Postprint of a Study on the Application and Effectiveness of a Mobile Platform for Perinatal Depression Screening and Intervention

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Abstract

Background Perinatal depression is an important public health problem affecting maternal and child health, and its effective management is imperative. Since 2021, Shenzhen has promoted perinatal depression screening and intervention across the city through the construction of a mobile health platform. Objective

This study utilizes routine data from Shenzhen's perinatal depression screening and intervention project to analyze the effectiveness of the mobile platform in promoting project implementation and to explore the most prominent current implementation bottleneck. Methods Pregnant and postpartum women who delivered in any maternity care institution in Shenzhen (82 institutions across 10 districts) from June 2020 to May 2022 were selected. Researchers exported all individual records of pregnant and postpartum women meeting the inclusion criteria from the backend of Shenzhen's Maternal and Child Health Management Information System to establish a foundational database. Based on the mobile platform activation time, eligible pregnant and postpartum women were divided into a routine service group (delivering from June 2020 to May 2021) and a mobile platform group (delivering from June 2021 to May 2022). The depression screening rate, screening positive rate, referral rate, and intervention rate during the first trimester, second trimester, third trimester, and postpartum period were observed for both groups. Results This study included a total of 311,719 pregnant and postpartum women, with 166,832 in the routine service group and 144,887 in the mobile platform group. The mobile platform group had higher depression screening rates, referral rates, and intervention rates during the first trimester, second trimester, third trimester, and postpartum period than the routine service group ($P<0.05$). The mobile platform group had higher screening positive rates in the first trimester and second trimester than the routine service group ($P<0.05$), while the screening positive rates in the third trimester and postpartum period were lower than those in the routine

service group (P<0.05). Conclusion The mobile platform provides effective tools and methods for the routine management of perinatal depression. The low intervention rate for screening-positive pregnant and postpartum women is currently the most prominent implementation bottleneck. Future research should focus on optimizing platform functional design, exploring optimal intervention measure combinations, enhancing health education, and developing effective, sustainable, and universal implementation strategies through innovative methods.

Full Text

Application and Evaluation of the Mobile Platform for Perinatal Depression Screening and Intervention

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Abstract

Background: Perinatal depression represents a significant public health issue affecting maternal and child health, necessitating urgent and effective management. Since 2021, Shenzhen has promoted city-wide perinatal depression screening and intervention through the development of a mobile healthcare platform. **Objective:** This study utilizes routine data from the Shenzhen Perinatal Depression Screening and Intervention Program to evaluate the impact of the mobile platform on program implementation and identify the most prominent implementation bottlenecks. **Methods:** This retrospective study included pregnant and postpartum women who delivered in any of Shenzhen's 82 midwifery institutions across 10 districts between June 2020 and May 2022. Eligible participants were divided into two groups based on the mobile platform activation date: the routine service group (deliveries between June 2020 and May 2021) and the mobile platform group (deliveries between June 2021 and May 2022). Depression screening rates, screening positive rates, referral rates, and intervention rates during early pregnancy, mid-pregnancy, late pregnancy, and postpartum were observed and compared between groups using Chi-square tests, with statistical significance set at P<0.05. **Results:** A total of 311,719 pregnant and postpartum women were included, comprising 166,832 in the routine service group and 144,887 in the mobile platform group. The mobile platform group exhibited significantly higher screening rates, referral rates, and intervention rates across all

perinatal stages compared to the routine service group (P<0.05). Screening positive rates in early and mid-pregnancy were higher in the mobile platform group (P<0.05), while rates in late pregnancy and postpartum were lower than in the routine service group (P<0.05). **Conclusion:** The mobile platform provides an effective tool and methodology for routine perinatal depression management. However, the low intervention rate among screening-positive women represents the most prominent implementation bottleneck. Future research should focus on optimizing platform functionality, identifying optimal intervention combinations, enhancing health education, and developing innovative, sustainable, and widely applicable implementation strategies.

Keywords: Perinatal depression; Screening; Intervention; Mobile platform; Effectiveness

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Introduction

Perinatal depression refers to depressive disorders occurring during pregnancy and within one year after childbirth, which can be categorized into antenatal and postpartum depression based on the timing of onset. It typically manifests as persistent low mood, loss of interest, sleep and/or eating disturbances, and in severe cases may lead to suicidal ideation. For offspring, perinatal depression may increase the risk of preterm birth, affect infant development, and have long-term adverse effects on cognitive, social, and emotional development. Additionally, maternal depressive symptoms can damage intimate relationships, trigger family conflicts, and even lead to family breakdown, while simultaneously burdening public health and social security systems.

