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Posted Date: 29 October 2025

doi: 10.20944/preprints202510.2154.v1

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Article

Investigation of Consistency in Sleep Quality Evaluation Using a Fitbit Device Compared to a Structured Questionnaire Among Breastfeeding Mothers in Ho Chi Minh City, Vietnam

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Abstract

Background: The popularity of wearable health monitoring devices, such as Fitbits, is on the rise. However, their applicability in various research demographics remains uncertain, particularly among postpartum women facing significant sleep challenges. **Objective:** This study aimed to evaluate the consistency between Fitbit Charge 6 and structured interview questions in measuring sleep quality among breastfeeding mothers. **Methods:** A cross-sectional study utilizing random convenience sampling was conducted in Ho Chi Minh City, Vietnam, involving 208 breastfeeding women one month postpartum. The participants used the Fitbit Charge 6 device continuously for four days and three nights to gather daily sleep information; then, they were administered a structured sleep questionnaire via home interviews. **Results:** The correlation between the total sleep time (TST) recorded by both the device and interview was weak ($r = 0.28$), as was the correlation for short nap duration ($r = 0.25$). The agreement between the Fitbit Sleep Score and sleep satisfaction from the questionnaire was 79.9%, with a notably low Kappa index (0.02), indicating a lack of strong agreement. **Conclusion:** The Fitbit Charge 6 did not show reliable correlation with the subjective sleep data reported by one-month postpartum breastfeeding women. Further research employing rigorous comparative studies is necessary to assess the validity and reliability of sleep data collection methods for this demographic.

Keywords: breastfeeding practice; diagnosis; health monitor; Fitbit Charge 6; sleep disorder; structured questionnaire; wearable device

1. Introduction

Breastfeeding offers numerous advantages for both mothers and their infants [1–3]. Nevertheless, this experience can sometimes be challenging, as many mothers report feelings of fatigue and inadequate rest. The Empowering Mothers Improving Breastfeeding (EMIB) project is a collaborative study between University of Medicine and Pharmacy at Ho Chi Minh city, Vietnam (UMC) and Yonsei University, Korea. EMIB aims to evaluate how breastfeeding practices affect mothers' physical and mental health. One of the aims of this study is to determine how breastfeeding practices affect mothers' sleep. Although some studies have shown that breastfeeding practices in any form do not affect mothers' sleep duration or sleep quality [4,5], others have shown that breastfeeding increases the number of times mothers wake up during the night [6,7].

In Vietnam, polysomnography (PSG) is the gold standard for assessing sleep quality. However, it is expensive, difficult to implement in the community, and only applicable to small sample sizes in controlled environments [8]. Therefore, the EMIB project used two sets of tools at the same time, the

Fitbit Charge 6 wearable device and a structured questionnaire, to record sleep data under natural living conditions.

No specific studies have evaluated the Fitbit Charge 6 wearable device in specific populations, such as postpartum women. In other words, results from healthy subjects may not necessarily apply to other specific populations. Choosing the right data collection instrument is crucial in community health evaluation. This choice not only guarantees the accuracy of the research findings but also conserves resources, including time and finances.

This research is affiliated with the EMIB project. The goal of this study was to evaluate the degree of alignment between two assessment tools (Fitbit Charge 6 and a structured interview questionnaire) in measuring sleep quality. The findings will assist researchers in selecting the most suitable tool for evaluating sleep in particular demographics.

2. Methods

2.1. Study Design and Participants

A cross-sectional study design was employed. The study utilized a convenient random sampling method. The inclusion criteria comprised mothers aged 18 and above who visited the University Medical Center's Healthy Child Clinic for a follow-up appointment, practiced breastfeeding within one month postpartum, and consented to participate in the research. The exclusion criteria consisted of mothers whose children had chronic illnesses, those using sleep aids, and mothers with breastfeeding contraindications, such as heart failure, severe pulmonary tuberculosis, advanced liver disease, treatment with antiepileptic or psychiatric medications, a breast cancer diagnosis, or drug addiction.

A pilot study was carried out involving the first four mothers to assess the correlation between sleep duration and nap length, as measured with the Fitbit device and through direct interviews. The determined correlation coefficient r ranged from 0.2 to 0.3. The data obtained from these initial four mothers were incorporated into the study.

