Biomechanics of childbirth

Anastasia Topalidou responds to a research article on biomechanics and fetal optimal positioning published in the May issue of the British Journal of Midwifery

Dear Editor,

With great interest, I read the paper published in your journal on 3 May, entitled '*Bouncing your way to labour and birth using biomechanics and foetal optimal positioning*', authored by Roisin Lennon (2024).

While I appreciate the alternative approach and the effort to link biomechanics with fetal positioning to facilitate labour, I have concerns regarding the use and interpretation of the term 'biomechanics' in the context of the article. Also, there are misleading parts and a potential level of bias.

Biomechanics, as a discipline, involves the scientific study of the mechanical laws relating to the movement or structure of living organisms. It encompasses not only the techniques to measure forces that act upon and within biological systems, such as the human body, but also the analysis of the mechanics of living organisms and the application of engineering principles to and from biological systems. This can include studying how muscles, bones, tendons and ligaments work together to produce movement, and how external forces, such as gravity or the environment, impact biological functions (Knudson and Knudson, 2007; Robertson et al, 2013; Innocenti, 2018). If I were to give a simple definition of what the biomechanics of childbirth is, I would say that the biomechanics of childbirth refers to the study of the mechanical processes and physical forces involved during labour and birth. It encompasses how the birthing person's body and the fetus interact and adapt to facilitate childbirth.

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Based on the above, we can only say 'biomechanics of birth' and not 'biomechanics for birth', as the use of 'of' refers to the study and analysis of the mechanical processes and forces involved in childbirth. However, the author throughout the paper uses the phrase 'biomechanics for birth' and 'biomechanics for birth toolkit', mainly referring to techniques and manoeuvres to assist childbirth (Lennon, 2024). Even if the word 'for' is used intentionally to shift the focus towards an external application or intervention designed to achieve or assist in childbirth, this can be misleading. It implies a practical or utilitarian approach, rather than a scientific analysis, which is what biomechanics is (Robertson et al, 2013).

In several fields, such as physiotherapy and sport sciences, the term biomechanics is used to refer to methods and techniques; however, an additional difference for these fields is that there are biomechanical studies to support the use of these manoeuvres, techniques, implementations and tools (Morris, 1977; Hay, 1978; Chaffin et al, 2006). It is crucial to highlight that to date, there is no biomechanical study conducted during labour, a topic which I will elaborate on further below. I conducted a scoping review, with the last search until August 2021, which is currently being updated before submission, to be certain that there is not one kinematic, kinetic or other biomechanical type study, other than computational modelling. Therefore, the use of 'for' misconstrues the fundamental principles and methodologies of biomechanics.

Areas of concern in the article

The title of the article says 'using biomechanics', although the author did not use biomechanics. In the introduction, the author states, 'with advances in three-dimensional models of the human body exploring how it works and moves, there has been a rise in different professionals investigating the workings of the pelvis during labour and birth. This has provided maternity healthcare professionals with a better understanding of the effects of pregnancy hormones and the biomechanical changes that affect the abdominal muscles and spinal curvatures', using as reference the systematic review conducted by Conder et al (2019). This review aims to explore the effects of pregnancy on the biomechanics and anthropometrics of the body and how this results in altered posture, stability and gait patterns that influence the body. This confirms, as stated above, that conditions, in this case pregnancy, affect the biomechanics of the body and not the biomechanics for pregnancy or birth. Furthermore, Conder et al (2019) included studies during the antenatal period only. Therefore, the author cannot use this reference in the introduction and claim that 'there has been a rise in different professionals investigating the working of the pelvis during labour and birth', as labour and birth are not part of this systematic review.

As mentioned above, to date, there are no published studies using biomechanics conducted during childbirth. The reason for this is that the usual methods for kinetic and kinematic analysis cannot be used during labour. Kinetic analysis requires instruments such as pressure sensors, which are impractical to use during labour. Kinematic analysis requires markers to be placed in several locations that cannot be removed or covered. In addition, the labouring person will not be able to lie down because of markers on the spine, hips etc. Additionally, approximately 12 cameras on heavy-duty tripods have to be set up in the labouring ward, along with processing, synchronisation and filtering units. These are just some of the limitations that mean that the currently available techniques cannot be used during childbirth (Szczerbik and Kalinowska, 2011; Desseauve et al, 2017; 2019; 2020; Topley and Richards, 2020). Recently, markerless methods have been developed, but because of other limitations, they cannot be used (Wade et al, 2022; Tang, 2023). The hardware setup with cameras and processing units is quite similar for these methods, and furniture, equipment and medical professionals cannot come between the markers/birthing person and the recording camera or cover it with their hands in an attempt to provide care.

