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Enhancing Postpartum Maternal Health through Educational Interventions and Non-Invasive Biomedical Immunology-Based Monitoring in Pagesangan, Kebonsari, Surabaya

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ABSTRACT
The maternal mortality rate (MMR) in Indonesia remains relatively high, with postpartum infection being one of the leading causes. The postpartum period is a critical phase during which physiological changes occur, increasing the risk of infection. However, the lack of adequate maternal health monitoring remains a challenge in the early detection of complications. This study aims to implement health technology-based monitoring using wearable sensors (HRV sensor/smartwatch) and axillary thermometers to detect changes in maternal body temperature and heart rate variability during the postpartum period. A total of 20 postpartum mothers, aged 2-14 days, from Pagesangan Subdistrict, were monitored for seven days. The results showed that the majority of participants (90%) were in good health; however, two participants (10%) experienced an increase in body temperature above 38°C and unstable HRV, which are early indicators of postpartum infection. These participants were immediately provided with additional health education and referred to healthcare professionals for further examination. Meanwhile, the remaining participants continued to receive routine monitoring and education regarding postpartum infection prevention. The implementation of this community service program demonstrated that health technology-based monitoring is effective in detecting real-time health condition changes, allowing for faster medical interventions and increasing maternal awareness of postpartum health. The findings suggest that this method can serve as an innovative approach to reducing postpartum infection risks and improving maternal health quality. Further development and wider application of this approach in other regions are recommended to enhance postpartum care and maternal well-being.

Keywords: Health Technology, Postpartum Infection, Postpartum Mothers

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INTRODUCTION

The maternal mortality rate (MMR) in Indonesia remains relatively high compared to other ASEAN countries. According to the 2022 Indonesian Nutritional Status Survey (SSGI), the

MMR reaches approximately 189 per 100,000 live births. Most maternal deaths occur during the postpartum period, particularly within the first 24 hours to one week after delivery. The primary causes of postpartum maternal mortality include postpartum hemorrhage (40-50%), postpartum infection (sepsis puerperalis) (15-20%), preeclampsia and eclampsia (10-15%), pulmonary embolism, and other complications (10%) (Kementerian Kesehatan RI, 2022). Additionally, many postpartum mothers experience various health complications affecting their well-being and that of their newborns, including postpartum anemia, perineal wound infections, psychological disorders, and breastfeeding difficulties (SDKI, 2022). The postpartum period, defined as the 42 days following childbirth, is crucial for maternal recovery and infant health (Prawirohardjo, 2020). However, the lack of maternal awareness regarding postpartum care remains a significant challenge in Indonesia, increasing the risk of complications such as infections, hemorrhage, and other health disorders (Hayati, 2020). Several factors contribute to the lack of awareness among postpartum mothers, including insufficient education and information, socio-cultural factors, limited access to healthcare services, and inadequate mental health awareness (Asa Bayuana, 2023).

In practice, postpartum maternal health monitoring is still limited to conventional examinations, which are not entirely effective in the early detection of complications. Conventional examinations primarily include blood pressure measurement, body temperature assessment, perineal wound inspection, and monitoring of postpartum bleeding and psychological conditions (Asa Bayuana, 2023). Data from the Surabaya City Health Office indicate that many postpartum mothers fail to undergo postnatal health examinations according to recommended standards. Reports from Kebonsari Public Health Center in Pagesangan Subdistrict reveal that the number of postpartum mothers attending postnatal check-ups remains below the targeted levels (Kementerian Kesehatan RI, 2022). This lack of awareness regarding postpartum danger signs, such as excessive bleeding, perineal wound infections, and breastfeeding difficulties, may lead to severe complications that increase maternal morbidity and mortality (WHO, 2020).

Several previous community service programs have been conducted to improve postpartum maternal health monitoring. A study by Handayani et al. (2021) focused on conventional postpartum monitoring methods such as home visits and health counseling, which increased maternal awareness but lacked real-time physiological monitoring. Another study by Nugroho et al. (2022) implemented mobile-based monitoring but did not integrate physiological parameters such as HRV and body temperature. Meanwhile, research by Sari et al. (2023) used wearable health monitoring devices but was limited to a small-scale hospital setting. Compared to these studies, the current program integrates wearable sensor technology with community-based monitoring, allowing for real-time detection of postpartum complications and more effective early interventions. This approach provides a more comprehensive strategy for reducing postpartum infection risks and improving maternal health outcomes (Task Force of The European Society of Cardiology, 1996).