2.2. Study Procedures

The study was described to all mothers who came for a 1-month postpartum check-up at UMC. If they agreed to participate, they would sign a consent form ($n=369$). A researcher would then schedule an appointment to visit the mothers' homes. At this appointment, a Fitbit device would be synchronized with a smartphone through a system-encrypted Google account. We also instructed the mothers on how to wear the device continuously for 4 days and 3 nights and advised them on how to ensure continuous data recording. However, during this period, 161 subjects refused to continue for various reasons: because they found it annoying, did not want to wear the device for fear of affecting the baby, or were allergic to the strap. On the 5th day, the researcher returned to the mothers' home to collect the device and interviewed them directly using a structured questionnaire integrated into the KoboToolbox software, including 136 questions, 10 questions of which were about sleep. The interview duration was 40 minutes. At this stage, only 208 cases remained for further study, 4 cases of which had incomplete data. Finally, 204 mothers had sufficient data for analysis, during the period from 07/2024 to 04/2025 (Figure 3).

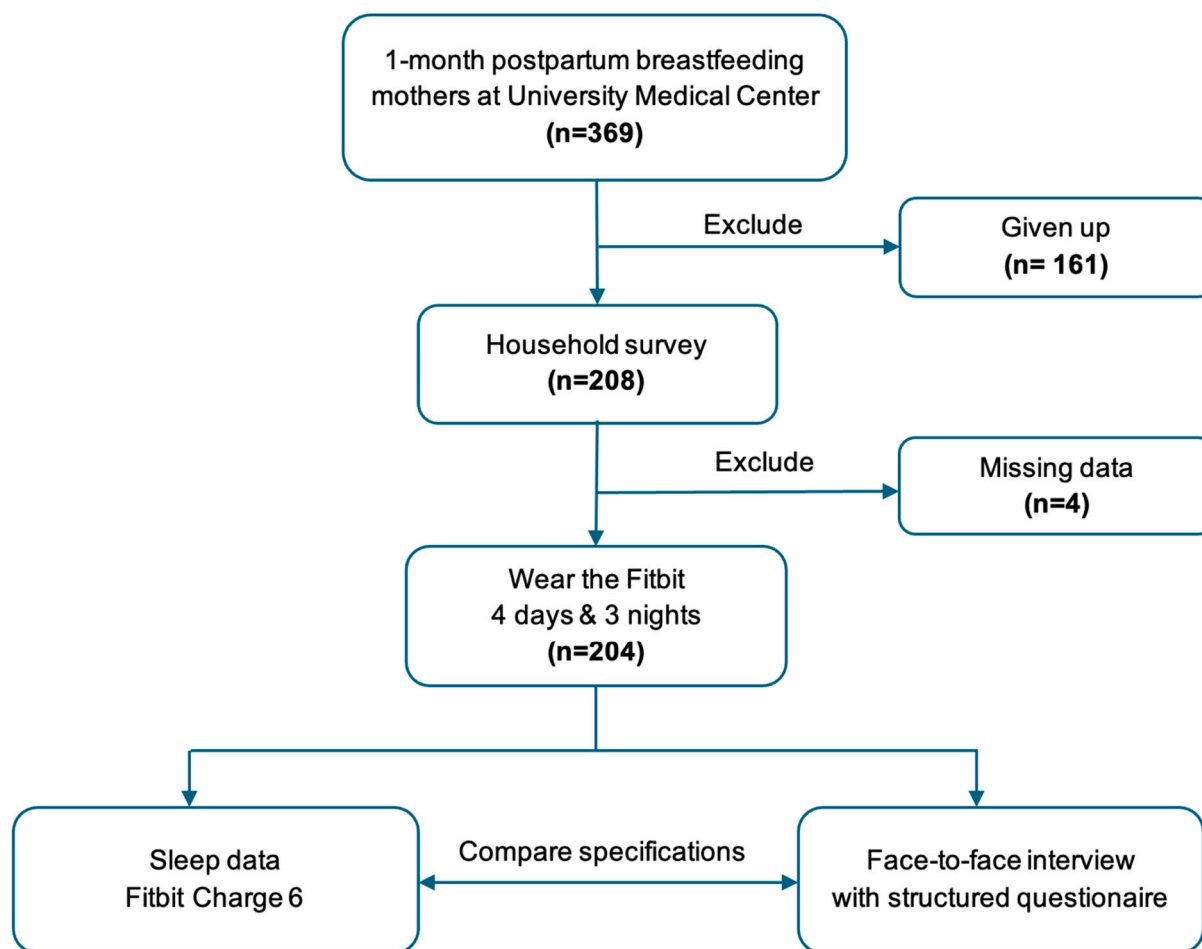


Figure 3. Research process flow chart.

