BMC Pregnancy and Childbirth

RESEARCH

Open Access

The mental health benefit of a community-based home-visiting program for prenatal women: evidence from a randomized controlled trial in China

Nan Wang[1], Baowei Li[2], Jie Yang[1*], Zhuo Liu[1], Yaojiang Shi[1] and Jingchun Nie[1]

Abstract

Background Maternal mental health is a global concern including in China. However, evidence on early prevention of maternal mental health problems in low- and middle-income countries is scarcely reported. This study sought to assess the effectiveness of a community-based home-visiting program facilitated by local Community Health Workers (CHWs) in rural areas of western China.

Methods This study used randomized controlled trial, 592 pregnant women in the sample were randomly divided into treatment group and control group, and pregnant women in the treatment group received home visits from community health workers(CHWs).The main outcome was the mental health of pregnant women, which was measured using the Depression Anxiety and Stress Scale-21 (DASS-21). Average treatment effect analysis and local treatment effect analysis were used to analyze the effects of the CHWs' home-visiting intervention on maternal mental health.

Results The regression analysis showed that the home-visiting intervention did not have a positive impact on maternal mental health in rural areas. However, the effects of the intervention varied depending on family support. Specifically, when the husband accompanies antenatal care, the home-visiting intervention had a significant positive effect, reducing maternal depression and stress tendency scores by 0.1 and 2.14 points respectively (10% significance level). Additionally, for pregnant women with a satisfactory relationship with their husbands, the intervention reduced their depression scores by 0.61 and anxiety scores by 0.52 (10% significance level).

Conclusions The interventions were not effective in improving the mental health of pregnant women on average. However, when pregnant women received greater family support and had a satisfying marital relationship, the interventions had a significant positive impact. Therefore, optimizing the design of the Community Health Worker (CHW) home-visiting intervention is essential to enhance its effectiveness.

Trial registration Registration number ISRCTN98898991.Registered 26/03/2019.

Keywords Rural china, Home-visiting intervention, Maternal mental health, Randomized controlled trial

*Correspondence:
Jie Yang
jyang0716@163.com

[1]Center for Experimental Economics in Education, Shaanxi Normal University, Xi'an, China
[2]School of Economics, Nankai University, Tianjin, China

Introduction

Women in the prenatal, perinatal, and postnatal periods are at high risk of maternal mental health problems such as depression, anxiety, and stress. According to the World Health Organization, more than 10% of prenatal women and 13% of postnatal women were experiencing mental health problems to various degrees of severity globally (WHO) [1]. Previous empirical research indicated an incidence of prenatal depression ranging from 6% to 38% across different regions [2]. In low- and middle-income countries (LMICs), these incidences are considerably higher, with approximately 15% to 57% [3] of mothers reporting symptoms of sadness and anxiety due to exposure to risk factors of mental health such as poverty, unemployment, and poor mental health services [4].

Numerous studies have reported robust associations between maternal mental health and peripartum or postpartum complications, stillbirth, low birth weight, congenital malformations, and stunted growth [5–7], thus making it among the factors most responsible for maternal and child morbidity and mortality. Additionally, maternal mental health was also reported to be a significant predictor of a compromised child's cognitive and socio-emotional development [8, 9].

China confronts significant mental health challenges among peri- and postnatal women with no exceptions, like other LMICs. Previous studies have reported a combined prevalence of maternal depression at 16.3%, encompassing rates of 19.7% for prenatal depression and 14.8% for postnatal depression [10]. Additionally, disparities exist based on reproductive and urban-rural divides. For instance, primiparous women experience higher rates of postpartum depression compared to women with prior childbirth experiences [11, 12]. Rural areas exhibit higher incidences of maternal depression, ranging from 23% to 32%, in contrast to around 15.5% observed in urban settings [13–15].

Regrettably, despite the known disparities in urban and rural maternal mental health status [16], in most economically disadvantaged rural areas, the overall status of maternal mental health problems is probably underestimated due to the lack of routine screening. Moreover, the shortage of mental health resources makes it even more difficult to effectively carry out prevention and treatment services of maternal mental health risks in rural areas. It is therefore urgently needed for policymakers to boost the quality of maternal and child health services in order to improve the psychological health of peri- and postnatal women in rural China.