According to a meta-analysis by Nisar et al., the pooled prevalence of perinatal depression in mainland China is 16.3%, comprising 19.7% for antenatal depression and 14.8% for postpartum depression. These rates fall between those of low- and middle-income countries (19-25%) and high-income countries (7-15%). Given that perinatal depression constitutes a major public health problem affecting women's and children's health, effective management is urgently needed. Universal screening and early intervention have proven effective in improving perinatal depression outcomes. With the development of information technology, the "Internet plus psychological intervention" model has become a trend

in perinatal depression management, with numerous domestic and international studies demonstrating its effectiveness. However, most existing research involves relatively small sample sizes and focuses primarily on late pregnancy and postpartum stages, lacking large-scale evidence covering the entire perinatal period.

Shenzhen has been implementing postpartum depression screening and intervention city-wide since 2013, funded by local government. In 2019, the city launched the Perinatal Depression Screening and Intervention Program, which requires all maternity healthcare providers and community postpartum visitors to conduct depression screening during routine prenatal check-ups and postpartum visits, followed by tiered referral and follow-up management for positive cases. Since 2021, the program has been further advanced through the development of a mobile platform integrated with the Shenzhen Maternal and Child Health Management Information System, using the "Shenzhen Women and Children" mini-program. This platform provides mental health services throughout the entire reproductive journey, from early pregnancy to six weeks postpartum, creating a new model of "Internet plus maternal mental health services." This study utilizes routine data from the Shenzhen Perinatal Depression Screening and Intervention Program to analyze the mobile platform's effectiveness in promoting program implementation and identify the most significant implementation bottlenecks.

Methods

Study Population

Inclusion criteria: (1) Pregnant and postpartum women who delivered in any of Shenzhen's 82 midwifery institutions across 10 districts between June 2020 and May 2022; (2) Individual records of perinatal depression screening and intervention available in the Shenzhen Maternal and Child Health Management Information System; (3) Voluntary participation in this study.

Exclusion criteria: (1) Women with severe psychiatric disorders or intellectual disabilities; (2) Women with certain physical conditions that made questionnaire completion difficult or effective communication impossible.

Researchers extracted all eligible individual records from the Shenzhen Maternal and Child Health Management Information System to establish a foundational database. All participants were fully informed about the study content and provided consent at the time of initial screening. Collected maternal data were kept strictly confidential and used exclusively by research team members. This study was approved by the Research Ethics Committee of Shenzhen Maternity and Child Healthcare Hospital (Approval No.: SFYLS[2021]066).

Screening Instruments

Patient Health Questionnaire (PHQ-9): The PHQ-9 comprises nine items based on depressive symptom criteria from the Diagnostic and Statistical Man-

ual of Mental Disorders, Fourth Edition (DSM-IV), published by the American Psychiatric Association in 1994. This self-report depression scale demonstrates good reliability and validity and is commonly used for screening and severity assessment of depressive symptoms in clinical practice. Each item is scored from 0 ("not at all") to 3 ("nearly every day"), with total scores ranging from 0 to 27, where higher scores indicate more severe depressive symptoms. Following domestic and international literature, this study defined a PHQ-9 score $ $5 during early, mid-, and late pregnancy as positive for antenatal depression screening, triggering referral and intervention during pregnancy.

Edinburgh Postnatal Depression Scale (EPDS): The EPDS consists of 10 items and was translated into Chinese by Li Decheng et al. in 1998, subsequently demonstrating good reliability and validity for postpartum depression screening and related research in China. Each item is scored from 0 to 3, with total scores ranging from 0 to 30, where higher scores indicate more severe depressive symptoms. Following domestic and international literature, this study defined an EPDS score $ $10 at 2-6 weeks postpartum as positive for postpartum depression screening, triggering referral and intervention.

Study Groups

Based on the official activation date of the mobile platform, participants were divided into two groups: the routine service group (deliveries between June 2020 and May 2021) and the mobile platform group (deliveries between June 2021 and May 2022). The perinatal depression screening and intervention services received by each group are described below.

