

# FEASIBILITY OF REMOTE FETAL HEART RATE MONITORING USING A NOVEL SELF-APPLIED NON-INVASIVE FETAL ECG MONITOR

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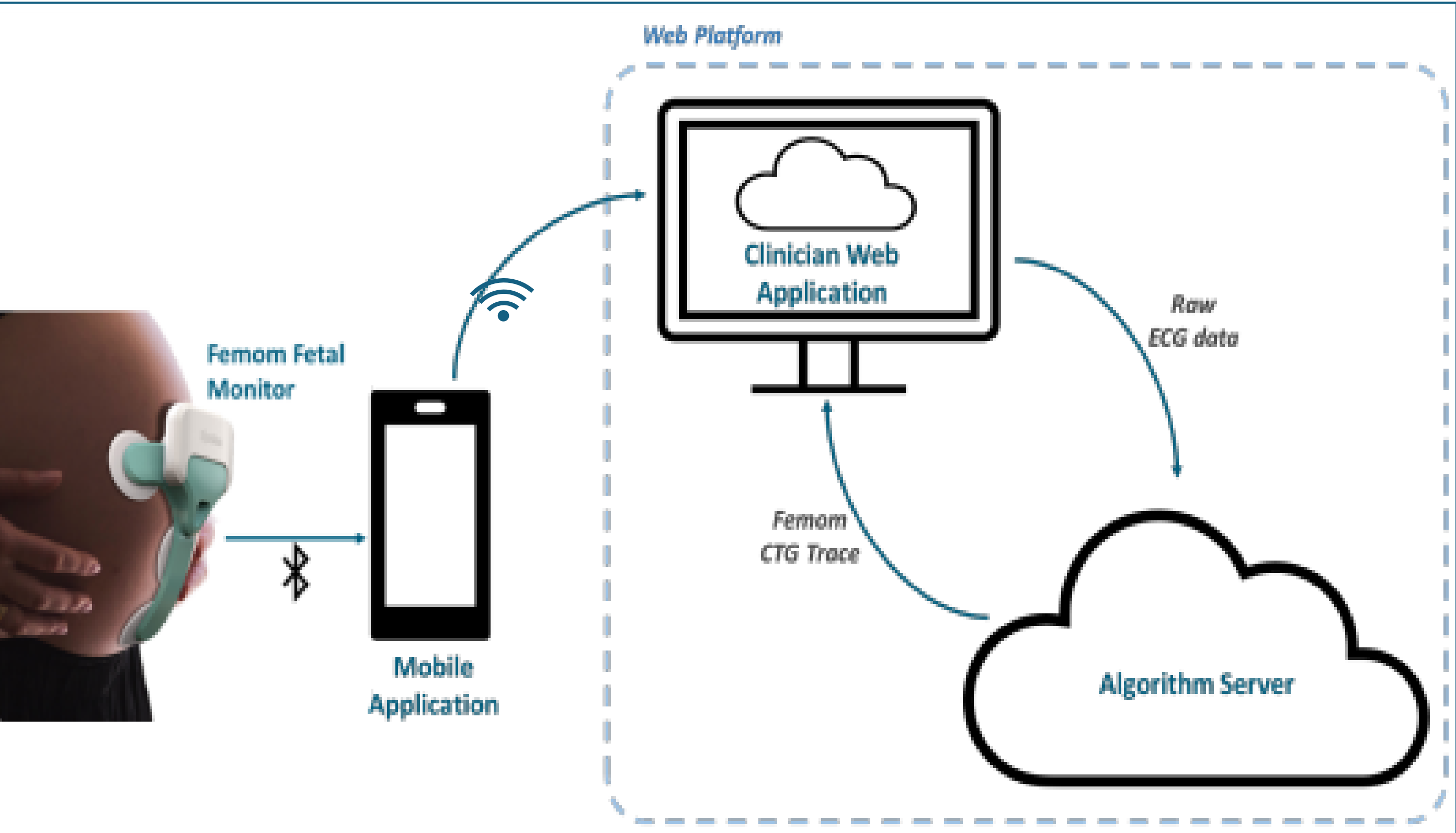
Disclosure Statement: CP is studying an MD(Res) which is funded by Biorithm Pte. CL is Signal Processing Engineer at Biorithm Pte. AN is the CEO of Biorithm Pte. BT is Medical Director of Biorithm Pte. AB holds a research grant from Biorithm Pte.