Some empirical studies in low- and middle-income countries (LMICs) suggest that home-visiting programs delivered by community health workers (CHWs) can effectively improve maternal mental health in economically disadvantaged areas. These programs typically involve regular home visits by trained CHWs to pregnant and postpartum women, providing services such as basic prenatal health checks, guidance on maternal care and postpartum recovery, and infant feeding and child-rearing practices [17]. This integrated model of service delivery has been widely implemented and evaluated in various LMIC settings, showing positive impacts on maternal and child health outcomes, including mental health improvements [18, 19]. Inspired by these successful experiences, our study draws on the structure of existing home-visit programs and evaluates their potential effectiveness in the context of rural China, where empirical evidence on such interventions remains limited.

The goal of this study is therefore to evaluate the impact of a home visiting program delivered by local community health workers (CHWs) on promoting maternal mental health in rural China. To identify the causal relationship between the intervention and maternal mental health, we conducted a cluster randomized controlled trial (RCT) in rural western China, which was recognized as the "golden standard" for impact evaluation.

Methods

Sampling and randomization

This study was conducted in 10 economically disadvantaged counties in a northwestern province of China. According to the National Bureau of Statistics of China (NBSC), in 2020, the average per capita income in rural China was 17,131 RMB (2,483 USD), while in the study province it was only 13,317 RMB (1,930 USD), ranking 27th out of 31 provinces. This setting reflects the typical challenges faced by underdeveloped rural regions in China, including poverty, health service shortages, and traditional gender norms, making it a relevant context for studying maternal health interventions.

To determine the sample size needed for this study, we assumed an intraclass correlation coefficient of 0.05 and an R-squared of 0.5. As is standard in much of literatures [20, 21], we set mental health standardized effect size = 0.25. We then calculated that we required at least 8 individuals per township. The final desired sample size was set at 550.

Figure 1 shows the trail sampling process. Within the sample region, we followed a three-step protocol to select the study sample. First, we randomly selected five prefecture-level cities in the province. Then, within each city, we randomly selected two economically underdeveloped counties, resulting in a total of ten counties. Second, in each sample county, we randomly selected ten townships from a list provided by the local Health Bureau, excluding the township that housed the county seat due to its wealthier and more urban characteristics. For counties with more than ten townships, we randomly selected ten. For counties with fewer than ten townships, all townships