The author of the paper states that 'these studies have demonstrated that obstructed labours are a mechanical imbalance in the pelvis that results in the fetus' position not being the best fit to negotiate the pelvis (Hemmerich et al 2019; Grimm, 2021; O'Brien, 2023)'. The first study by Hemmerich et al (2019) is a computational modelling study. Since we cannot use other techniques to date, biomechanists and bioengineers worldwide work with computational modelling techniques, including finite element analysis, to understand childbirth. However, computational models and simulations have well-known limitations, assumptions and simplifications. The models are usually subject-specific, represent only a specific condition and situation, and many factors are either treated as assumptions or cannot be computed (Beller et al, 2010; Parente et al, 2010a, b; Kasiteropoulou et al, 2020).

Hemmerich et al (2019) have made significant contributions to the area of biomechanics of pregnancy and childbirth, with many well-known studies (Cripton et al, 2001; Moorcroft et al, 2003; Hemmerich et al, 2018). In their referenced study, they clarify all limitations and highlight the importance of in vivo data (Hemmerich et al, 2019). It is important to understand that while computational modelling is a great way to investigate complex situations, it provides basic knowledge, and the results might not be representative of any specific individual.

The second reference is an excellent work by Grimm (2021), which uses computational models as part of a comprehensive approach to understanding the biomechanics of childbirth. This study provides a macro-level explanation, attempting to bridge detailed biomechanical knowledge (such as forces acting during childbirth) with larger-scale physiological processes. However, as stated above, these are computational model studies. The third reference is O'Brien (2023), which introduces 'biomechanics for birth', which appear to be techniques and manoeuvres integrated into the education curriculum. Therefore, these references are not the most appropriate for the statements in that section.

The author states, that 'upright positions, squatting and mobilising maximise the effect of gravity and the effectiveness of contractions', using the published study by O'Brien et al (2022) as a reference. This is a mixed-methods study, mostly with qualitative data, about midwives' experiences of implementing the labour hopscotch framework. How, from this study, can the author of this paper claim that 'upright positions, squatting and mobilising maximise the effect of gravity and the effectiveness of contractions'? Gravity was not assessed or analysed as part of O'Brien et al's (2022) paper. Data from tocodynamometers, internal uterine pressure catheters,electromyography or palpation were not collected, analysed and used to assess the effectiveness of contractions. There is only one quote by a midwife mentioning contractions. These are just some examples of misleading information in this paper, inadequate referencing and biased writing.

It is surprising that pregnancy records, including birth outcomes, were collected, which constitutes clinical data, without requiring ethical review and approval for this study. Moreover, an alteration to usual practice was applied, which exceeds the boundaries of a clinical audit, with the introduction of an unvalidated toolkit, yet no ethical approval was required. In addition, the methodological design, missing variables (such as ethnicity), no reporting on data access, management and storage of both personal and clinical data, do not align with the basic principles of 'good research practice' and exhibit a level of bias, potentially leading to the predefinition of results.

Finally, the author states that 'all participants received continuity of care from the advanced midwife practitioner with biomechanics, exercise, and labour hopscotch being discussed at each appointment from 26 weeks on'. This raises important questions about the content and basis of these discussions. Specifically, given the limited knowledge of the biomechanics of childbirth, primarily derived from computational models, what specific biomechanics were discussed? Additionally, what knowledge or relevant qualifications does the author, an advanced midwife practitioner, have to effectively discuss biomechanics?

Apart from the above, I would appreciate further details on the biomechanical models and theories that underpin these interventions. Specifically, it would be enlightening to understand the biomechanical scientific basis and actual biomechanics for the exercises and manoeuvres recommended in the toolkit, beyond observations and experiential knowledge, and how these directly influence the mechanical environment of the pelvis during labour. Providing any evidence-based information would greatly enhance the readership's understanding of the interplay between biomechanics and practical midwifery interventions, ensuring a more comprehensive appreciation of the alternative approaches being implemented to optimise natural childbirth processes.

It is essential for the readership to consider these aspects to avoid potential misinterpretations that could arise from the article. Future discussions in this area would benefit from including detailed biomechanical analyses or references to peer-reviewed biomechanical research to clarify how these methods/approaches (such as the 'biomechanics for birth toolkit' and 'labour hopscotch') directly influence the physiological processes of labour. BJM

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