *et al*. report that this pelvis is characterized by 'delivery and labour [that are] usually easy' [5, p. 52]. The main difference in labour between the gynaecoid and the anthropoid pelvis is the set of rotations experienced by the fetus; the anthropoid pelvis has a slightly higher frequency of persistent occipito-posterior position of the fetus, so that the baby is more often born facing forward [4–6]. So, why is the mechanism of birth associated with the anthropoid pelvis not described as an alternative model of normal labour, especially given that this pelvic shape is quite common in many populations?

The focus on the gynaecoid pelvis and the related fetal rotations could have been reinforced by a common narrative of how human childbirth evolved. The narrative goes like this: because of bipedal adaptation, the human pelvis evolved a twisted birth canal, which starts with a transversally oval inlet and changes into an antero-posteriorly oriented outlet. This differs from the canal of other apes, which is antero-posteriorly oriented throughout. Because of the twisted canal, human birth requires a unique set of rotations that lead the fetus to emerge facing backward instead of forward. While in other primate species, the mother can help extract the baby from the vagina by pulling it forward towards her, human mothers would risk harming the neck and spinal cord of their child by pulling its head backward. As such, humans have evolved childbirth support in the form of midwives [43].

This ubiquitous narrative, with a description of human childbirth clearly based on the gynaecoid pelvis, emphasizes the differences between humans and other apes and unwittingly implies that the anthropoid pelvis and the mechanism of labour that often accompany it are less typically human, or as Caldwell *et al*. put it, represent an 'arrest in evolution from the ape form' [20, p. 487]. The proposed link between a backward-facing presentation of the baby at birth and the evolution of midwifery could also have contributed to the continuing prominence given to the occipito-anterior presentation as the 'normal' human type of fetal emergence, despite the fact that a forward-facing occipito-posterior position is fairly common in our species (5–12%; [34] and references therein).

A good understanding of canal shape variation and expected fetal rotations becomes essential in the case of childbirth complications that require mechanical intervention to facilitate the birth. Forceps or a ventouse are often used when the fetus cannot progress through the canal, or is showing signs of distress and birth needs to be accelerated. These instruments are applied to the fetal head and used to gently pull the fetus out. During this delicate manoeuvre, the fetus sometimes needs to be rotated to align the longest head diameter to the most spacious canal diameter. *Moloy's evaluation of the pelvis in obstetrics* [4] dedicates a chapter to the significance of pelvic shape in the treatment of fetal arrest in the canal. In order to manually rotate the fetus to favour the progression of birth, it is essential to understand that the most spacious diameter of the canal depends on the mother's pelvic shape. The application of forceps in women with an anthropoid pelvis would require a different procedure from the standard set of rotations based on the gynaecoid pelvis [34]. For example, Steer states that, for arrest in the occipito-posterior position at mid-pelvis, 'the most successful manoeuvres followed the principle that in anthropoid types the head should be brought to lower levels, with its long axis favouring the long antero-posterior pelvic diameters and avoiding the narrow transverse diameters of the pelvis' [4, p. 84]. In the case of the platypelloid pelvis, by contrast, the transverse diameter is the largest one throughout the canal, and the 'head should be allowed to descend in this

Table 2. Frequency (%) of intervention by pelvic type recalculated from Caldwell & Moloy's data of frequency of pelvic shapes by type of birth [15, p. 12]. *N*, number of individuals per pelvic type.

pelvic type	spontaneous	low forceps	low–mid-forceps	mid-forceps	C-section	*N*
anthropoid + anthropoid–gynaecoid	22.9	28.4	21.1	12.8	14.7	109
android + android–anthropoid + android–gynaecoid	12.4	14.2	21.6	25.7	26.1	218
gynaecoid	34.3	29.6	11.1	13.9	11.1	108
platypelloid (all mixed types)	16.9	9.2	27.7	23.1	23.1	65

Table 3. Frequency (%) of operative interventions (including forceps and caesarean sections), C-sections, breech and occipito-posterior presentations for each pelvic type in Thoms [14]. *N*, number of individuals per pelvic type.

pelvic type	operative interventions	C-section	breech presentation	occipito-posterior	*N*
dolichopellic	15.7	0	10	18.6	70
mesatipellic	18.2	0.5	2.9	10.8	203
brachypellic	19.8	5.1	4.4	8.2	156
platypellic	33.3	19	0	9.5	21

diameter to the pelvic floor' [16, p. 500]. Persistent attempts at rotation of the fetus against the main canal diameter could lead to injury of the mother and baby and even stillbirth [15,16], highlighting the potential risks, especially for non-European women, associated with of a lack of understanding of pelvic variation among midwives and obstetricians.