## Background:

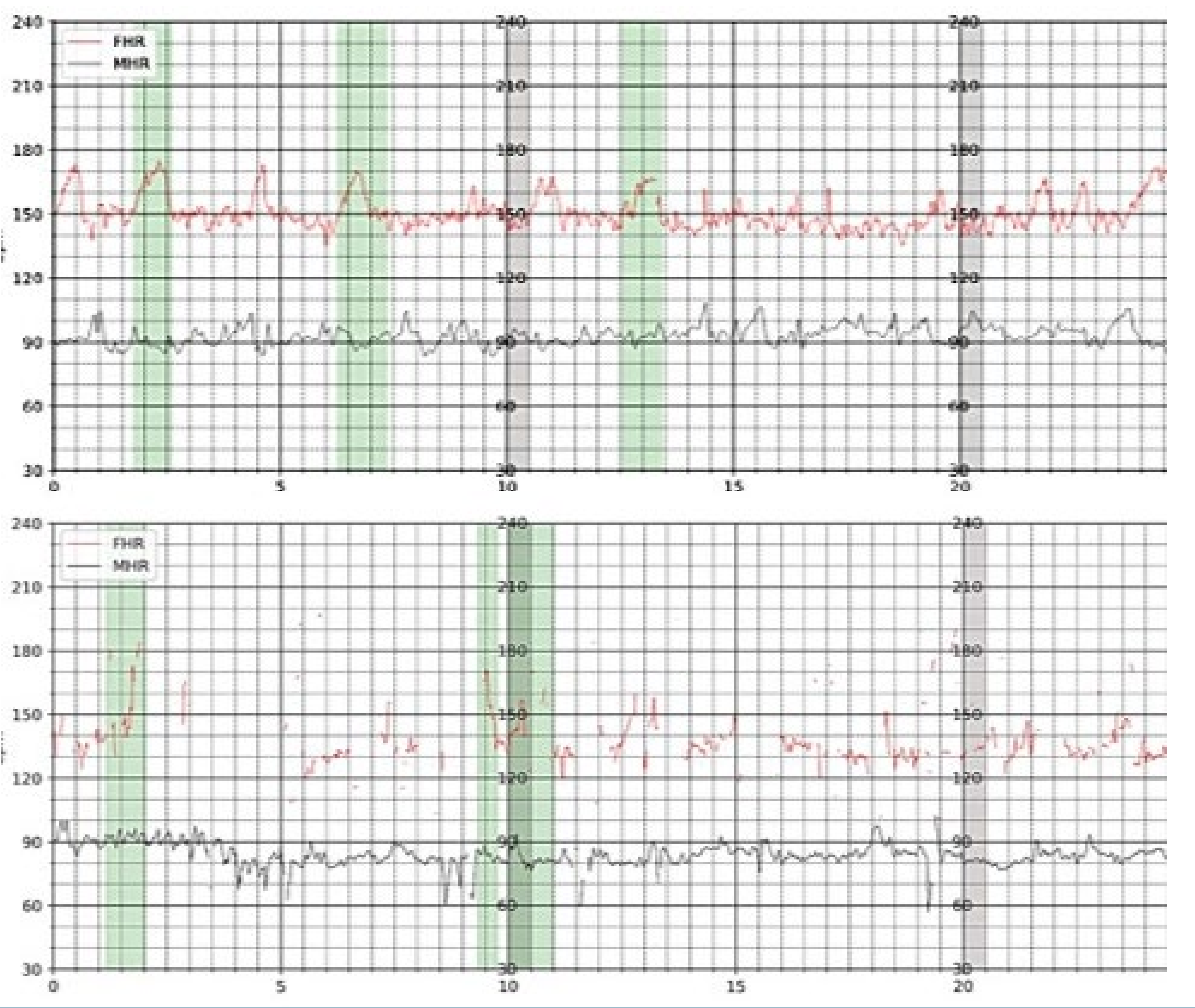
- Current Fetal heart rate monitoring is hospital based requiring trained healthcare professionals to place Cardiotocograph (CTG) transducers which is both time consuming and costly.
- **Non-invasive fetal ECG (NIFECCG)** technology offers a promising alternative for fetal monitoring in a remote (self-applied) setting<sup>1,2</sup>.
- **Feasibility, acceptability, and signal quality** of remote NIFECCG need to be evaluated in a real-world antenatal setting.