2.3. Sample Size

Sample size was estimated using the correlation coefficient estimation formula:

$$n \geq \left(\frac{Z_{1-\alpha/2} + Z_{1-\beta}}{\frac{1}{2} \log_e \frac{1+r}{1-r}} \right)^2 + 3$$

With $\alpha = 0.05$ and $\beta = 0.2$, the estimated correlation coefficient between Fitbit-recorded sleep time and direct survey questions across the pilot studies ranged from 0.2 to 0.3; we chose $r = 0.2$ to determine the largest minimum sample size. The minimum sample size was calculated to be 194 1-month postpartum breastfeeding mothers.

2.4. Variables and Measurements

Regarding the structured questionnaire, sleep quality is based on the Oxford Sleep Survey and CDC Sleep Quality Module (BRFSS) [9]. It consists of 10 questions focusing on total sleep time (TST) including sleep latency, frequent nighttime awakenings, daytime short nap habits, sleep disorder symptoms, and body sensation after waking up.

The Fitbit Charge 6 tool, from Fitbit Inc., a technology company officially acquired by Google in 2021, helps expand the integration between health monitoring hardware and the Google Health data platform [10]. Fitbit Charge 6 is the latest version of the Charge wristband device line, with advantages in sleep monitoring (Figure 1). It operates on the principle of integrating physiological indicators such as heart rate, heart rate variability (HRV), etc., and motion sensors to produce specific parameters in each sleep stage [11,12].



Figure 1. Fitbit Charge 6 device.

Parameters extracted from the device include the total sleep time, time awake during sleep cycle, light sleep time, deep sleep time, REM sleep time, time of short naps during the day, and sleep quality score (Figure 2). Some studies show that Fitbit has reliable results and can replace polysomnography (PSG) when monitoring the health of subjects in the field [13–15]. According to a comparative study with PSG, the Fitbit Charge 3 series on student subjects has high sensitivity in detecting sleep (0.95), superior specificity in detecting wakefulness (0.69 compared to 0.33 and 0.29 in actigraphy algorithms), and a very high positive predictive value (0.99) [14].

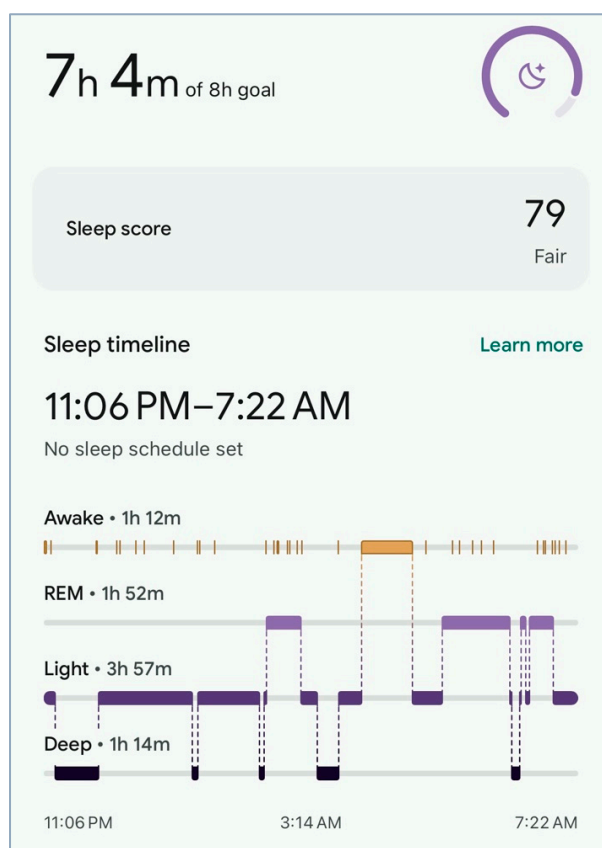


Figure 2. Sleep data and components recorded in the study.

We focused on analyzing 9 groups of variables related to sleep characteristics, including total sleep time (TST), short nap time, sleep latency, sleep satisfaction after waking up, sleep stages, sleep disorder symptoms, co-sleeping habits with infants, number of roommates, and causes of insomnia (Table 1).