Routine Service Group: According to the Shenzhen Perinatal Depression Screening and Intervention Program Protocol, obstetric healthcare providers instructed pregnant women to complete paper-based PHQ-9 questionnaires during routine prenatal check-ups, with at least one screening during early pregnancy (before 13 weeks), mid-pregnancy (16-24 weeks), and late pregnancy (25-32 weeks), with specific timing determined by the woman's visit schedule. Community postpartum visitors instructed women to complete paper-based EPDS scales during home visits (2-6 weeks postpartum). Healthcare providers distributed educational materials on perinatal depression prevention and treatment to women with positive screening results, reminding them to visit their district maternal and child health institution's psychological clinic for diagnosis or psychological intervention. Women with severe depressive disorders were referred to psychiatric hospitals or general hospital psychiatry departments for treatment. Healthcare providers conducted at least four weeks of follow-up via telephone for screening-positive women, collecting information on whether they attended appointments, the institutions visited, what psychological interventions/treatments they received, and changes in depressive symptoms. All collected data were manually entered into the Shenzhen Maternal and Child Health Management Information System.

Mobile Platform Group: The Shenzhen Perinatal Depression Screening and Intervention Mobile Platform comprises multiple modules. The user module provides pregnant and postpartum women with a series of mobile services, including maternal health information queries, mental health assessments, maternal and infant health knowledge learning, and prenatal school appointments. The healthcare provider module enables query of screening results, alerts for positive results, and "one-click" referral functionality. The management module includes functions for case tracking, health education, and data quality control. Using this platform, obstetric healthcare providers instructed pregnant women to complete PHQ-9 questionnaires online via mobile devices during routine prenatal check-ups, with at least one screening during early, mid-, and late pregnancy, with specific timing determined by the woman's visit schedule. Community postpartum visitors instructed women to complete EPDS scales online via mobile devices during home visits. Healthcare providers could query screening results in real-time (with the platform automatically identifying positive results), remind screening-positive women to register for appointments via mobile devices, or directly "one-click" refer them to their district maternal and child health institution's psychological clinic or psychiatric hospitals/psychiatry departments, followed by at least four weeks of tracking management. City- and district-level program managers could query information on referred women through the platform and proactively conduct telephone follow-up with those who had not yet attended appointments. Most collected data could be automatically synchronized to the Shenzhen Maternal and Child Health Management Information System. Additionally, program managers regularly pushed perinatal depression prevention and education materials to all registered users of the "Shenzhen Women and Children" mini-program, including public account articles and short videos.

Quality Control

As the leading implementation unit for the Perinatal Depression Screening and Intervention Program, Shenzhen Maternity and Child Healthcare Hospital regularly conducted city-wide data quality control using the Shenzhen Maternal and Child Health Management Information System to ensure data accuracy and completeness. District-level maternal and child health institutions also regularly conducted quality checks on data within their jurisdictions to maintain accuracy and timeliness. Furthermore, each midwifery institution assigned dedicated personnel in obstetrics or preventive healthcare departments to supervise program implementation and ensure effective operation. In this study, researchers obtained 317,634 individual records and conducted repeated checks on the foundational database to identify and remove duplicate data, exclude data violating known logic, and standardize data formats, ultimately retaining 311,719 (98.1%) valid records.

Statistical Methods

Researchers imported the valid database into SPSS 26.0 for data analysis. Observed indicators included depression screening rates, screening positive rates, referral rates, and intervention rates during early pregnancy, mid-pregnancy, late pregnancy, and postpartum. Screening rate was calculated as: (number of women with screening results / total number of women) × 100%. Screening positive rate was calculated as: (number of screening-positive women / number of screened women) × 100%. Referral rate was calculated as: (number of women with referral records [received referral reminders or "one-click" referred by the platform] / number of screening-positive women) × 100%. Intervention rate was calculated as: (number of women with intervention records [follow-up data showing attendance at corresponding medical institutions] / number of screening-positive women) × 100%. Continuous variables were expressed as ($\bar{x}\pm s$), and categorical variables as number of cases (%). Categorical data were analyzed using Chi-square tests or trend Chi-square tests. Statistical significance was set at $P<0.05$. As this study used routine data from a public health program, some items had missing data. Considering the small proportion of missing data and that this study did not conduct correlation analysis between maternal general characteristics and observed indicators, it was determined that this would not significantly impact the main conclusions, and therefore no deletion or imputation of missing data was performed.

Results

General Characteristics

This study included 311,719 pregnant and postpartum women with a mean age of (29.7$±$4.5) years. Based on mobile platform activation timing, participants were divided into the routine service group (n=166,832) and the mobile platform group (n=144,887). In both groups, over 70% of women were aged 25-35 years; the primary occupation was cadre/company employee (over 50%); education level was predominantly university/college (over 55%); and the proportion reporting personal or family psychiatric history was below 0.3%. Statistically significant differences existed between the two groups in age, occupation, education level, and family history ($P<0.05$) .

