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Monitoring Postpartum Risk Using Information System Decision-Making Support System: A Literature Review

Sri Winarni, Nauval Aghram, Lintang Mela Rosyida, Afif Algoritma and Farid Agushybana*
Department of Biostatistics, Faculty of Public Health, Diponegoro University, Semarang, Indonesia
*Corresponding author: farid_agushybana@live.undip.ac.id

Abstract

The postpartum period begins after the expulsion of the placenta and fetal membranes and ends when the mother's reproductive organs return to their pre-pregnancy state. This recovery period is the most critical for a woman. Increased maternal morbidity and mortality rates mark maternal mortality during this period. Each year, there are 295,000 maternal deaths and 6 million prenatal deaths during childbirth and the postpartum period. This study aims to find out the health disorders that can be experienced by mothers in the postpartum period as well as information systems to monitor these problems. The study is a literature review of original articles published between 2018 and 2023. Sources were searched using the Science Direct, Scopus, and Proquest databases with the keywords "postpartum" and "monitoring system." Inclusion and exclusion criteria were used to determine article eligibility. The inclusion criteria were articles discussing the high-risk postpartum period and monitoring efforts, published between 2018-2023, and original articles. The exclusion criteria included inaccessible articles, abstracts or reviews, and articles not aligned with the study's objectives. Based on the article search results, 16 out of 6,152 identified articles met the criteria for review in this literature review. Health issues that can arise during the postpartum period include both physical and psychological problems. Physical issues include postpartum hemorrhage, postpartum hypertension, and venous thromboembolism. The most common psychological issue is postpartum depression. Developed and developing countries have increasingly implemented information systems during high-risk postpartum periods. These information systems are developed based on the specific issues mothers face during the postpartum period in each country.

Keywords: Information system, Monitoring system, Postpartum period

Introduction

The postpartum period is the period experienced by the postpartum mother, which generally lasts 6-8 weeks after delivery but is uncertain in the span of the week (Yasmini et al., 2022). The postpartum period begins after the removal of the placenta and fetal membranes and ends when the mother's reproductive organs return to their pre-pregnancy state (Sugita & Widiastuti, 2016). The postpartum period is one of the most critical periods for a woman. During this period, her organs recover to the same condition as before pregnancy (Anggorowati et al., 2022).

The period of childbirth and postpartum is a high-risk period for both mothers and babies, where 295,000 maternal deaths and 6 million prenatal deaths occur every year (Boatin et al., 2021). Postpartum bleeding is the leading cause of maternal mortality and severe morbidity globally, affecting 26% of women who give birth in Africa and 13% of women who give birth in Europe and North America (Pertile et al., 2022). South Korea, as one of the developed countries in Asia, is also still facing the problem of postpartum hemorrhage. Hemorrhage is one of the main causes of maternal death in the country (Misugi et al., 2022).

Hypertension is one of the diseases that aggravate the problem in the postpartum period. Postpartum hypertension is associated with various types of maternal morbidity and accounts for a quarter of all hospital readmissions in the United States (Lopes Perdigao et al., 2020). Postpartum depression is also one of the most common complications of postpartum. This depression affects 15% and 13% of postpartum

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mothers, respectively, in the U.S. and around the world (Shin et al., 2020).

Other problems associated with the postpartum period are obesity and venous thromboembolism. The postpartum period triggers significant disruptions in circadian rhythms, including rhythms related to eating, physical activity, sleep, and exposure to dark and light, which are related to obesity and cardiometabolic disease, respectively (Conlon et al., 2023). Meanwhile, venous thromboembolism is a health disorder that often occurs in the postpartum period. There are about 120 cases per 100,000 pregnancies and is 9% of the cause of death due to pregnancy (Walker et al., 2023).

Research that discusses health disorders in postpartum mothers has been carried out to date, but there is still little discussion about the use of information systems in monitoring problems in the postpartum period. This study aims to find out the health disorders that can be experienced by mothers in the postpartum period as well as information systems to monitor these problems.