Different shapes of the canal have been linked to different likelihoods of complications. Caldwell & Moloy [15] report the frequency of pelvic types in 500 births, selected so that 100 births were spontaneous (unassisted vaginal birth), 100 required forceps at the low pelvis (outlet forceps), 100 at the low–mid-level, 100 at the mid-pelvis and 100 required a caesarean section. I have used their data to calculate the frequency of each type of intervention for the four main pelvic types (table 2). As the original study distinguished mixed pelvic shapes (e.g. android–gynaecoid or android–anthropoid), I grouped the cases based on their main type, which is the first component of the name. Caldwell & Moloy's use of pelvic stations to differentiate the types of forceps applications preceded the revision in forceps use terminology of the American College of Obstetricians and Gynecologists in 1988 [44], and the low forceps used in their table should be interpreted as outlet forceps, which are applied when the maximum breadth of the fetal cranium is past the ischial spines and is visible during contractions. As the authors had selected the data so that all birth scenarios were equally represented (100 cases each), we would expect the frequency of each type of intervention and spontaneous birth to be equal also within each pelvic type, if pelvic shape does not affect the chance of different birth interventions. Instead, table 2 shows that the gynaecoid and anthropoid pelves have the highest proportions of spontaneous and low forceps delivery, where the head could progress through the canal. The android pelvis and platypelloid pelvis, on the other hand, had the highest proportions of mid–low and mid-pelvis forceps, and of caesarean sections.

Thoms [14,42] made similar observations in the late 1930s, albeit using a different classification of pelvic types. I have summarized in table 3 the results from his study of 450 white primiparous (i.e. giving birth for the first time) women who delivered at term [14]. He found that the incidence of operative deliveries (including both forceps and caesarean sections) was lowest for dolichopellic shapes, and increased in the mesatipellic, brachypellic and especially platypellic shapes. Thoms's dolichopellic and platypellic shapes are broadly equivalent to the anthropoid and platypelloid shapes from Caldwell and Moloy's classification, but it is more difficult to match his mesatipellic and brachypellic shapes, which could have included both gynaecoid and android pelves. Thoms's classification is based on the proportion between the transversal and anterior–posterior diameters of the inlet, but this proportion tends to be quite similar in the gynaecoid and android pelves, which are differentiated instead by a rounder versus wedge-like shape of the inlet. Despite this limitation, it is apparent that Thoms's results are aligned with Caldwell and Moloy's results in showing lower operative interventions in the anthropoid/dolichopellic and gynaecoid/mesatipellic–brachypellic pelves with respect to the platypelloid/platypellic shape.

It is difficult to evaluate whether this link between pelvic types and frequency of interventions is indicative of a causal relationship. Combining the evidence available—that different pelvic shapes have different prevalence of certain fetal positions (e.g. occipito-posterior more common in anthropoid pelves) and tend to be characterized by different sets of rotations to align the fetal head to the widest canal diameter—suggests that pelvic shape does indeed have an effect on the mechanism of labour. Pelvic shape could affect the likelihood of birth intervention through cephalo-pelvic disproportion, which can be owing to the position in which the head descends as well as to the size of the canal diameters. It is also possible that pelvic shape has an indirect effect on the occurrence of certain complications. There is some evidence that a persistent occipito-posterior position is linked to longer labour and higher likelihood of severe perineal tears, but not fetal outcome in the form of Apgar scores at 5 min [45,46]. It is unclear whether the increased likelihood of severe perineal tears is owing to the more frequent use of augmentation of labour and forceps/ventouse when the fetus presents in this position [46]. This fetal position occurs more often in women with an anthropoid or android pelvis [4]; if non-gynaecoid pelves are more often associated with fetal positions and rotations that differ from the model of 'normal' childbirth described in textbooks, this mismatch could ring alarm bells and precipitate birth interventions even in the absence of obstructed labour [47].

4. Why the current model of the 'normal' pelvis and childbirth is problematic

There is good evidence that the shape of the birth canal is highly variable and tends to differ both within and among human populations, and that using the gynaecoid shape as a model for all women is empirically unsupported, factually inaccurate and potentially dangerous, especially for women of non-European ancestry. Expectations of normal labour progression have been largely shaped by Friedman's studies of white American women, on the basis of which he suggested a subdivision into a first phase of labour characterized by cervical dilation, and a second phase characterized by active pushing [48,49]. He indicated the normal duration of these phases based on his sample, and these time ranges became benchmarks to determine when a labour was delayed (i.e. not 'normal') and intervention might be needed [50–53]. Several studies have, however, reported differences in the length of labour in women of different ancestry. Kolawole *et al.*, comparing pelvic measurements in Nigerian and Welsh women, note that engagement of the fetal head happens later in the former, and 'rarely occurs until the end of the first or onset of the second stage of labour' [54, p. 86], an observation that I have heard echoed in anecdotal conversations with practicing midwives. While Lister [55] writes that later engagement of the head does not prolong labour in Nigerian women, Peckham [56] reports longer labour in black women with respect to white women in Baltimore, Maryland. Albers and co-workers [57,58] compared the duration of the first and second stage of labour in American women of different ethnicity and found that white women tend to have a shorter first stage and a longer second stage with respect to other ethnic groups. More recent studies in different human populations have shown that labour duration exceeded Friedman's model for many women who had a spontaneous birth with a positive outcome (e.g. [59–62]). It is unclear at present whether pelvic shape variation has any bearing on the duration of labour and, since population differences could be largely owing to other biological and/or cultural factors, more research is needed.