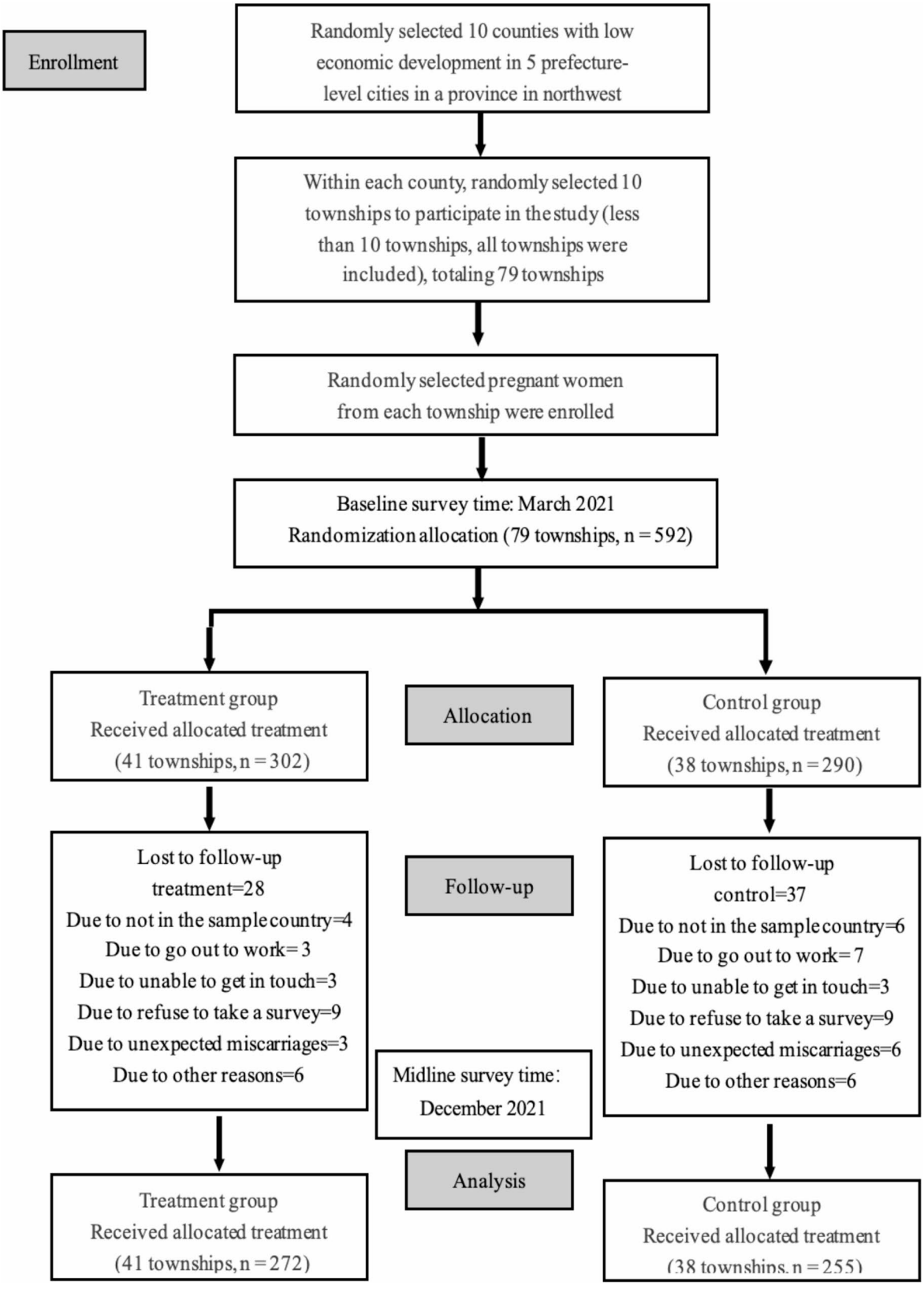

Fig. 1 The flow of the study participants through the trial according to the criteria recommended in the CONSORT guideline

were included, totaling 79 townships. Finally, Within the selected townships, a list of households with pregnant women was obtained from the local health administrator (the Township Health Center). We then randomly selected ten households from each list. In townships with fewer than ten eligible households, all were included.

Inclusion and exclusion criteria. To ensure that participants could fully engage in the intervention and provide reliable information, we applied the following inclusion: (1) aged between 18 and 45 years; (2) had resided in the study area for at least one year prior to enrollment. We excluded participants who had been diagnosed with severe mental disorders (e.g., schizophrenia, bipolar disorder) or had significant cognitive impairment that would hinder informed participation. Based on these criteria, 14 out of the initial 606 identified pregnant women were excluded from the study. Finally, A total of 592 eligible pregnant women from 79 townships were enrolled in the study. All 592 eligible pregnant women agreed to participate in the project and completed the baseline survey.

As shown in Fig. 1. Baseline survey was conducted in March 2021. After initial data analysis, we randomly allocated 41 sample townships to the treatment arm of the study and 38 townships to the control arm using computer-generated random numbers. The random allocation was stratified at county level to ensure that the randomization process accounts for potential differences between counties. The home-visiting services started immediately after the allocation on May. Midline survey was conducted in December 2021, which was 8 months after the allocation.

Intervention

Households in the treatment group received a structured caregiver education intervention aimed at improving early childhood nutrition and health, as well as maternal well-being. The intervention was delivered through monthly home visits and follow-up phone calls by trained community health workers (CHWs), covering the period from early pregnancy to six months postpartum, depending on the gestational age at enrolment.

CHWs were recruited from women and children's specialists working in township health centers. All CHWs were female, with an average age of 33 years, and over 80% had completed at least junior college education. Each home visit lasted approximately 40 to 60 min and included educational sessions, demonstrations, and interactive discussions designed to help families absorb and apply key health information. Households in the control group received no intervention.