Methodology

This research is a literature review that traced the article's source through the Science Direct, Scopus, and Proquest databases. The keywords used in the article search are *postpartum* and "*monitoring system*". The article eligibility criteria used include inclusion criteria and exclusion criteria as shown in Table 1.

From the search results with the determined keywords, 24 articles met the inclusion criteria, exclusion criteria, and research objectives. Figure 1 shows a flowchart for article search.

Table 1 Article inclusion and exclusion criteria.

Inclusion Criteria	Research articles on the postpartum period at risk and monitoring efforts carried out during that period
	Published in 2018-2023
	Original article
Exclusion Criteria	Inaccessible
	Only abstract
	Articles are only a literature review
	Not following with the purpose of the research

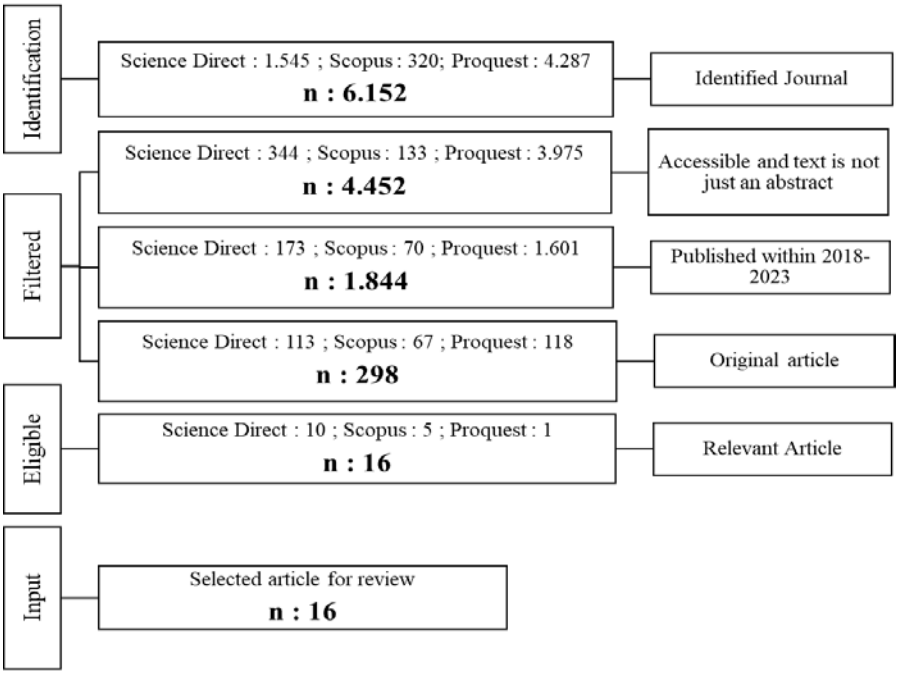

Figure 1 Article selection flowchart.

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Results and Discussion

Table 2 The results of the research article used.