Of these, four variables (collected simultaneously via the Fitbit device and structured questionnaire) were selected for direct comparison: TST, short nap duration, sleep satisfaction, and Wake After Sleep Onset (WASO). In particular, the sleep satisfaction variable from the questionnaire reflecting the subjective perception of rest and recovery after sleep was compared with the Fitbit Sleep Score, a composite measure calculated by Fitbit's internal machine learning algorithm based on components such as sleep duration, deep/REM sleep ratio, and restoration index [16]. For WASO, we compared objective data recorded with the wearable device with the mothers' subjective perception of how often they woke up during the night. According to the American Academy of Sleep Medicine (AASM), healthy adults have a total wake time of only 20 - 40 minutes in the sleep cycle; exceeding this threshold is a warning sign of significant sleep fragmentation [17].

Other clinical data collected included the socio-demographic characteristics of the study participants: age, religion, education level, pre-pregnancy BMI, exclusive breastfeeding, and number of roommates. These variables were used to help interpret the results and further discuss factors affecting sleep in postpartum women with breastfeeding practices.

Table 1. Variables used to examine conformity between the two tools.

Main variables	Fitbit Charge 6	Interview questions
Total sleep time	Total Sleep Time (min)	During the past week, on average how many hours of actual sleep did you get at night?
Nap duration	Time Asleep (min)	During the past week, did you take naps during the day? If yes, how long do you nap for a day?
Sleep satisfaction	Sleep Score	During the past week, have you been feeling sleepy or tired even after getting sleep?
Sleep stages	Time Awake (min)	During the past week, have you been waking up repeatedly during the night?
	REM (min)	-
	Light (min)	-
	Deep (min)	-
Sleep latency	-	On average how long does it take you to fall asleep?
Sleep disorder symptoms	-	Are you having any symptoms of a sleep disorder (such as snoring or gasping for air)?
Co-sleeping with Newborn	-	Are you sleeping with your newborn baby?
Number of people sleep in room	-	How many other people sleep in the same room with you?
Causes of poor sleep	-	If you don't sleep well, what are the causes?

2.5. Data Analysis

The Fitbit device would be synchronized with a smartphone through a system-encrypted Google account. The structured questionnaire integrated into the KoboToolbox software. All data from the two sources above will be entered, cleaned, and analyzed using Stata 17.0 software (Stata Corp LLC, Lakeway Drive, College Station, April 2021-TX, USA).

We used frequencies and percentages to describe qualitative variables and means and standard deviations to describe quantitative variables. The correlation between sleep duration and nap duration recorded with the Fitbit and direct survey questionnaire was assessed using Pearson's correlation coefficient, classified as strong (> 0.5), moderate ($0.50 - 0.30$), and correlation (< 0.30) [18]. Agreement between the Fitbit Sleep Score and sleep satisfaction from the direct interview was

assessed with the Kappa index, classified as very good (1.00 - 0.81), good (0.80 - 0.61), fair (0.60 - 0.41), poor (0.40 - 0.20), and very poor (< 0.20) [19].

2.6. Ethical Considerations

This study was conducted in accordance with the Declaration of Helsinki. Ethics approval for the study was obtained from the HCMC University of Medicine and Pharmacy Ethics Council on Bio-Medical Research via Decision No. 619/UMP-BOARD, issued on May 2, 2024. Written informed consent for participation was obtained from all subjects involved in this study. Data was kept anonymous and confidential during all stages of the study. Mothers with a sleep disorder that seriously affected quality of life were referred to a specialist for appropriate management.

3. Results

3.1. Characteristics of Research Subjects

The subjects of our study were all mothers who breastfed their babies about 1 month after giving birth. The average age of the mothers in the study was 30.3 ± 3.9 years, with the majority being between 25 and 35 years old (83.3%). Most of the mothers did not follow any religion (92.7%), had a college or university degree or higher (90.7%), and had a maternal BMI at the time of the survey according to Asian standards from 18.5 to 22.9 (49.5%) with a high rate of overweight (45.6%) (Table 2).

Table 2. Socio-demographic characteristics of participants (n = 204).

