Web-based rule-based expert system to screen postpartum depression

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Abstract. The high prevalence of postpartum depression significantly increases maternal morbidity. Lack of diagnosis for postpartum depression results in mothers missing early treatment necessary. The traditional screening method using questionnaire presents its own disadvantage in diagnosis. Therefore, development of postpartum screening method that focuses on ease in implementation is very much needed to improve postpartum maternal health. This paper proposes a screening information system for postpartum depression to help its proper treatment. This research employed the rule-based method to diagnose postpartum depression and the expert system to input symptoms data that will result in diagnoses. Respondents input symptoms data to be diagnosed by the system. The system then automatically generate output of suggested treatment based on expert input associated with the diagnoses the system is working on. This research employed the Randomized Control Trial method with Control Group Pre and Post Tests Design. Samples of this research were 52 postpartum mothers consisting of 26 respondents in the system group, and the other 26 in the manual group. Results show that 42.31% (n=11) of mothers suffer from postpartum depression. There is a significant difference in EPDS score prior to and after the use of the information system (P=0.000). The system also successfully generated very high TAM score, meaning that it is capable of postpartum screening along with ease of use and some other advantages. Therefore, screening for postpartum depression using information system is very effective and ensures proper and timely treatment.

1. Introduction
Screening is the best way to figure out postpartum depression to speed up treatment process [1]. Late diagnosis and treatment may result in lower life quality and they also affect overall physical and mental health. Therefore, it is important to further study and improve screening methods for postpartum depression. This process will lead to a more effective and easy method of screening to be implemented by health professionals, as well as patients. One attempt to improve health care for postpartum mothers is the use of information system. The advent of new technology and the availability of information means that patients are tend to be more proactive in dealing with their health issues. Patients are directly involved in their personal treatment to better maintain their condition and to have better prognosis [2].

Depression is one of the public health issues that cause morbidity among women with twice prevalence to that of men [3]. Postpartum depression results in psychological disorder either in short or long term and not only for the mother, but also for the family members. Children of depressed mother
tend to suffer from retardation in psychological, cognitive, neurological, and motor developments. This retardation experienced by children and their depressed mother may last until they reach the age of 4 to 8 years. There are reports suggesting that depressed mothers are 3 times more likely to have emotional problems with their children and are 10 times more likely to have bad relationships with their children [4]. Considering the serious consequences of postpartum depression, it is such a shame that the level of proper care and treatment is still below expectation [5]. This discouraging fact closely relates to difficulties in diagnosis as screening is still carried out manually, and difficulties in administering treatment by health professionals [6,7].

Determination of postpartum depression status still relies on paper-based questionnaires with which health professionals estimate the status of postpartum depression by manual calculation of scores from the questionnaire. This is further hampered by the many types of questionnaires available that makes it hard for them to decide which one to use. Moreover, health professionals do not have ample time to conduct screening, and at times they do not even know how to deal with positive screening results [1,8]. Lack of knowledge from the mothers themselves in understanding what they are going through tend to make them passive as they regard postpartum depression as a normal phase after giving birth. This may result in depressed mothers not getting proper treatment as their depression status is not known [6,7]. Information system has great potential in supporting treatment of postpartum depression in mothers. A web-based system can be used effectively in improving diagnosis potential for postpartum depression. Web-based screening is effective as it comes with ease of use and it provides suggestions that match the problems [2].

2. Methods

With the information system, screening for postpartum depression can be done anytime and anywhere. Patients can readily know their status from diagnosis results displayed. Diagnosis in this information system is based on scores from compulsory questions that patients must answer. Meanwhile, treatment suggestions are matched to patient’s diagnosis results. A diagram of the information system is shown in Figure 1.

Users access website from any browser and come to the home page. An administrator can use access rights by logging in with user name and password. The administrator is in charge of analyzing data and providing suggestion for treatment from experts. Meanwhile, users can access the system by first registering on the registration menu and filling out characteristics biodata.