Regional variability in pelvic morphology and labour has long occurred alongside traditional childbirth support and an understanding of possible normal courses of childbirth for each population. The process of migration and globalization has broken down these links, while a European model of 'normal' labour has become widespread. In modern multiethnic societies, women of non-European ancestry are inadvertently being discriminated against by maternal care training that does not give equal attention to the range of pelvic and childbirth variation experienced by women across the world. Even in regions such as sub-Saharan Africa, where white women are a minority, the books used for training midwives and obstetricians are largely the same as used in majority-white regions, often second-hand earlier editions of textbooks donated by university libraries from wealthier countries. The potential detrimental effects of basing maternal care training on studies of mostly white women in non-white populations have not been investigated, yet.

Black women in Britain are five times more likely to die in childbirth than white women, and women of Asian background have twice the risk of maternal death [8]. While childbirth mortality has declined substantially in the UK in the past decades and is today very low (9.78 maternal deaths for 100 000 maternities; [8]), it in only the tip of the iceberg in terms of ethnic inequality in maternal health outcomes. Significant ethnic differences have also been identified in the risk of severe maternal morbidity [7,63], which affects a much higher number of women and has substantial short- or long-term effects on a woman's health. Nair *et al.* [7] report a higher risk of severe maternal morbidity for non-white women in the UK, with black women having the highest values (double the risk with respect to white women). Similar ethnic differences in maternal mortality and morbidity rates exist in other developed countries [9,10].

Several factors have been linked to these disparities, including ethnic differences in socio-economic status, access to and quality of prenatal care, environmental exposure and overall structural racism [64,65]; nonetheless, this ethnic morbidity and mortality gap is still largely unexplained even after accounting for known contributing factors [7,8,66]. I argue that a model of 'normal' childbirth developed in predominantly white women could be a contributing factor: by deviating more often from this model, many women of other ancestries could potentially undergo unnecessary interventions. Differences in pelvic shapes among human populations could play an important role owing to their effect on the mechanism of labour. The anthropoid pelvic shape, which is more common in black women, has been associated with lower rates of childbirth intervention in some American studies from the 1930s [14,15,42]. A higher rate of interventions in black and minority ethnic women in today's Britain is, therefore, unlikely to be owing to pelvic shape in itself, but it could be partly explained by labour patterns that differ from the 'norm', as currently understood.

Recent maternity statistics for England (NHS Maternity Statistics 2018–19, published on https://digital.nhs.uk on 31 October 2019) show that white women have the highest frequency of spontaneous birth with respect to other ethnic groups, for which childbirth interventions are more common (electronic supplementary material, table S1). The report also shows that black women have the highest rate of caesarean sections, accompanied by the lowest rate of forceps application (electronic supplementary material, table S1). Potential causes for this difference remain to be investigated, but it is possible that forceps training that focuses on the gynaecoid pelvis means that obstetricians are less confident or less successful in using forceps on women with an anthropoid pelvis, a shape that is more common in black women, and resort to an emergency caesarean section more often than in other ethnic groups. Childbirth interventions such as forceps application and caesarean section increase the likelihood of thrombosis, haemorrhage and sepsis, which are leading causes of maternal mortality and severe morbidity [8], and could be fuelling the higher mortality and morbidity rate in non-white women in the UK and other countries.

When modern obstetrics and midwifery textbooks base their description of human childbirth on the gynaecoid pelvis, they disadvantage women of non-European ancestry not only because they are less likely to fit within this model, but also because they implicitly accept the racist underpinnings of the model itself. Defining human childbirth based on characteristics of the pelvis that apply to a minority of women (mostly white) reinforces, albeit implicitly, the idea that other morphologies, and by extension the populations in which they commonly occur, are less human (read inferior). The study of human biological—especially skeletal—variation has a very dark history associated with the idea that human races are defined by essential differences in their physical, intellectual and moral characteristics, and with an ideology of white supremacy [22]. Ignoring human variation and assuming that a model of human biology based on white people can apply to all humans can, however, be extremely damaging and discriminatory. This has become evident in recent years in regard to ethnic differences in the effectiveness of certain medications, and several studies have highlighted the danger of developing medicines and establishing safe doses without testing them on a highly diverse sample of people (e.g. [67–69]). Standardizing birthing protocols on white women's anatomy and physiology privileges a group that is already disproportionately favoured in other socio-economic aspects [70], and might embed ethnic discrimination and racist ideas within obstetric practice, potentially contributing to higher maternal mortality and morbidity in black and minority ethnic women.

Maternal care cannot be inclusive if it does not understand and anticipate human diversity and build its protocols involving women from a variety of ethnic backgrounds. To be clear: acknowledging diversity *does not* mean implementing ethnic profiling in maternal care nor associating certain ethnicities with specific pelvic types and fetal presentations. Rather, it means avoiding privileging a model of maternal anatomy and childbirth largely based on white women, and revising textbooks to include a more equitable explanation of normal variation in pelvic shape, fetal movement and labour progression. In order to achieve this, significantly more research is needed on women's pelvic and labour diversity.

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