Content

To ensure scientific rigor and practical feasibility, the stage-based curriculum used during the visits was jointly developed by our research team in collaboration with experts in medicine, pediatrics, and psychology from Stanford University School of Medicine, Peking University Health Science Center, and Xi'an Medical University. The curriculum was structured around the physiological and psychological needs of women and infants at different perinatal stages. Core topics included (as shown in Fig. 2):

1. folic acid supplementation and maternal nutrition,
2. psychological adjustment during pregnancy,
3. preparation for breastfeeding and newborn care,
4. postpartum recovery and self-care,
5. family communication and support strategies.

CHWs followed a structured manual and used printed materials and visual aids to deliver content in an accessible and culturally appropriate manner. The intervention also emphasized emotional support and encouraged the involvement of husbands or other family members during the visits, aiming to enhance social support within the household.

Supervision

The selected CHWs underwent a 5-day systematic Training of the Trainers (TOT) prior to home visiting. This covered maternal nutrition and health, communication skills, home visit process, and quality monitoring. We also conducted advanced training sessions for CHWs every three months to reinforce their skills.

After the intervention was initiated, we also collected process data through a systematic approach involving the supervision and documentation by county-level supervisors. Community Health Workers (CHWs) recorded their home visits and documented the visits with photos and written reports. The supervisors in each county were responsible for collecting these records and reporting the CHWs' activities to the research team on a regular basis. All process data were securely stored and properly cleaned. Our researchers analysed and reviewed the data to examine the quality and quantity of the home visits.

Outcome measures

We used a questionnaire survey method in our study, with trained enumerators conducting face-to-face interviews with every participant.

We conducted two rounds of surveys, referred to as the baseline survey in March 2021 and midline surveys in December 2021. Both surveys collected data on maternal mental health, perceived social support, and demographic characteristics of sample pregnant women. The outcome measures used in this article are explained as follows in detail.