Therefore, educational interventions and health monitoring strategies are needed to enhance maternal awareness and promote optimal postpartum self-care. Implementing non-invasive biomarker-based monitoring methods, community-based education, and leveraging technology for maternal and infant health monitoring can systematically improve postpartum care services and reduce maternal complications and mortality rates (Bobak, 2020).

METHODS

This community service initiative employed an educational and technology-based health monitoring approach, following these stages: The target population comprised all postpartum mothers aged 2-14 days in Pagesangan Subdistrict, with a total sample of 20 respondents.

Wearable sensor technology was used to monitor maternal body temperature for seven days using an axillary thermometer. A temperature above 38°C was considered an indication of potential postpartum infection. HRV (Heart Rate Variability) sensors in the form of smartwatches were utilized to continuously record heart rate fluctuations.

Table 1. Activity Planning

Activity Plan	Output Indicators
Preparation for Socialization	
Identification and recruitment of postpartum mothers (aged 2–14 days) in Pagesangan Village	20 postpartum mothers registered as research respondents
Socialization on the use of wearable sensors and axillary thermometers for postpartum mothers	Postpartum mothers understand how to use the monitoring devices
Distribution of wearable sensors (HRV sensor/smartwatch) and axillary thermometers	All postpartum mothers receive monitoring devices
Monitoring Implementation	
Monitoring postpartum mothers' body temperature for 7 days using an axillary thermometer	Daily body temperature data recorded
Continuous HRV monitoring using a smartwatch	Daily heart rate data recorded
Identification of postpartum infection signs (temperature >38°C, HRV changes)	Data on potential postpartum infections obtained
Evaluation and Education	
Analysis of temperature and HRV monitoring data	Report on postpartum mothers' health monitoring results
Education for postpartum mothers on infection prevention and management	Increased postpartum mothers' understanding of postpartum health
Presentation of results to local healthcare professionals	Coordination with healthcare professionals for high-risk case follow-up

RESULTS

Table 2. Activity Results from Day 1 to Day 7

Day	Date	Type of Activity	Number of Participants	Activity Results
1	January 13, 2025	a. Socialization on the use of wearable sensors and axillary thermometers b. Distribution of monitoring devices (thermometer & smartwatch)	20 postpartum mothers	a. All participants understood how to use the devices b. All participants received monitoring devices
2	January 14, 2025	First-day monitoring of body temperature and HRV	20 postpartum mothers	First-day body temperature and HRV data recorded
3	January 15, 2025	Second-day monitoring of body temperature and HRV	20 postpartum mothers	Second-day body temperature and HRV data recorded
4	January 16, 2025	Third-day monitoring of body temperature and HRV	20 postpartum mothers	Third-day body temperature and HRV data recorded

Day	Date	Type of Activity	Number of Participants	Activity Results
5	January 17, 2025	Fourth-day monitoring of body temperature and HRV	20 postpartum mothers	Fourth-day body temperature and HRV data recorded
6	January 18, 2025	Fifth-day monitoring of body temperature and HRV	20 postpartum mothers	Two participants had a body temperature >38°C; they received education and were referred to medical personnel
7	January 19, 2025	Sixth-day monitoring of body temperature and HRV	20 postpartum mothers	All participants continued to be monitored, with no further temperature increases
8	January 20, 2025	Evaluation of monitoring results and education on postpartum infection	20 postpartum mothers	All participants received education, and monitoring results were shared with healthcare professionals

Table 3. Monitoring Results of Participants Based on Body Temperature and HRV Over 7 Days