Characteristics	Number of cases (n = 204)	Proportion (%)
	Age*: 30.3 ± 3.9 (20; 43)	
< 25	16	7.8
25 - 35	170	83.3
> 35	18	8.8
Religion		
No	191	93.6
Buddhism	12	5.9
Catholic	1	0.5
Education		
High school	9	4.4
College-University	185	90.7
Postgraduate	10	4.9
	Maternal BMI at survey *: 22.9 ± 3.0	
Normal (18.5 – 22.9)	101	49.5
Light weight (< 18.5)	10	4.9
Overweight (> 22.9)	93	45.6
	Exclusive breastfeeding	
No	109	53.4
Yes	95	46.6
	Number of people sleeping in the same room: 3 ± 1 (1; 5)	
≤ 3	153	75.0
> 3	51	25.0
	Co-sleeping with newborn baby	
No	4	2.0
Yes	200	98.0

*: Mean ± SD.

3.2. Assessment Using Fitbit Device

Table 3 shows the assessment results of sleep characteristics using Fitbit watches. The average sleep time of the study subjects was 5.5 ± 1.4 (hours), of which the majority had a sleep time of less than 6 hours (60.3%). The majority awoke during the sleep cycle (99.0%), with 54.0% of total awakenings lasting more than 40 minutes and took naps during the day (71.6%). Sleep Score was classified according to the device manufacturer's instructions (good: ≥ 80 points; poor: < 80 points), and the majority of study subjects had poor Sleep Scores (95.6%).

Table 3. Results of sleep quality assessment using Fitbit device.

Characteristics	Number of cases (n = 204)	Proportion (%)
Sleep time (hours): 5.5 ± 1.4		
< 6 hrs	123	60.3
≥ 6 hrs	81	39.7
Waking up during sleep cycle		
No	2	1.0
Yes	202	99.0
Time awakes during sleep cycle (minutes)^a: 43.7 ± 36.8		
< 40	93	46.0
≥ 40	109	54.0
REM sleep time (minutes): 63.6 ± 23.3 (0; 130)		
Light sleep time (minutes): 184.0 ± 46.0 (54; 347)		
Deep sleep time (minutes) (n= 182): 50.2 ± 17.5 (0;130)		
Naps		
No	58	28.4
Yes	146	71.6
Time of naps^b (minutes)(n=146): 99.9 ± 35.7		
Sleep Score: 66.6 ± 8.1		
Not good	195	95.6
Good	9	4.4

^a: recorded in people with awakenings during sleep cycles (n = 202). ^b: noted in people with short naps (n = 146).

3.3. Assessment Using Direct Interview

Table 4 shows the assessment results obtained via direct interview with the study participants. The average sleep time of the study participants was 4.6 ± 1.0 (hours), and some participants slept less than 6 hours (83.8%). Most of them woke up during the sleep cycle (90.7%), took short naps during the day (92.2%), and were not satisfied with their sleep (82.4%).

Table 4. Results of sleep quality assessment using direct interview.

Characteristics	Number of cases (n = 204)	Proportion (%)
Sleep time (hours): 4.6 ± 1.0		
< 6 hrs	171	83.8
≥ 6 hrs	33	16.2
Sleep latency (minutes): 14 ± 9.6		
Normal (< 20 min)	168	82.4
Difficulty (≥ 20 min)	36	17.6
Frequent awakenings during sleep cycles		
No	19	9.3
Yes	185	90.7
Naps		
No	16	7.8
Yes	188	92.2
Time of naps^a (minutes): 50.1 ± 19.1		

Characteristics	Number of cases (n = 204)	Proportion (%)
Feeling after waking up (tired, sleepy):		
Not good	168	82.4
Good	36	17.7
Symptoms of sleep disorders:		
No	184	90.2
Yes	20	9.8
Reasons:		
Can't get enough sleep	150	73.5
Can't sleep	48	23.5
Wake up during the night	153	75.0
Baby waking up	195	95.6
Others	8	3.9

^a: noted in people with short naps (n = 188).