*The aim of this study was to assess the acceptability and compliance by mothers, as well as success in obtaining interpretable FHR recordings using remote NIFECCG monitoring.*



The femom<sup>®</sup> device consists of a pod and spreader which stick to the mother's abdomen with electrodes - developed for self application by mothers without healthcare worker intervention. It connects to the mobile phone via Bluetooth and monitoring sessions are started using the mobile application. The app transfers the data to the Clinician's web portal via wifi which is transformed by the server translates into a femom<sup>®</sup> CTG trace.

**Examples of femom<sup>®</sup> CTG traces:** The first trace demonstrates minimal signal loss, deemed acceptable under conventional criteria. The second contains at least 10 consecutive interpretable minutes distributed non-consecutively across the recording.



## Methods

Low-risk women >26<sup>+0</sup> weeks' gestation from a tertiary hospital. Self-applied home FHR monitoring was performed using the femom<sup>®</sup> device (Biorithm Pte, Singapore) daily for minimum 45 minutes for 7 days. **Acceptability and compliance** was defined as the proportion of women able to complete at least onehome monitoring session.

Raw ECG signal underwent de-noising and amplification to obtain the fetal ECG. **Success** was defined as the proportion of traces deemed ACCEPTED with <50% FHR signal loss (current and arbitrary convention). Each trace was processed to calculate the number of interpretable minutes: minutes with <50% signal loss at 4Hz using time window shifting in 15 second increments.

## Results



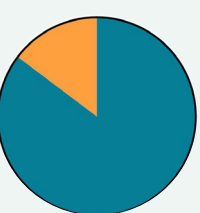
129 low-risk pregnant women  
517 remote fetal ECG traces