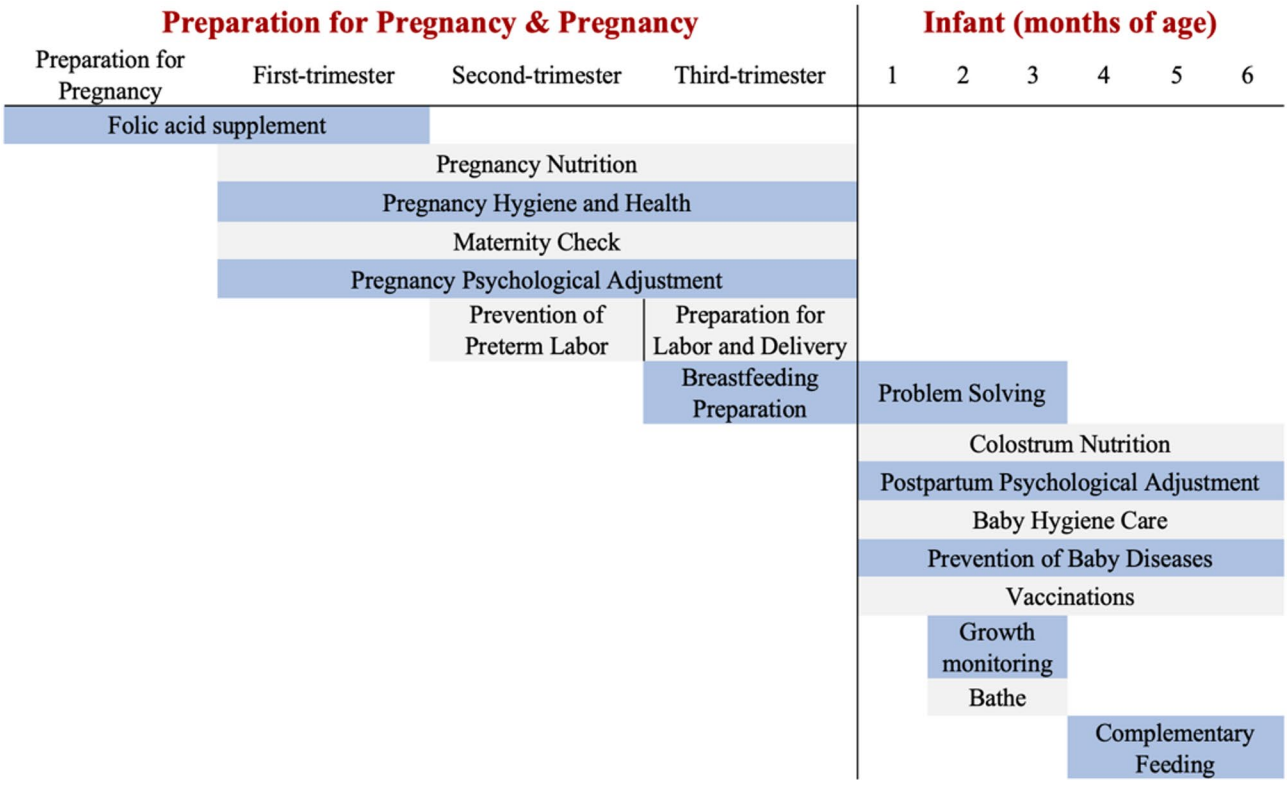

Fig. 2 Framework of the curriculum content

Maternal mental health: The main outcome of this research is maternal mental health. In each survey round, participating women completed the Depression, Anxiety, and Stress Scales-21 (DASS-21), developed by Lovibond [22]. The DASS-21 has been empirically validated and demonstrates high internal consistency among pregnant women from diverse cultural backgrounds, making it a reliable tool for assessing maternal mental health [23]. Numerous studies in China have further supported its accuracy in reflecting maternal mental health levels [24–26].

The DASS-21 assesses tendencies of depression, anxiety, and stress in individuals aged 24 and older [27]. Studies have demonstrated the DASS-21's high reliability and validity globally and in China as well [28, 29]. The scale comprises 21 items, divided into three subscales: depression, anxiety, and stress. Each subscale has 7 items scored from 0 (did not apply to me at all over the last week) to 3 (applied to me very much or most of the time over the past week). Because the DASS-21 is a short form version of the DASS (the Long Form has 42 items), the final score of each item groups (Depression, Anxiety and Stress) needs to be multiplied by two (x2). Therefore, each subscale scores range from 0 to 42, with higher scores indicating a greater likelihood of experiencing depression, anxiety, or stress in the previous week.

In this paper, DASS-21 scores are defined in three ways: (1) individual subscale scores for depression, anxiety, and stress; (2) a dummy variable indicating any tendency toward depression (score > 9), anxiety (score > 7), or stress (score > 14), coded as 1 if present and 0 otherwise; and (3) a dummy variable indicating moderate to severe tendency toward depression (score > 13), anxiety (score > 9), or stress (score > 18), coded as 1 if present and 0 otherwise.

Demographic characteristics: We collected information on maternal, child, and household characteristics. Maternal characteristics included age, education level, employment status, timeliness of prenatal care, gestational age, and number of illnesses during pregnancy. Child characteristics included gender and first-born status. Household characteristics included years of marriage, number of household members, household asset index, husband's age, education level, and employment status.

Baseline characteristics, balance, and attrition of sample

The balance test is a statistical method that compares whether the sample pregnant women in the treatment and control arms are statistically identical in terms of baseline characteristics, and the results respond to whether the randomized controlled trials assignment was appropriate and whether the counterfactual assumptions were met.