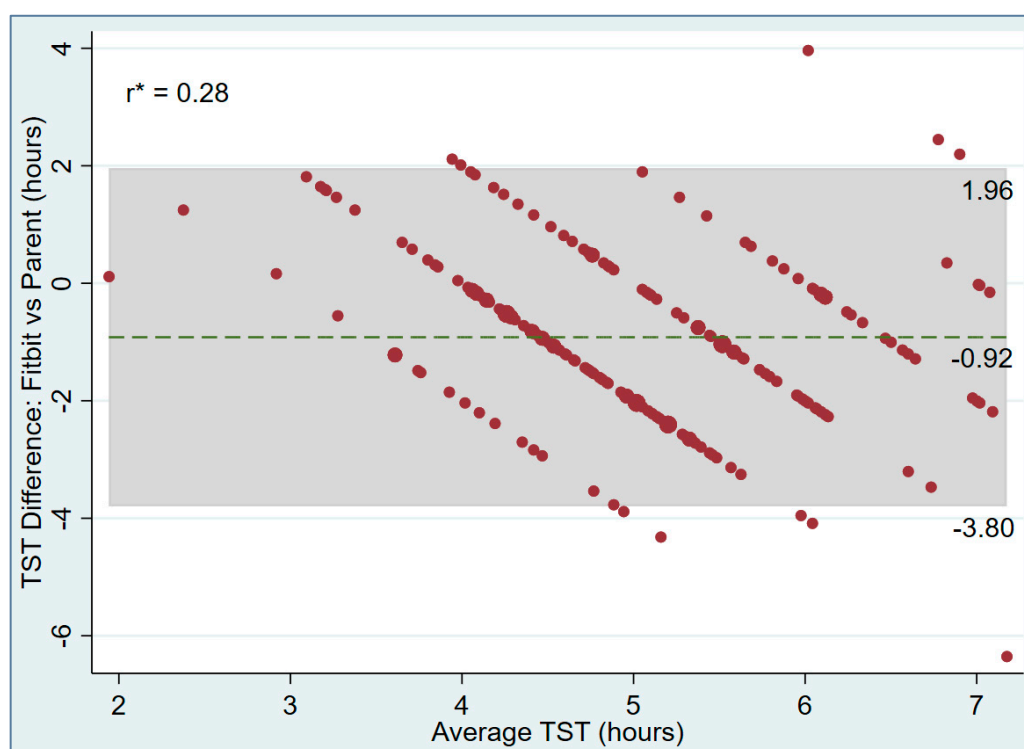
3.4. Conformity Between the Two Recording Toolkits: Fitbit vs. Face-to-Face Interview Panel

Table 5 shows a statistically significant and weak correlation ($r = 0.28$) between total sleep time (TST) recorded via Fitbit and face-to-face interview, as well as for nap time ($r = 0.25$).

Table 5. Correlation between information from Fitbit and direct interview.

Sleep characteristics	Correlation coefficient	p
Sleep time	0.28	< 0.001
Time of naps	0.25	< 0.001

A Bland–Altman plot shows the level of agreement between total sleep time (TST) recorded via Fitbit and face-to-face interview [mean difference (hours): -0.92; range of agreement (hours): -3.8 to 1.96] (Figure 4A), and another shows the same for nap time [mean difference (minutes): 44.77; range of agreement (minutes): 0.48 to 89.06] (Figure 4B).



(A)