No.	Author, Year, Country	Research Methods	Sample	Key findings
1.	Riccardo Pertile, Fabrizia Tenaglia, Silvano Piffer, 2022, Italy	Retrospective analysis observational studies	Women who had a postpartum hemorrhage in the Province of Trento during the period 2011-2016	The risk of postpartum bleeding is five times higher in mothers with third-degree vaginal tears due to spontaneous delivery. Furthermore, the risk of postpartum bleeding is three times greater in mothers with a cesarean delivery of more than one baby.
2.	Kenesha Smith Barber et al. 2019, Missouri	Analysis of U.S. Prams secondary data in 2012-2014	89,366 new mothers aged >12 years	Premature birth is significantly associated with despair for mothers who experience premature birth. However, the opposite result occurs in losing the mother's interest in her routine.
3.	Gabriela A. Barber, Julia R. Steinberg, 2022, United States	Cross-sectional *study* from Pregnancy Risk Assessment Monitoring System Data in 2012–2019	243,677 women	Postpartum depression symptoms are more at risk in women who have an unwanted pregnancy. Similar results also occurred in women who became pregnant after taking fertility enhancing drugs compared to women who became pregnant with the help of drug insemination procedures/ART.
4.	Adeline A Boatin et al., 2021, Uganda	Pilot pragmatic implementation with quasi-experimental	An average of 10 women per day who are ≥ 18 years old and undergo emergency cesarean delivery at Mbarara Regional Referral Hospital (MRRH)	The effectiveness of the system is assessed based on the number of near-miss accidents according to WHO, the maternal mortality rate, and the case fatality rate for postpartum hemorrhage, hypertension, and sepsis. Furthermore, the effectiveness of the implementation of system interventions will be assessed using the Reach, Efficacy, Adoption, Implementation, and Maintenance framework after four months of experimentation.
5.	Joana Lopes Perdigao, 2020, United States	Random Controlling Trial Method	84 women with gestational hypertension disorder who gave birth between August 2016 and January 2017 in the United States	Postpartum blood pressure is affected by race and BMI. Black women have a higher average blood pressure compared to non-black women. In addition, the decrease in postpartum blood pressure in women with a BMI of < 35 was more stable than that of those with a BMI of ≥ 35.
6.	Mengrui Lin et al., 2022, China	A cohort study	1,496 mother-infant pairs who had complete medical record questionnaire data from June 2015 and May 2018	Exposure to nine mixtures of perfluoroalkyl substances was positively correlated with the risk of postpartum hemorrhage. The riskiest exposure chemical for postpartum bleeding is perfluorohexane sulfonate.

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No.	Author, Year, Country	Research Methods	Sample	Key findings
7.	Edward J. Booth et al., 2021, Amerika	Cross-sectional retrospective study of Massachusetts PRAMS data from 2012-2017	8,453 women which 710 of whom have a disability	The risk of developing postpartum depressive symptoms in women with disabilities is higher than in non-disabled women. Moreover, a similar condition also occurs in stress-triggering events. Stress-triggering events were reported to be more common in women with disabilities (86.6%), compared to women without disabilities (66.6%).
8.	Amanda H.X. Lee et al., 2019, Kanada	Multicenter research with a retrospective approach	102 women who gave birth after a spinal cord injury	The prevalence of postpartum depression (25–37%) and postpartum anxiety (18–33%) is higher in women with spinal injuries than in the general maternal population.
9.	Rob F. Walker et al., 2023, United States	Retrospective cohort study using the MarketScan Commercial and Medicare Supplemental administrative databases	757,303 women of childbearing age whose date of delivery is valid for at least 12 weeks of follow-up	Women with autoimmune diseases such as systemic lupus, erythematosus, and Crohn's disease are at a higher risk of developing venous thromboembolism at 12 weeks after giving birth than those who do not.
10.	Chen Chi Duan et al., 2022, Chinese	A cohort study	10,209 women who received ANC services and gave birth from October 11, 2019 and February 14, 2021 at five hospitals participating in the study	Exposure to airborne chemicals such as PM10, CO, and NO_2 can increase the production of stress hormones during pregnancy. Among these hormones, namely cortisone, cortisone, epinephrine, and norepinephrine, will affect the neuropathology of postpartum depression.
11.	Alzina Koric et al., 2021, United States	A cohort study	3,906 postpartum women (2-6 months)	Women with PCOS had a 76% higher prevalence of postpartum depression/ anhedonia than women who did not have PCOS.
12.	Rachel P. Kolko Conlon, et al., 2023, United States	Experimental research with theory-based intervention methods	Seven postpartum mothers with BMI before pregnancy ≥ 25	Respondents perceive that ClockWork intervention and digital monitoring can help manage weight-related health behaviors during the postpartum period.
13.	Lisette T. Jacobson et al., United States, 2020	Controlled randomization test	72 healthy pregnant women who had a check-up at Ascension Via Christi Hospitals Wichita or Kearny County Hospital	eMOMS™ (Electronic Monitoring of Mom's Schedule) is an information system focusing on diet, exercise, and education about breastfeeding. The development of this system is based on the discovery that maternal overweight and obesity conditions contribute to postpartum overweight gain.