Table 1 Balance test

Variable	Control (*n*=290)	Treatment (*n*=302)	*P*-value
	mean ± SD or N (%)	mean ± SD or N (%)	
Panel A：mental health			
Depression（1=Yes）	62 (21.2%)	57 (19.0%)	0.498
Anxiety（1=Yes）	71 (24.3%)	72 (24.0%)	0.929
Pressure（1=Yes）	32 (11.0%)	40 (13.3%)	0.377
Panel B：Maternal Characteristics			
Maternal Age	28.80 ± 4.28	28.72 ± 4.30	0.81
Maternal Education（1 = ＞9years）	113 (38.7%)	118 (39.3%)	0.874
Mother has a work（1 = Yes）	62 (21.2%)	63 (21.0%)	0.945
Gestational age	6.18 ± 1.97	6.09 ± 1.96	0.543
Takes pregnancy test on time（1 = Yes）	197 (67.5%)	204 (68.0%)	0.889
Number of illnesses during pregnancy	1.04 ± 1.16	1.13 ± 1.20	0.359
Panel C：Baby Characteristics			
Male（1=men）	——	——	——
first-born（1=Yes）	104 (35.7%)	108 (36.0%)	0.922
Panel D：Household Characteristics			
Marriageable age	4.82 ± 3.90	4.98 ± 4.16	0.619
Number of household members	6.94 ± 0.84	7.00 ± 0.92	0.395
Household asset index（1 = ＞0）	161 (55.1%)	165 (55.0%）	0.973
Husband's age	31.09 ± 4.35	31.11 ± 4.97	0.957
Husband's education（1= ＞9years）	136 (46.6%)	132 (44.0%)	0.529
Husband has a work（1 = Yes）	263 (90.1%)	266 (88.7%)	0.58

Table 1 presents the descriptive statistics and balance tests of baseline characteristics between the treatment and control groups. There was no significant difference between the two groups in all variables, proving the basic premise of the randomized controlled trials.

Panel A provides the baseline percentage of the tendencies of mental health problems. Overall, about 20% of our sample had demonstrated tendencies of depression, almost a quarter of them had anxiety tendencies, and about 11%-13% reported feeling stressed.

Panel B provides the baseline statistics for pregnant women. The average age of pregnant women is around 28 at baseline, and about 40% of them have over 9 years of education on average, but only 20% reported that they were previously employed. Slightly over two-thirds of the pregnant women were able to take regular prenatal care. About 36% of them were about to have their first child.

Some of the household characteristics are presented in Panel C including the socioeconomic status of the household, family size, and basic characteristics of the father. It is worth noting that the average family size of the households is nearly 7 people, and it was common for our participating women to live with either their parents or their parents-in-law. Fathers remain the main labor force in the family, with nearly 90% of fathers employed.

The attrition was acceptable in both intervention and control groups in our sample. Of the 592 samples at baseline, a total of 65 pregnant women dropped out due to reasons such as being out of work, being unable to be contacted, or experiencing unexpected miscarriages, etc., with 37 in the control group and 28 in the treatment group, yielding an overall attrition rate of 11.0%. As shown in Table 2, the attrition rate is balanced between the treatment and control groups. In Table S2 (see Appendix A), we further tested if the baseline characteristics are still balanced after removing attritted samples, and the differences in maternal and household characteristics are all insignificant, indicating that the sample attrition will not cause bias in the estimation outcomes in this research.

Table 2 Attrition test

Independent variable	Dependent variable: attrition (1 = Yes;0 = No)
Treatment (1 = Test)	-0.04
	(0.02)
Control variables	
Mental health	Yes
Maternal characteristics	Yes
Baby characteristics	Yes
Household characteristics	Yes
Constant	0.13
	(0.23)
County FE	Yes
R2	0.026
Observations	592

Estimation strategy

Average treatment effect

In a randomized controlled trial, comparisons of the mean(s) of the outcome variable(s) between the treatment control groups provide unbiased estimates of the program effects on outcomes due to random treatment assignment. We estimated the intent-to-treat (ITT) effects of the CHW intervention by using the ordinary least squares (OLS) regression models and the basic specification of the model is as follows:

$$Y_{ij\_midline} = \alpha_0 + \alpha_1 T_{ij} + \alpha_2 Y_{ij\_baseline} + \alpha_3 X_{ij} + \varepsilon_{ij} \quad (1)$$

Where $Y_{ij\_midline}$ is the mental health of postpartum woman i in town j at midline. T_{ij} is a dummy that indicates the treatment assignment of pregnant or postpartum woman i in town j. $Y_{ij\_baseline}$ is the mental health of pregnant woman i in town j at baseline. X_{ij} represents a vector of baseline variables that would be correlated with pregnant or postpartum women's mental health. These baseline variables include maternal, child, and household characteristics. The coefficient α1 captures the ITT effects of the CHW home visiting intervention on pregnant or postpartum women's mental health. We controlled for randomization strata (county) and adjusted the robust standard errors(se) for clustering at the town level because individual values within the same towns are correlated, which might result in biased se in the regression.