Afterwards, users can log in with their user name and password on the main menu. Users can see their postpartum depression status by answering 10 questions available in the system. Unregistered users cannot gain access from the main menu and hence, cannot perform screening for postpartum depression. This research employed the Randomized Control Trial method with Control Group Pre and Post Tests Design. Samples were 52 respondents, 26 of which are in the intervention group and the remaining 26 are in the control group in Public Health Center.

The intervention group underwent diagnosis using the information system, while the control group went through the manual method. Intervention for both the intervention and manual group was
conducted for 2 weeks. Pretest was performed for both groups on the first visit, whereas posttest was carried out on the second visit, which is two weeks after the first one. Comparison was then conducted for pretest and posttest results, both within each group and between the two groups.

The resulting system was tested against real data of the object using the EPDS questionnaire. Testing was performed in line with the rule of the system and the results from information system and manual methods were then compared. System testing was performed using the 10 EPDS questionnaire data available from diagnosis by a nurse. Calculation for system accuracy value is gained from division of the number of matching data to that of the total data, and then times 100%.

3. Results and discussion

3.1. Information system to identify status of postpartum depression

Results of data testing show that system output is in accordance to that of EPDS questionnaire administered by nurses, which means that the system is valid. Diagnostic test for both system and manual diagnoses is given in Table 1.

| EPDS Questionnaire Score | Post-Partum Period/days | System Diagnosis              | Manual Diagnosis                  | Explanation |
|--------------------------|-------------------------|-------------------------------|-----------------------------------|-------------|
| 11                       | 3                       | Postpartum blues              | Postpartum blues                  | Valid       |
| 10                       | 3                       | Postpartum blues              | Postpartum blues                  | Valid       |
| 4                        | 21                      | Normal                         | Normal                            | Valid       |
| 13                       | 32                      | Suspected postpartum depression| Suspected postpartum depression    | Valid       |
| 6                        | 13                      | Normal                         | Normal                            | Valid       |
| 8                        | 14                      | Normal                         | Normal                            | Valid       |
| 0                        | 2                       | Normal                         | Normal                            | Valid       |
| 12                       | 17                      | Suspected minor postpartum depression| Suspected minor postpartum depression| Valid       |
| 3                        | 10                      | Normal                         | Normal                            | Valid       |
| 9                        | 5                       | Normal                         | Normal                            | Valid       |

In terms of information system, diagnosis for postpartum depression is obtained after input of symptom data is done. Samples for normal diagnosis are shown in Figure 2.

Identification for postpartum depression status in this research is validated by EPDS score and postpartum period. A description of EPDS questionnaire scores and postpartum period for the group screened with information system method is given in Table 2.

![Figure 2. Postpartum depression diagnosis using information system.](image-url)
Table 2. EPDS score for the group screened with information system method.

| Variable                                      | EPDS Questionnaire Score Before using the information system method (n=26) | EPDS Questionnaire Score Before using the manual method (n=26) |
|-----------------------------------------------|--------------------------------------------------------------------------|---------------------------------------------------------------|
| EPDS Questionnaire Score                      |                                                                          |                                                               |
| Mean ±SD                                      | 9.04±3.33                                                                | 8.23±3.23                                                    |
| Minimum                                       | 4                                                                        | 3                                                             |
| Maximum                                       | 17                                                                       | 15                                                            |
| Postpartum Period/days                        |                                                                          |                                                               |
| Mean ±SD                                      | 17.77±9.56                                                               | 18.35±8.74                                                  |
| Minimum                                       | 4                                                                        | 3                                                             |
| Maximum                                       | 37                                                                       | 32                                                            |
| Postpartum depression category                |                                                                          |                                                               |
| Normal                                        | 15 (57.69%)                                                              | 16 (61.54%)                                                  |
| Postpartum blues                              | 7 (26.93%)                                                               | 6 (23.08%)                                                   |
| Suspected minor postpartum depression         | 4 (15.38%)                                                               | 4 (15.38%)                                                   |
| Suspected postpartum depression               | 0 (0%)                                                                   | 0 (0%)                                                       |
| Suspected postpartum psychosis                | 0 (0%)                                                                   | 0 (0%)                                                       |