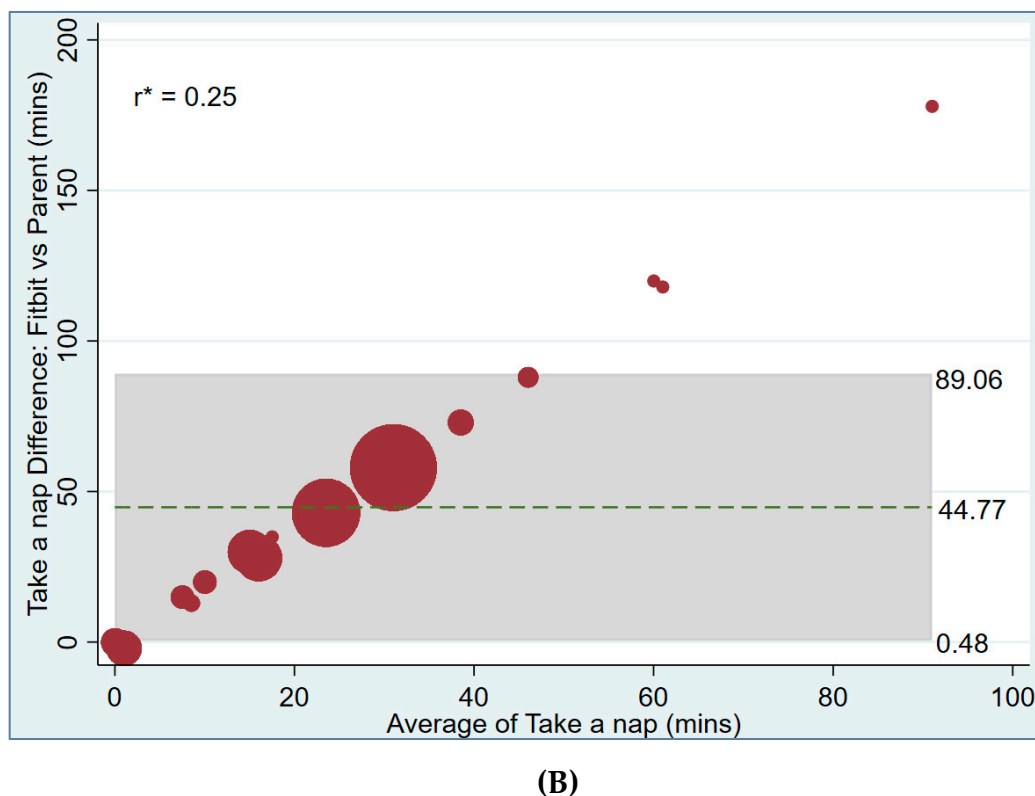


Figure 4. Bland–Altman plot; (A): Agreement between total sleep time (TST) recorded via Fitbit and face-to-face interview; (B): Agreement between nap time recorded via Fitbit and face-to-face interview; *: statistically significant correlation ($p < 0.05$).

The comparison between the two groups of Sleep Score (good and bad) and sleep satisfaction (satisfied and dissatisfied) was 79.9%, and the assessed Kappa index was 0.02 (weak). The WASO index shows that the level of agreement between Fitbit and the questionnaire was very low (50.98%), with Kappa = - 0.04, which is not statistically significant ($p = 0.856$). The results show that the two methods were almost in disagreement in assessing the time of wakefulness in the sleep cycle (Table 6).

Table 6. Concordance comparison between Fitbit and structured questionnaires when assessing sleep.

Characteristics	Agreement (%)	Kappa
Wake After Sleep Onset (WASO)	51.0%	- 0.04
Sleep Score and Sleep satisfaction	79.9%	0.02*

* $p < 0.05$.

4. Discussion

The EMIB study employed two assessment tools to evaluate sleep quality in breastfeeding mothers one month postpartum. This allowed for comparison of the tools in community research. The study serves as a significant pilot for exploring the link between breastfeeding practices and maternal health, which will be discussed in a separate paper.

The correlation between sleep duration measured by Fitbit and self-reported sleep in our study was weak ($r = 0.28$; $p < 0.001$). This correlation is substantially lower than that observed in populations with stable sleep patterns, such as young adults in Lee's study [20] ($r = 0.55$) and children in Brazendale [21] ($r = 0.71$), as well as lower than the correlation between Fitbit and EEG reported by Kawasaki [13] ($r = 0.83$). Fitbit measures total sleep time through constant monitoring of sleep stages, while self-reports rely on personal perception, which can misrepresent sleep duration for mothers with disrupted sleep after childbirth.

The study found a low agreement (50.98%) between Fitbit data and subjective questionnaires regarding wake time during sleep (WASO), with a κ coefficient of -0.04 and no statistical significance ($p = 0.856$). These results are like those of Dong X [22] on subjects with characteristics of chronic sleep disorders, comparing the Fitbit Charge 4 device with the gold standard PSG. The authors found that the Fitbit device's WASO measurements were not significantly different from PSG but had low specificity (62.2%) in identifying wakefulness. This indicates that it often overlooks brief wakeful moments. While it can accurately track total sleep time, its ability to assess sleep quality and disturbances is limited when only using the device. Thus, caution is advised for interpreting results, particularly in individuals with disrupted sleep, like postpartum mothers who experience frequent awakenings.

The study found a weak correlation ($r = 0.25$; $p < 0.001$) between nap durations tracked by Fitbit and those reported by users, making data analysis more difficult. Fitbits record sleep stages only after a certain duration is met for heart rate to stabilize. In our sample, it failed to capture naps shorter than 54 minutes, suggesting that many short naps commonly reported by participants may have been overlooked. This limitation aligns with previous findings showing that wearable devices often fail to detect naps under 1 hour [23], which likely contributes to the weak agreement between objective and self-reported measures.