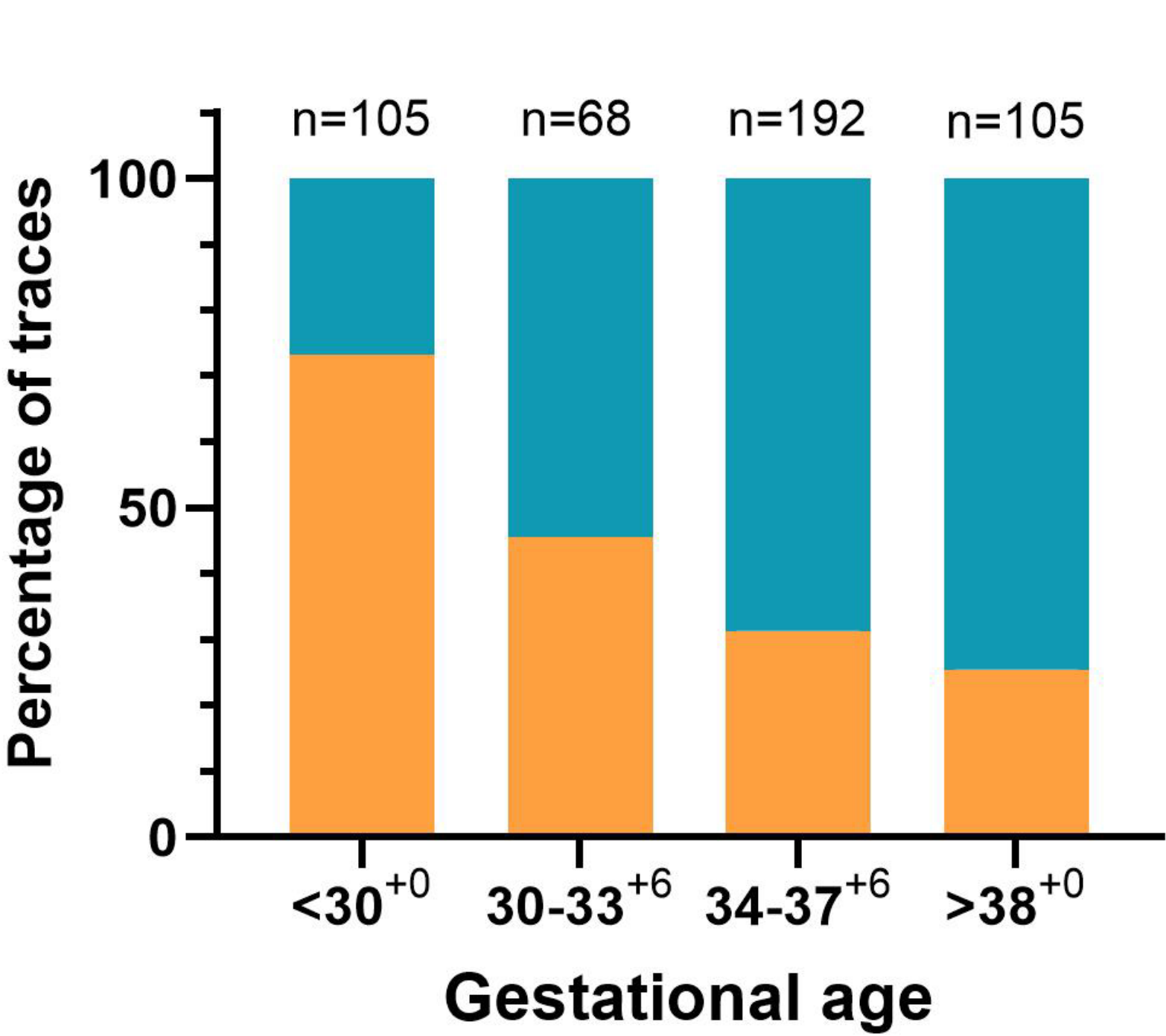
Gestation age 36 (IQR: 31<sup>+6</sup> - 38<sup>+1</sup>)  
Trace length: 44.1min (IQR: 32.1 - 60.0min)