It can be seen in Table 2 that the mean score for EPDS from respondents belonging to the information system group is 9.04, while it is 8.23 from the manual group. There is no difference in EPDS scores from both groups prior to intervention. This is evident from the same mean EPDS score. In terms of percentage, respondents that do not suffer from postpartum depression are 15 mothers (57.69%) for the information system group and 16 mothers (61.54%) for the manual group.

Meanwhile, respondents diagnosed with postpartum blues are 7 mothers (26.93%), in the information system group, and 4 mothers (15.38%) are suspected of minor postpartum depression. On the other hand, respondents diagnosed with postpartum blues are 6 mothers (23.38%), in the manual group, and 4 mothers (15.38%) are suspected of minor postpartum depression. More respondents are diagnosed with postpartum depression in the information system group (42.31%), compared to the manual group (38.46%).

Varied status of postpartum depression is understood to be due to different postpartum periods among respondents in both the information system and the manual groups. Postpartum blues tend to be experienced by mothers on the third day to the first two weeks after giving birth [9,10].

Meanwhile, postpartum depression has its onset from the first two weeks to the first year after giving birth [11]. This vast time range of recruitment for respondents results in varied diagnoses.

Identification for postpartum depression with both information system and manual methods show similar results. This is due to the same aspect and characteristics of questions in the questionnaires [12]. Results of the use of information system in this research agree with those of other researches. An earlier research comparing screening for depression and anxiety using online based system and paper system on grown-ups with cystic fibrosis show similar internal consistency between online-based and paper-based measurements [13].

Some other research suggest that online questionnaires provide valid results as are paper-based questionnaires [14,15]. Researchers over the past decade have revealed that online questionnaires are capable of generating more accurate information compared to its paper-based counterpart [7]. Moreover, with respondents independently filling out the questionnaires (instead of undergoing interviews) both for online and paper-based format, yield comparative results [16].

Development in information system provides easy access to all kinds of health information, including postpartum depression. The advent of a postpartum depression screening instrument has paved the way for helping mothers assessing their postpartum depression status. Screening using information system can be widely used by the community and has been proven to be valid and reliable [12]. This system is interesting for mothers having difficulties in understanding how they feel and dealing with the anxiety of being labeled having mental disorder. This means that mothers are now more proactive in making use of postpartum depression screening instrument that will provide them with privacy and comfort.
Screening online comes with more advantages than manual screening. Ease in filling out forms, increased data completeness, minimized entry error, are among the advantages of screening with information system. Other than those, filling out questionnaires using information system is faster than its paper-based counterpart [16]. This fact is supported by an earlier research stating that online questionnaire completion takes approximately 2 minutes, while manual questionnaire completion needs around 5 minutes [7,17].

The use of information system to identify postpartum depression will also be beneficial for women with high risks as they do not have to visit health professionals to do so. They can easily access information of postpartum depression status from the comfort of their homes [18]. Earlier screening using information system also results in better prognosis. Moreover, this method eases the burden of health professionals with its easy and effective diagnosis. Results show that screening using information system can be used to recruit and filter mothers with symptoms of postpartum depression. Therefore, the use of information system to help find out depression status of postpartum mothers, is an innovative solution [7].

3.2. Information system for suggested treatment for postpartum depression

In terms of information technology, suggested treatment for postpartum depression is based on system diagnoses. Samples of suggested treatment for normal diagnosis are shown in Figure 3.