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No.	Author, Year, Country	Research Methods	Sample	Key findings
14.	Meishan Cui et al., Japan, 2020	The cohort study was based on data from the Japan Environment Children's Study (JECS)	80,872 pregnant women	Women who quit smoking early in pregnancy or five years before giving birth and who smoke after pregnancy have a higher risk of developing *postpartum* depression compared to women who have never smoked.
15.	Takuya Misugi et al., South Korea, 2022	Prospective observational studies	21 patients	The Clear Sight system is more accurate and precise than invasive monitoring systems in monitoring the blood pressure of the mammalian artery that is sensitized with spinal anesthesia. The system measures the presence of hemodynamic changes during a cesarean section.
16.	Dayeon Shin et al., United States, 2020	Retrospective cohort study of pregnancy risk assessment monitoring system data on 2012-2013	28,755 records	Mothers who had a history of depression before pregnancy were 3.15 times more likely to experience postpartum depression than mothers who did not have a history of postpartum depression.

Health Problems in the Postpartum Period

The postpartum period is one of the most critical periods for a woman. During this period, various health problems often arise as complications caused by the pregnancy and childbirth process. From Table 2, health problems in the postpartum period can be classified into physical and psychological problems.

a. Physical Problems

Some of the physical health disorders that occur in the postpartum period include postpartum bleeding, postpartum hypertension, and venous thromboembolism.

1. Postpartum hemorrhage

Postpartum hemorrhage is a blood loss of more than 500 cc experienced by mothers after giving birth vaginally or more than 1000 cc in mothers with cesarean delivery within 24 hours to before six weeks after delivery (Satriyandari & Hariyati, 2017) (Simanjuntak, 2020). Postpartum hemorrhage is the leading cause of maternal mortality and morbidity globally and is estimated to be responsible for a quarter of deaths that occur during pregnancy, childbirth, and postpartum (Pertile et al., 2022).

2. Postpartum Hypertension

Postpartum hypertension has a meaningful relationship with various occurrences of maternal diseases such as stroke, seizures, congestive heart failure, pulmonary edema, kidney failure, and even death. Postpartum hypertension accounts for at least a quarter of all hospital return hospitalizations in the United States (Lopes Perdigao et al., 2020).

3. Venous Thromboembolism

Venous thromboembolism is a disorder consisting of pulmonary embolism and deep vein thrombosis that occurs in about 120 out of every 100,000 pregnancies. Venous thromboembolism is characterized by the formation of blood clots in the deep veins in the legs, groin, or arms. If it moves in the blood circulation to the lungs and settles in the lungs it is known as a pulmonary embolism. In the postpartum period, the highest risk of venous thromboembolism occurs during the first week after delivery (90 per 100,000) and then decreases as the weeks go by (Walker et al., 2023).

b. Psychic Problems

Psychic problems are a common complication in pregnancy and are the underlying cause of about 9% of pregnancy-

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related deaths (Bauman et al., 2018). The main and most frequent psychological problem during the postpartum period is postpartum depression. Postpartum depression is a form of abnormal physiological adaptation experienced by postpartum mothers. Postpartum depression is a serious mental health disorder that can trigger a variety of impacts on maternal and infant health, affecting about 10% of women worldwide (Booth et al., 2021).

Risk Factors Related to Postpartum Disorders

a. Postpartum Hemorrhage

Some of the risk factors that cause postpartum bleeding are vaginal tears, multiple births, and exposure to chemicals (*perfluoroalkyl*).

1. Vaginal Tears

Vaginal tears occur due to sudden and excessive stretching of the birth canal when the fetus is born. Vaginal tears can be a separate wound or a continuation of a perineal tear (Booth et al., 2021). A vaginal tear can cause a rupture of a vein (Eriza et al., 2015).

2. Multiple Births

Multiple births or multiple (twin) pregnancies are pregnancies with two or more fetuses at once (Julizar et al., 2019). Multiple pregnancies are related to excessive uterine stretching (Aisyah, 2022). This condition can cause the uterus to be unable to contract immediately after the placenta is born, which often triggers uterine atony. Uterine atony increases the risk of postpartum bleeding (Julizar et al., 2019).

