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P-775 What is the potential of cervicovaginal mucus as a biomarker for identifying the fertile window and the effectiveness of AI-enhanced prediction for scalability and accessibility?

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Study question: What is the potential of cervicovaginal mucus as a biomarker for identifying the fertile window and the effectiveness of AI-enhanced prediction for scalability and accessibility?

Summary answer: Cervicovaginal mucus is a reliable biomarker for the fertile window. AI Foundation models show promise in enhancing this method's scalability and predictability.

What is known already: The timing of ovulation corrosponds to the fertile window. Although modern methods of ovulation detections yield high accuracies, they often require the purchase of sensors/equipment which creates a barrier to those in low-resource settings. Natural fertility awareness based methods, such as CVM monitoring, eliminate this problem, but there are limited recent large-scale studies validating cyclical CVM changes. Digitising CVM monitoring could remove the subjectivity of the interpretation of symptoms. Despite the advances of AI in other FABM areas, limited work has been done on computer vision models for CVM evaluation, which could revolutionise accessibility and scalability, particularly in low-resource settings.

Study design, size, duration: The study involved analysis of self-reported CVM characteristics data from over 57,000 individuals; largest sample size used in any study investigating the use of CVM as a biomarker. Furthermore, a dataset of CVM images were collected from the public survey and labeled manually (n = 13). The study included retrospective and pilot components, employing statistical analyses like ANOVA, chi-squared, and Spearman

correlation, and AI techniques like zero-shot learning for binary segmentation of CVM from smartphone-captured images

Participants/materials, setting, methods: Self-reported CVM data was obtained from a fertility tracking app and analysed using ANOVA and chi-squared tests to identify and validate findings of cyclical variations, and correlation with lifestyle data. Zero-shot learning was employed using foundation models. An ethically-reviewed survey was generated to collect images for subsequent model training Images from the survey were segmented using the Grounding DINO and the SAM. The surface area and elasticity extracted are used to determine the fertility score.

Main results and the role of chance: In individuals with 28-day cycles, CVM showed significantly higher quality during the ovulatory phase, marked by increased elasticity ($p = 0.00001$), amount ($p = 0.00001$)), and lubricative texture ($p < 0.0001$), when compared to both the follicular and luteal phases. However, variations in individuals with longer, irregular cycles of over 35 days length, were less pronounced. Age was found to significant positive correlation with overall CVM quality ($r = 0.06$, $p < 0.0001$), while no significant correlations were observed with smoking ($r = 0.11$, $p = 0.23$), alcohol consumption ($r = 0.13$, $p = 0.17$), or BMI ($r = 0.006$, $p = 0.41$)). Zero-shot learning for segmentation showed improved accuracy in detecting and extracting CVM from images, with precision of 0.867 and F1 score of 0.929, highlighting the model's ability to correctly distinguish between CVM patterns corresponding to fertile and infertile status. The intersection over union score suggested consistent model performance. Overall, CVM emerged as a scalable fertility biomarker in typical menstrual cycles, with AI models showing potential for enhancing prediction accuracy and scalability.

Limitations, reasons for caution: The study's limitations include its reliance on self-reported CVM data and the potential bias in the foundation models as there was no fine-tuning, due to a small dataset ($n = 13$). Additionally, the effectiveness of CVM as a biomarker in irregular menstrual cycles and subfertility requires further exploration.

Wider implications of the findings: Automated analysis of CVM can be a low-cost, scalable (potentially to millions, via mobile application), non-invasive method for fertility awareness. Our findings highlight the potential of AI in empowering fertility awareness, especially in low-resource settings with little access to reproductive healthcare, thus contributing to global health equity.

Trial registration number: n/a

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