![Figure 3. Suggested treatment from the information system.](image)

Suggested treatment for postpartum depression is depicted in different pretest EPDS scores resulting from screening in the information system groups is given in Table 3.

| Variable                  | Group          | Information System | Manual       |
|---------------------------|----------------|--------------------|--------------|
| Pre-EPDS Questionnaire Score | 9.04±3.33   | 8.23±3.23         |
| Minimum                   | 4             | 3                  |
| Maximum                   | 17            | 15                 |
| Post-EPDS Questionnaire Score | 3.35±2.50   | 4.85±3.21         |
| Minimum                   | 0             | 0                  |
| Maximum                   | 10            | 12                 |
| P value                   | 0.000         | 0.000              |

Ability of the information system in giving suggested treatment for postpartum depression is shown in differences in scores prior to and after its use. It can be seen in Table 3 that pre and post intervention test show p-value of 0.000, with p < 0.05 which can be concluded that both groups have difference in EPDS score changes. This shows the effect of intervention, either with the information system or with the manual method.

Psychological therapy for postpartum depression is usually administered face to face. However, this method of counseling and using leaflets is prone to patients forgetting and losing the suggestions. Other than that, health personnel also have limitations in providing treatment for postpartum depression. In
line with technological development, change in lifestyle, and real life needs, psychological therapy based on information technology has become a viable alternative for postpartum depression treatment in many countries. Overcoming access difficulties for postpartum depression treatment is another advantage of online therapy. As long as internet connection is available, therapy can be accessed anytime, anywhere [19].

The information system group has more mothers diagnosed with postpartum depression compared to its manual counterpart. This is perhaps because mothers in the information system group are more active in screening for postpartum depression. It is suggested in one earlier research that individuals with chronic condition tend to seek for more health information from the web. Mothers who have just given birth and are suffering from symptoms of postpartum depression tend to be more active in using the internet to help them access health services not available traditionally, as they want speedier treatment for postpartum depression [20,21].

This is in line with Lazakidou who said that one advantage of web-based information system is its easy access from just about anywhere. The web site developed here is very practical and can be readily accessed with any device, including smart phones [22]. Treatment for postpartum depression given in this research is designed by an expert (psychologist) to help midwives providing care for postpartum depression. Treatment for postpartum depression using information system is seen as an effective approach in terms of cost and labor, compared to treatment with manual method. In agreement with an earlier research suggesting that online psychological therapy has proven to be effective in handling and reducing the risk of postpartum recurrence. Significant results in this research proves the system’s capability in providing effective are to help mothers coming to terms with their postpartum depression.

3.3. Effectiveness of information system in using information system

Testing for the system built employed TAM questionnaire. Results of TAM questionnaire analysis based on two perceptions of Perceived Ease of Use and Perceived Usefulness of the system developed are shown in Figure 4.

![Figure 4](image_url)

**Figure 4.** Diagram of TAM questionnaire answers of perceived ease of use and perceived usefulness variable.

Assessment for effectiveness of screening system of postpartum diagnosis is based on acceptance of the system built. In its detail, acceptance of information system is seen from two aspects of perceived usefulness and perceived ease of use. It can be seen from Figure 4 that variable Perceived Ease of Use
gets a maximum answer of 5 and the minimum answer 3. Meanwhile the most common answer is 4, which means agree. This means that respondents agree that the system for postpartum depression screening is really easy to use.

The variable of Perceived Ease of Use gets a maximum answer of 5 and the minimum answer 3. Meanwhile the most common answer is 4, which means agree. This means that respondents agree that they gain advantage from the system of postpartum depression screening. Hence, both results indicate that respondents find easy and useful intervention.

Results in this research are in line with those of Cujipers et al on global scale online depression prevention measures The system developed here is very effective in helping mothers understand their postpartum depression status and know how to deal with it [23].

4. Conclusion

The screening system developed here has been validated and is proven to be valid in identifying status of postpartum depression. Identification relies on the 10 EPDS questions automatically set in the system. And, the screening system developed here has been validated and is proven to be valid in providing suggested treatment for postpartum depression, based on knowledge input from experts in related diagnoses generated by the system. Therefore, screening for postpartum depression using information system is very effective and ensures proper and timely treatment.

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