3. Exposure to Chemicals (Substances *perfluoroalkyl*)

Perfluoroalkyl substance is an artificial chemical usually used in various models, such as food packaging, kitchen utensils, foam fire extinguishers, paper, textile coatings, and medical equipment. Exposure to substances *perfluoroalkyl* in the mother can cause negative impacts, such as placental dysfunction, gestational hypertension, gestational diabetes, and preeclampsia. Research shows that if the placenta malfunctions, the placenta will attach to the myometrium, which causes no separation between the surface of the placenta and the uterus, so a separation process is needed. This separation process can increase the risk of postpartum hemorrhage. Exposure to substances such as perfluoroalkyl can also impair liver function, decreasing liver coagulation function. This condition triggers an increased risk of postpartum bleeding (Lin et al., 2022).

b. Postpartum Hypertension

Risk factors for postpartum hypertension are black women, BMI (Body Mass Index), age, and maternal readiness to undergo the postpartum period, which affect the mother's calm so that blood pressure in the mother tends to be high.

1. Skin Color (Race)

Skin color is related to trends and postpartum blood pressure recovery periods *(Lopes Perdigao et al., 2020)*. Black women experienced a slower decline in postpartum blood pressure compared to white women and had higher blood pressure than white women at the end of the 6th week of the postpartum period. Black women have twice as long cardiovascular recovery as white women (Hauspurg et al., 2020).

2. Body Mass Index (BMI)

A high pre-pregnancy BMI can increase the risk of postpartum hypertension and increase blood pressure trends in all trimesters of pregnancy *(Lopes Perdigao et al., 2020)*. The body mass index (BMI) correlates directly with blood pressure. The greater the body mass, the more blood is needed to supply oxygen and food to the body's tissues. Thus, the volume of blood circulating through the blood vessels increases, putting greater pressure on the artery walls (Simamora et al., 2019).

c. Venous Thromboembolism

One of the risk factors for venous thromboembolism is the presence of autoimmune diseases suffered by the mother. Systemic autoimmune diseases such as systemic lupus erythematosus are associated with increased inflammation. Systemic lupus erythematosus can potentially increase molecular procoagulant factors, ultimately triggering venous thromboembolism. Another autoimmune disease that can be a risk factor is Crohn's disease, which generally affects the digestive system. Disease-induced inflammation Crohn's can lead to complications outside the intestinal system that increase the risk of venous thromboembolism. Other factors such as smoking, obesity, and certain obstetric procedures and complications (e.g., cesarean delivery, obstetric bleeding, or preeclampsia) are also known to increase the risk of venous thromboembolism (Walker et al., 2023).

d. Postpartum Depression

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Risk factors that can increase the incidence of postpartum depression are premature birth, unwanted pregnancy, pregnant women who use fertility enhancing drugs, women with disabilities, women with spinal cord injuries, exposure to chemicals (PM10, CO, and NO_2), *Polycystic Ovary Syndrome* (PCOS), smoking history, maternal age, education, marital status, first pregnancy age, and history of depression that has been experienced.

1. Premature Birth

Increased levels of prematurity will increase the likelihood that mothers will feel hopeless. Parents of babies born prematurely are more likely to have feelings of fear and anxiety as a result of their new role as parents coming sooner than expected. As the rate of premature birth increases, the likelihood of mothers feeling hopeless also increases (Barber et al., 2021).

2. Unwanted Pregnancy

Unwanted or unplanned pregnancies will have a psychological impact on the mother due to the burden that the mother must bear (Solama et al., 2023). Unplanned pregnancies are related to the physical, mental, and economic readiness of the mother. If the mother has strong physical and mental readiness, she will be more able to adapt to her new role. This condition is different for mothers who are not ready for pregnancy; for example, if the mother experiences an unplanned pregnancy, the risk of postpartum depression will be higher (Qiftiyah, 2018).

3. Use of Fertility Enhancing Drugs

Some fertility enhancement drugs, such as Clomiphene Citrate, work directly in the hypothalamus, which plays a role in the regulation of emotions and moods. This drug is known to disrupt mood so mothers who use it have a higher risk of experiencing postpartum depression (Barber & Steinberg, 2022).