Perinatal Depression Screening Rates

Compared with the routine service group, the mobile platform group showed significantly higher depression screening rates in early pregnancy, mid-pregnancy, late pregnancy, and postpartum ($P<0.05$) .

Perinatal Depression Screening Positive Rates

The mobile platform group exhibited higher screening positive rates in early and mid-pregnancy compared to the routine service group, while showing lower

rates in late pregnancy and postpartum, with all differences being statistically significant (P<0.05) .

Perinatal Depression Referral Rates

The mobile platform group demonstrated significantly higher referral rates in early pregnancy, mid-pregnancy, late pregnancy, and postpartum compared to the routine service group (P<0.05) .

Perinatal Depression Intervention Rates

The mobile platform group showed significantly higher intervention rates in early pregnancy, mid-pregnancy, late pregnancy, and postpartum compared to the routine service group (P<0.05) .

Trends in Screening Rates and Positive Rates After Mobile Platform Activation

Figure 1 [Figure 1: see original paper] illustrates trends in depression screening rates and positive rates across perinatal stages during the first year after mobile platform activation. Screening rates in early pregnancy (^{2} trend=13,902.862, P<0.001), mid-pregnancy (^{2} trend=5,577.567, P<0.001), and late pregnancy (^{2} trend=4,886.518, P<0.001) showed continuous improvement, particularly in early pregnancy, which increased from 41.0% to 80.4%. Postpartum screening rate reached 94.5% initially and further increased to 97.1% (^{2} trend=270.489, P<0.001). Early pregnancy screening positive rate showed an upward trend (^{2} trend=178.878, P<0.001), rising from 10.6% at platform activation to 15.5%. Mid-pregnancy positive rate fluctuated slightly between 6-8% (^{2} trend=24.583, P<0.001). In contrast, late pregnancy positive rate (^{2} trend=30.218, P<0.001) and postpartum positive rate (^{2} trend=65.369, P<0.001) showed gradual downward trends, decreasing from 8.3% to 7.2% and from 3.1% to 2.2%, respectively.

Trends in Referral and Intervention Rates for Screening-Positive Women After Mobile Platform Activation

Figure 2 [Figure 2: see original paper] presents trends in referral and intervention rates for screening-positive pregnant and postpartum women during the first year after mobile platform activation. Overall annual data showed that referral rates across all perinatal stages remained high, generally above 95%, except for early pregnancy, which showed an upward trend (^{2} trend=110.218, P<0.001). However, intervention rates among screening-positive women were consistently low. Although intervention rates in mid-pregnancy (^{2} trend=65.395, P<0.001) and late pregnancy (^{2} trend=4.349, P<0.05) increased after platform activation, neither exceeded 20%. Compared with pregnancy stages, postpartum intervention rate showed a more substantial increase (^{2} trend=90.700, P<0.001), rising continuously from 33.5% at platform activation to 59.3%.

Discussion

Effectiveness of the Mobile Platform for Perinatal Depression Screening and Intervention

This study demonstrates that the mobile platform implemented in Shenzhen in 2021 significantly improved perinatal depression screening rates, referral rates, and intervention rates across all stages, with these effects persisting after platform activation. Unlike existing studies focusing primarily on commercially oriented perinatal depression intervention platforms, this platform was government-led, serving a key public health program with characteristics of public benefit, strong accessibility, and high acceptability. The platform's design closely integrated program implementation needs, featuring user, healthcare provider, and management modules that embodied patient-centered care while maintaining strong feasibility and sustainability. The observed improvements in screening, referral, and intervention rates can be attributed to multiple advantages of the mobile platform, including convenience, accessibility, and safety. Compared with traditional psychological interventions, mobile health interventions offer broad functionality, time and cost savings, freedom from geographic constraints, strong interactivity, privacy protection, and high acceptance, while effectively mitigating the negative impact of the COVID-19 pandemic on maternal mental health.

A 2023 meta-analysis by Yang Zhongting et al. reported that the detection rate of depression among Chinese women was 24.5% in early pregnancy, decreasing throughout the reproductive process, with rates of 20.6%, 17.8%, and 17.0% in mid-pregnancy, late pregnancy, and six weeks postpartum, respectively. In comparison, the screening positive rates across perinatal stages in this study were lower, though the overall trend was consistent. This discrepancy may be because our study used routine data from a city-wide program covering a broader population, more comprehensively reflecting real-world screening conditions and reducing bias and uncertainty inherent in small-scale studies.