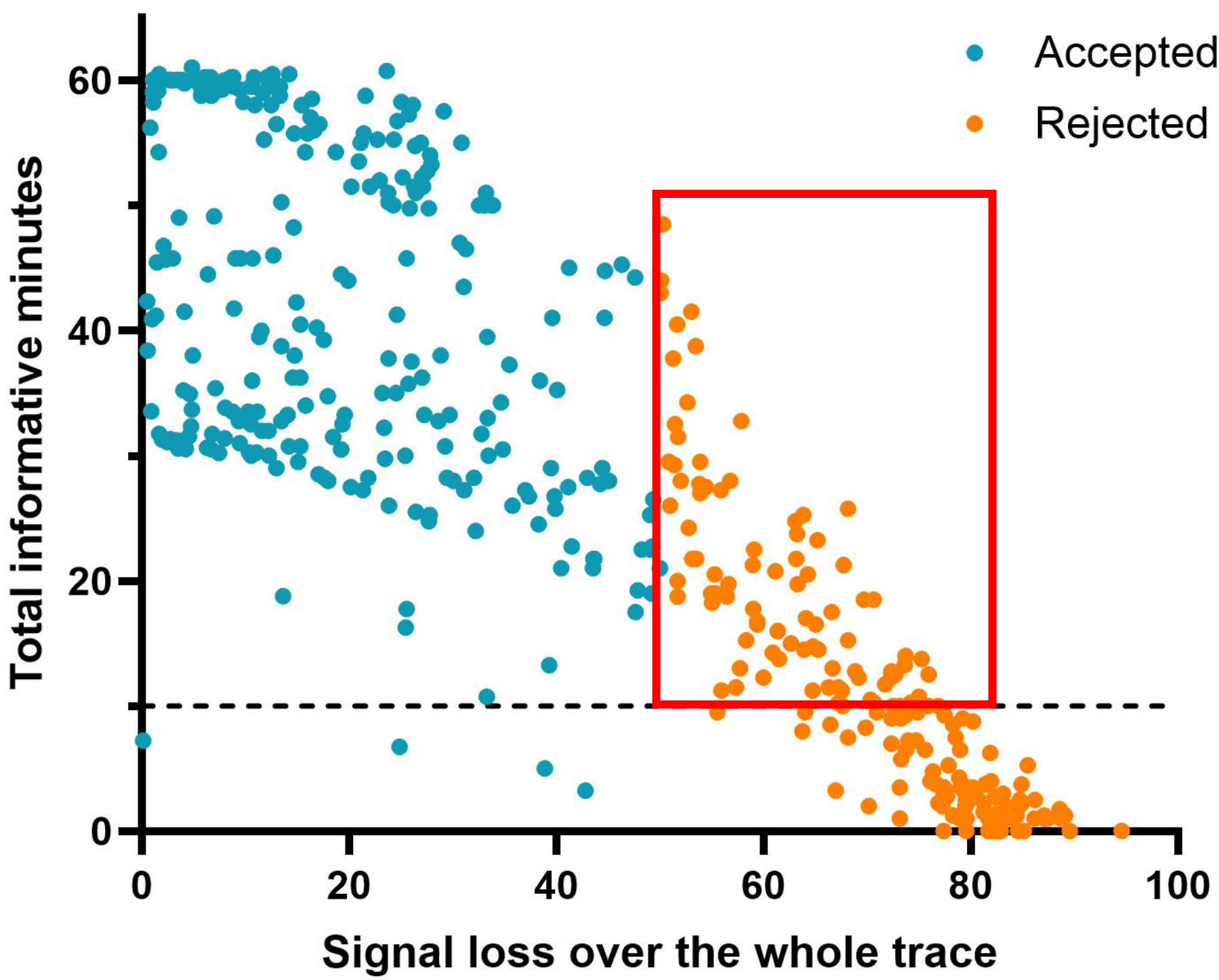
Signal loss over entire trace 33.8% (IQR:12.5-67.1%)  
Total interpretable minutes 29.4min (IQR: 10.3-45.8)



85.3% of women were able to perform at least one recording at home



**Proportion of accepted traces depending on gestational age.** Accepted traces are in blue and rejected in orange. Using the conventional arbitrary cut-off of 50% signal loss, 58% of all traces were accepted. Signal loss decreased with gestational age.



**Overall signal loss (%) vs. total interpretable minutes per trace.** Accepted traces are in blue and rejected in orange. The dotted line marks a proposed 10-minute threshold, which would increase the number of acceptable traces to 85% (red rectangle).

## Conclusion

- Most women can undertake self applied fetal heart rate monitoring using the femom<sup>®</sup> device, which makes it a feasible alternative to current costly and time-consuming hospital-based practices.
- The criteria currently used to decide trace acceptability are based on arbitrary signal loss thresholds. Using different thresholds with alternative time epochs can improve the yield of acceptable NIFECCG traces.
- Further studies and larger numbers are needed to validate alternative signal loss thresholds and the influence this change may have on assessing fetal status.

## References:

1. Liu, B., Ridder, A., Smith, V., Thilaganathan, B. & Bhide, A. Feasibility of antenatal ambulatory fetal electrocardiography: a systematic review. *The Journal of Maternal-Fetal & Neonatal Medicine* **36**, (2204).
2. Liu, B., Thilaganathan, B. & Bhide, A. Correlation of short-term variation derived from novel ambulatory fetal electrocardiography monitor with computerized cardiotocography. *Ultrasound in Obstetrics & Gynecology* (2023) doi:10.1002/uog.26191.