4. Disability Circumstances

Women with physical disabilities are likely to experience a variety of reactions to their new status as mothers, such as distrust, intrusive questions, or even feelings of inferiority (Lee et al., 2021). Women with physical limitations are more prone to experiencing various types of stress such as financial stress, traumatic experiences, relationships, and emotions (Booth et al., 2021).

5. Spinal Injuries

Spinal cord injuries can trigger muscle stiffness, neuropathic pain, bladder and bowel dysfunction, and autonomic dysreflexia. This can restrict/interfere with a mother from activities such as breastfeeding her baby due to limited mobility and lactation dysfunction. Breastfeeding is known to reduce the risk of postpartum depression (Lee et al., 2021). Mobility limitations also make it difficult for women with spinal cord injuries to access health services to monitor their physical and mental condition. Thus, it will trigger stress, depression, and anxiety as well as other mental health problems in mothers who have suffered spinal cord injuries.

6. Chemical Exposure $(PM)_{10}$, CO, and NO_2)

PM_{10} exposure, CO, and NO_2 during pregnancy increases the risk of postpartum depression. Air pollution can trigger oxidative stress and neuroinflammation that can increase the production of stress hormones such as cortisol, cortisone, epinephrine, and norepinephrine, which affect the neuropathology of postpartum depression (Duan et al., 2022).

7. *Polycystic Ovary Syndrome* (PCOS)

Women with PCOS have an increased vulnerability to postpartum depression and anxiety due to hormonal imbalances and metabolic disorders such as increased androgens, hypothalamic-pituitary-adrenal axis hypersensitivity, plasma adrenocorticotropic hormone, and serum cortisol levels. So they are more susceptible to stress triggered by the pregnancy process (Koric et al., 2021).

8. Mother's Smoking History

Women are prone to depression and are prone to mood swings during periods of hormonal changes such as pregnancy, postpartum period, and menopause due to changes in sex steroid hormones (estrogen and progesterone). Smoking has an anti-estrogenic effect by decreasing endogenous estrogen biosynthesis as well as bioavailability resulting in an increased risk of postpartum depression (Cui et al., 2020).

9. History of Depression

Women who have depressive symptoms will continue until the postpartum period (Arami et al., 2020). A history of depression is related to the interaction of cortisol levels with cytokinins. Cortisol is a hormone in the body that plays a role in responding to stress (Ambarwati et al., 2018). The existence of this interaction causes

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mothers who have a history of depression to be more at risk of postpartum depression.

Information System Related to Postpartum Disorders

Health risks during the postpartum period should not be ignored. Let's take one example of gestational diabetes mellitus in the United States, where 6%-20% of pregnant women experience it. This problem can trigger various pregnancy and childbirth complications that can increase maternal and neonatal morbidity and mortality. The main risk factors for gestational diabetes mellitus are overweight and obesity. In the United States, the prevalence of overweight and obesity in women is relatively high, at around 27% and 41% respectively. In addition, the rate of mothers who breastfeed exclusively for six months is also relatively low, at 25%. Exclusively breastfeeding is one of the protective factors of gestational diabetes mellitus. This condition is the reason for the development of the Electronic Monitoring of Mom's Schedule (eMOMS™), which adopted the Diabetes Prevention Program (DPP). eMOMS™ has been tested nationally to reduce the risk of diabetes and combined with breastfeeding support. Table 2 also shows us some information systems have been developed to help handle health problems in the postpartum period in several countries.

1. Birth Assistance Certificate (CedAP) of Italy

The Clinical Epidemiology and Evaluation Service of the Provincial Health Authority of Trento, Italy, has a birth event monitoring system, namely the Birth Assistance Certificate (CedAP). The annual CedAP provincial database is recorded by midwives in each maternity unit's electronic media as a basic tool for recording the incidence of postpartum hemorrhage. Information regarding the occurrence and entities of blood loss is recorded in the "*placenta removal*" section in CedAP. The advantages of CedAP include allowing the identification of risk factors for postpartum hemorrhage, especially those related to maternal factors and childbirth factors. CedAP can also be used to monitor the quality of health services and improve efficiency and effectiveness in both data collection, analysis, and access. The disadvantages of CedAP are the lack of in-depth analysis of the data produced and the limited data and information because the scope of the system only covers the Province of Trento, Italy (Pertile et al., 2022).