The agreement between the Fitbit Sleep Score and the participants' self-reported sleep satisfaction was low (concordance % = 79.9; Kappa = 0.02). In adults, Schyvens [8] reported a moderate agreement between Fitbit Charge 5 and PSG, with a Kappa of 0.41. While Haghayegh [24] found a Kappa of 0.54 comparing Fitbit with EEG, noting high sensitivity (95%) but only moderate specificity (57%). These results reveal that wearable devices have limitations in accurately measuring sleep. Differences between device readings and personal experiences can occur because the Sleep Score is derived from an internal algorithm that doesn't always match how someone feels about their sleep. In postpartum women, disrupted sleep from frequent waking at night makes self-reported total sleep and perceived sleep quality even less accurate. Supporting this, Young Lin (2025) [23] using the Fitbit device, which demonstrated a significant and prolonged reduction total sleep time, including deep and REM sleep postpartum, reflecting a pattern of fragmented and less restorative sleep. Postpartum women often experience disrupted sleep due to nighttime childcare, leading them to feel they are not getting enough quality sleep, even if their total sleep duration isn't significantly lower. A meta-analysis showed that total sleep time and sleep efficiency decreased after childbirth for both fathers and mothers, with increased wake-up time after sleep onset [25]. The majority of causes of decreased sleep time are due to natural physiological changes as well as anatomical changes that return mothers' bodies to a non-pregnant state [26]. In addition, breastfeeding practices as nighttime feeding may also be associated with shortened nighttime sleep duration [27], and the need to breastfeed after sleep onset negatively affects sleep duration in the first months of life [28].

In summary, Fitbit measures sleep quality using factors like sleep duration, interruptions, and stages, which suit the general population. However, for postpartum individuals, sleep is often disrupted by the baby's needs and breastfeeding schedules. Both Fitbit and surveys may miss or misjudge personal sleep details. For instance, short naps might go undetected by the device, and the survey's results depend on personal memory. Thus, any tool used should be thoughtfully applied, and findings should be understood within the postpartum context instead of normal adult sleep standards.

New point in applicability: This research involves a large community sample and gathers data over four days and three nights during everyday activities, improving its representativeness. The results show that each assessment method has distinct advantages and disadvantages for certain metrics. Furthermore, the study suggests improving sleep algorithms in wearable devices to better fit the physiological and behavioral characteristics of breastfeeding mothers. These findings can help researchers choose more appropriate tools and guide sleep and mental health policies for postpartum mothers.

Limitation of study: Information bias may be inherent due to the structured nature of the interview, which necessitates recall from participants. We have analyzed awakenings during sleep in general, assuming that they have the same effect on the mother. This may be a potential bias from a scientific perspective, as natural awakenings are different from active awakenings for breastfeeding. This research shows that the two methods for assessing sleep quality differ, but it doesn't prove which one is better.

5. Conclusion

The study findings indicate that, despite a statistically significant relationship between the two methods for measuring sleep duration and napping, their association is weak. Specifically, concordance is minimal between the Fitbit Sleep Score and the sleep satisfaction levels obtained from direct interviews, as evidenced by a Kappa index that suggests nearly no agreement. It is necessary to perform additional studies utilizing a "diagnostic test study" framework with a gold standard for evaluating sleep quality, such as polysomnography, to reassess the efficacy of both research instruments among mothers engaged in breastfeeding.

Data Availability Statement: The original contributions presented in this study are included in the article. Further inquiries can be directed to the corresponding author.

Acknowledgments: This work received support from the Korea International Cooperation Agency (KOICA) under the project titled "Education and Research Capacity Building Project at University of Medicine and Pharmacy at Ho Chi Minh City", conducted from 2023 to 2025 (Project No. 2021-00020-3). The authors thank all members for their participation in this study implementation, as well as all the doctors and staff of University Medical Center's Healthy Child Clinic at Ho Chi Minh city, Vietnam, for their support.

Author contributions: All authors have remarkably contributed to the formation of study concepts, the study design, data collection, and data analysis and interpretation; participated in writing or editing important contents; approved the final report for publication; and agreed to take responsibility for all aspects of the research work.

Conflicts of interest: The authors confirm there is no conflict of interest in this work.

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