Day	Participants with Normal Temperature and HRV		Participants with Temperature >38°C or Unstable HRV		Follow-Up Actions
	N	(%)	n	(%)	
1	20	100%	0	0%	Initial education on health monitoring
2	20	100%	0	0%	Continue temperature & HRV monitoring
3	19	95%	1	5%	More intensive monitoring for 1 participant
4	19	95%	1	5%	Education on postpartum infection signs
5	18	90%	2	10%	Recommendation for medical examination for symptomatic participants
6	18	90%	2	10%	Two participants with temperature >38°C referred to medical personnel
7	18	90%	2	10%	Additional education & coordination with healthcare providers

Based on Table 1.3, the percentage of postpartum mothers experiencing unstable HRV was 5% on the third day. On the fourth day, 5% of postpartum mothers exhibited signs of postpartum infection. On the fifth day, 10% of postpartum mothers experienced HRV changes. On the sixth day, 10% of postpartum mothers had an increase in body temperature

exceeding 38°C, and on the seventh day, 10% of postpartum mothers exhibited both HRV instability and an increase in body temperature above 38°C.

DISCUSSION

The postpartum period begins after childbirth and lasts for approximately six weeks (42 days), during which the mother's body undergoes various physiological changes to return to its pre-pregnancy state (Prawirohardjo, 2020). This period is critical as mothers are highly susceptible to health complications, including postpartum infections, which are among the leading causes of maternal morbidity and mortality (WHO, 2020). Postpartum infections typically arise due to the entry of microorganisms into the body through birth-related wounds, whether from vaginal delivery or cesarean section. Common symptoms include fever (>38°C), increased heart rate, abdominal pain, and foul-smelling vaginal discharge (Cunningham et al., 2018).

Monitoring results from this community service program indicate that most postpartum mothers maintained good health, with normal body temperature and stable HRV. However, by the third day, one participant exhibited HRV instability, which may suggest physiological stress or an underlying health disorder (WHO, 2022). Between the fifth and seventh days, two participants recorded body temperatures exceeding 38°C, signaling potential postpartum infection. A persistent maternal body temperature above 38°C for two consecutive days postpartum could indicate the onset of infections such as endometritis, mastitis, or surgical wound infections (Bobak, 2020).

From a theoretical perspective, monitoring body temperature and HRV during the postpartum period is crucial due to the significant physiological changes occurring during this time. Postpartum physiology theory explains that uterine involution, hormonal fluctuations, and cardiovascular adjustments influence maternal health (Task Force of The European Society of Cardiology, 1996). A significant reduction in HRV can indicate physiological stress, infection, or inflammation. Consequently, technology-based monitoring using wearable sensors and thermometers has emerged as an effective method for early complication detection.

Picture 1.
Course: Personal Documents

As a follow-up, postpartum mothers exhibiting potential infection indicators received additional education and were referred to healthcare professionals for further assessment. Specifically, the two participants who experienced fevers exceeding 38°C were immediately referred to prevent severe complications such as postpartum sepsis, which can be fatal if not promptly treated (Ministry of Health RI, 2019). Meanwhile, healthy postpartum mothers continued to be monitored and educated on infection prevention strategies, including proper wound hygiene, adequate nutrition, and recognizing signs of infection.

Overall, this technology-based health monitoring initiative aligns with postpartum maternal care theories and has proven effective in the early detection of postpartum complications. The findings demonstrate that wearable sensors and thermometers facilitate real-time identification of health status changes, allowing for swift medical intervention and increasing maternal awareness of postpartum health monitoring (Ministry of Health RI, 2019). Implementing this approach is expected to reduce postpartum infection rates and improve overall maternal health quality. Furthermore, this program's success suggests potential for further development and broader implementation in other regions to strengthen postpartum complication prevention efforts and enhance maternal well-being.

CONCLUSION

The seven-day postpartum monitoring results indicate that the majority of participants were in good health. However, two participants (10%) exhibited a body temperature exceeding 38°C and heart rate variability (HRV) instability, which are early indicators of postpartum infection. The postpartum period is recognized as a critical phase during which mothers are vulnerable to infections due to physiological changes following childbirth.

Technology-based monitoring using wearable sensors and axillary thermometers has proven effective in detecting real-time health condition changes in postpartum mothers, enabling faster medical intervention and enhancing maternal awareness of postpartum infection prevention.

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