2. eMOMS™ in the United States

The Electronic Maternal and Obstetric Monitoring System (eMOMS™) is a lifestyle change program through Facebook that focuses on diet, exercise, education, and breastfeeding support through regular face-to-face counseling sessions during and after pregnancy. The program also provides weekly 15-minute videos on nutrition and exercise during and after pregnancy, as well as online breastfeeding education and ongoing support. Electronic Maternal and Obstetric Monitoring System (eMOMS™) as a system for monitoring the health of pregnant women and fetuses during pregnancy, during childbirth, and postpartum. Data is taken from patients through fetal monitoring devices, blood pressure, and blood glucose. eMOMS™ will provide reports and analysis of maternal and fetal health risk factors so doctors can provide more appropriate and effective treatment. The advantages of eMOMS™ include content that is easy to access anywhere and anytime, affordable program costs, and support pregnant women and postpartum mothers to adopt a healthy lifestyle. The eMOMS™ system is still in the trial stage, so further research is needed to determine its long-term effectiveness. The delivery of program content through social media requires participants to have access to the internet and technological capabilities (Jacobson et al., 2020).

3. ClockWork in the United States

In the postpartum period, mothers can experience healthy behavioral irregularities such as disturbances in circadian rhythms related to obesity and weight management and a dark and light 24-hour cycle related to the regularity of biopsychosocial rhythms. Biological clocks regulate these behavioral deviations with the dark-light cycle of the environment. The advantages of ClockWork include 12 personal coaching sessions that deal with behavioral indicators and factors related to weight management and the postpartum period. The app is also easy for digital self-monitoring to provide real-time feedback and interventions. The calendar view on this app allows users to see which behavioral indicators they have monitored over a while. Further research is still needed to find out the effectiveness and shortcomings of ClockWork (Conlon et al., 2023).

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4. Heart Rate Variability *monitoring system* via *smartwatch* in Finland

A study in Finland implemented an information system to monitor Heart Rate Variability (HRV) during pregnancy and postpartum. Heart rate variability can indicate the presence of hypertension or preeclampsia and reflect the mental health status of pregnant and postpartum women. The parameters of Heart Rate Variability (HRV) are typically measured using an electrocardiogram (ECG) or photoplethysmogram (PPG). The system collected data by capturing photoplethysmogram (PPG) sensors using a Samsung Gear Sport smartwatch and a cross-platform mobile application. The collected data was stored in the smartwatch's internal memory and manually transmitted via a Wi-Fi connection to a cloud server. The advantages of using a smartwatch for HRV monitoring include providing early remote warnings non-invasively, being more affordable, and being more straightforward to use daily. However, the limitations of HRV monitoring systems include reduced accuracy due to sensitivity to environmental temperature, skin movement, and skin condition, as well as the limited number of measurable parameters (Sarhaddi et al., 2022).

Conclusions and Recommendation

The postpartum period is a critical period for mothers as they are vulnerable to health issues. Health problems that may arise during the postpartum period include physical issues such as postpartum hemorrhage, postpartum hypertension, and venous thromboembolism, as well as mental health issues such as postpartum depression.

The use of information systems during the postpartum period at risk has begun to be widely applied in various countries. For example, CedAP in Italy is used to monitor bleeding during the delivery which is then used to identify risk factors for postpartum hemorrhage, especially those related to maternal factors and childbirth factors. Furthermore, in the United States there is an eMOMS designed to monitor the health of pregnant women and fetus during pregnancy, childbirth, and postpartum and support mothers to breastfeed exclusively as an effort to prevent gestational diabetes mellitus. In the United States, there is also ClockWork that helps mothers maintain a healthy lifestyle after childbirth as an effort to manage the mother's postpartum weight. In addition, in Finland there is a monitoring system for heart rate variability through smartwatches during pregnancy and postpartum to detect hypertension or preeclampsia, and describe the mental health status of pregnant women and postpartum.

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