Additionally, we observed an upward trend in screening positive rates in early and mid-pregnancy after platform activation, consistent with existing research. This may be attributed to higher engagement and convenience of the mobile platform, particularly during the pandemic when face-to-face medical services were reduced, leading to identification of more potential cases. Simultaneously, the mobile platform group showed significantly lower screening positive rates from late pregnancy through postpartum compared to the routine service group, reflecting the effectiveness of early identification and intervention for perinatal depression and further validating the effectiveness of delivering psychological interventions through mobile platforms. These findings align with multiple domestic and international studies, emphasizing the important value and potential of mobile technology in public health, particularly for perinatal depression prevention and treatment.

Implementation Bottlenecks in Perinatal Depression Screening and Intervention

Although the mobile platform significantly improved screening rates, with over 90% of screening-positive women referred to district-level maternal and child health institution psychological clinics or psychiatric hospitals/departments, the proportion actually receiving psychological intervention/treatment remained low, falling short of the 80% target outlined in the program protocol. This phenomenon was particularly severe during pregnancy. A systematic review by Thombs et al. noted that low psychological intervention rates substantially reduce the utility of perinatal depression screening, thereby affecting overall prevention and treatment effectiveness. The reasons for low intervention rates among screening-positive women are multifaceted. On one hand, poor accessibility of mental health services represents a major barrier, with some women avoiding appointments due to concerns about high treatment costs, transportation inconvenience, or stigma. On the other hand, most screening-positive women experience only temporary or mild depressive symptoms requiring simple mental health support rather than specialized professional care. In a cohort study in Hunan Province, 80% of women who declined psychological counseling believed they could "handle depressive symptoms themselves." Additionally, while mobile health interventions offer advantages in coverage compared to traditional approaches, they also have potential limitations, such as monotonous information presentation and unengaging content, leading to difficulty in sustained user engagement. Therefore, future research should thoroughly explore user preferences and factors influencing mobile platform implementation, considering perspectives from both supply and demand sides to provide evidence for optimizing platform design and developing effective, sustainable implementation strategies.

Limitations

This study relied on data from the Shenzhen Maternal and Child Health Management Information System. Although the sample size was large, the findings have certain regional specificity, primarily reflecting Shenzhen's context and potentially limiting generalizability to other areas. Additionally, retrospective data analysis can only reflect the mobile platform's impact on program implementation and cannot evaluate the effectiveness of specific interventions (such as particular psychological interventions or health education) in reducing maternal depressive symptoms. Notably, statistically significant differences existed between the routine service and mobile platform groups in age, occupation, education level, and family history. While these differences may be attributable to large sample sizes making minor differences statistically significant, they may still confound study results to some extent. Furthermore, because some items had missing data and this study did not perform deletion or imputation, this may have affected the interpretability of between-group comparisons. Moreover, the study was conducted during the pandemic, when social, economic, and healthcare environmental changes may have influenced women's healthcare-

seeking behavior. While this provides a unique perspective on maternal psychological needs during public health emergencies, the special circumstances may limit applicability of findings to normal situations. Future research should explore different regions under normal circumstances, control confounding factors through experimental methods such as randomized controlled trials, evaluate the effects of different interventions or intervention combinations on reducing maternal depressive symptoms, and explore effective implementation strategies to provide generalizable scientific evidence for constructing and optimizing perinatal depression prevention and treatment strategies.

Conclusion

The implementation of Shenzhen's Perinatal Depression Screening and Intervention Mobile Platform significantly improved screening, referral, and intervention rates for perinatal depression, providing an effective tool and methodology for routine management. However, the low intervention rate among screening-positive women remains the most prominent implementation bottleneck. Future research should comprehensively understand the needs of pregnant and postpartum women, healthcare providers, and other stakeholders; continuously optimize mobile platform functionality; identify optimal intervention combinations; enhance health education; and develop effective implementation strategies through innovative approaches. This will provide reference for exploring feasible, sustainable, and universally applicable service models for perinatal depression prevention and treatment, ultimately promoting maternal mental health and well-being.

Author Contributions: Dadong Wu conceptualized and designed the study; Lei Jiang coordinated program implementation and quality control; Dadong Wu and Lei Jiang revised the final manuscript and take responsibility for the paper; Huimin Liu collected data; Jiayi Zhang cleaned data and performed statistical analysis; Jiayi Zhang and Siyuan Liu drafted the initial manuscript; Guanglin Zhao managed and extracted routine data from the Shenzhen Maternal and Child Health Management Information System; Shuyan Jin supervised the study.

Conflict of Interest: The authors declare no conflict of interest.

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Note: Figure translations are in progress. See original paper for figures.