Local treatment effect

The CHW home visit for pregnant women in the treatment group in this study still had compliance issues, such as the presence of some pregnant women in the treatment group who did not receive home visiting from CHW as set in the program. According to our process data, the overall compliance rate in the treatment group was 65%. To address this issue, we also analyzed the Treatment on the Treated (TOT) effect of the intervention.

The research team collected and recorded the number of home visits received by pregnant women during project implementation. The total number of home visits for the treatment group was based on monthly records, where completed visits were marked as 1 and incomplete visits as 0 for each month. The final count was the sum of these monthly records. The instrumental variable being whether the sample was assigned into treatment groups, which were randomly assigned and highly correlated with whether the sample received home visit instructions on time but not with other unobservable variables. The TOT analysis was carried out using the following model:

First stage:

$$Attend_{ij} = \beta_0 + \beta_1\ Treatment_{ij} + \beta_2\ Y_{ij\_baseline} + \beta_3\ X_{ij} + \beta_4\ county_{id} + \varepsilon_{ij} \quad (2)$$

Second stage:

$$Y_{ij\_midline} = \gamma_0 + \gamma_1\ Attend_{ij} + \gamma_2\ Y_{ij\_baseline} + \gamma_3\ X_{ij} + \gamma_4\ county_{id} + \varepsilon_{ij} \quad (3)$$

Where $Attend_{ij}$ is the total number of home visits received by pregnant or postpartum women i in town j from the start of the program until the end of it. The remaining variables are the same as in the Eq. (1). The coefficient γ1 captures the TOT effects of the CHW home visiting intervention on pregnant or postpartum women's mental health.

Heterogeneity analysis

To examine the heterogeneity effect of the intervention among pregnant women with different characteristics, we constructed a set of interaction variables. Analysis was conducted using the following specifications:

$$Y_{ij\_midline} = \delta_0 + \delta_1\ T_{ij} + \delta_2\ Y_{ij\_baseline} + \delta_3\ T_{ij} * H_{ij} + H_{ij} + \delta_4\ X_{ij} + +\varepsilon_{ij} \quad (4)$$

Where H_{ij} is a variable that includes basic household characteristics, including maternal age, education level, whether or not they work, whether or not they have a first child, baby gender, and household assets. The remaining variables are the same as in the Eq. (1). The heterogeneous effect of the intervention is represented by the interaction term coefficient δ_3.

Results

The average treatment effects on maternal mental health

Table 3 presents the estimated ITT effects of the home visiting program on maternal mental health (depression, anxiety, and stress). According to the results of regression (1) (2) (3), there was no significant effect of the CHW home visit on maternal depressive, anxiety, and stress tendency scores compared to the control group. In accordance with the findings of regressions (4), (5), and (6), we also treated the dependent variable as a dummy variable for the presence of a specific mental health problem, but this did not change the conclusion that there was no influence of home visits on maternal mental health. Despite further adjustment for the dependent variable (an investigation of the predisposition to moderate or higher mental health problems), the regressions (7), (8), and (9) still no evidence of a short-term effect of the home visiting intervention on improving maternal mental health.

Table 3 ITT effect of intervention on maternal mental health (depression, anxiety, stress)

	Mental Health Score			Presence of Mental Health Problems			Presence of Moderate or Higher Mental Health Problems		
	Depression	Anxiety	Stress	Depression	Anxiety	Stress	Depression	Anxiety	Stress
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Treatment	0.51	0.40	0.27	0.01	-0.03	0.01	0.00	0.02	0.03
	(0.49)	(0.33)	(0.51)	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)
Baseline depression scores	Yes			Yes			Yes		
Baseline anxiety scores		Yes			Yes			Yes	
Baseline stress scores			Yes			Yes			Yes
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	3.96	2.89	6.92*	0.22	-0.03	-0.07	-0.19	-0.02	-0.06
	(3.93)	(2.66)	(3.86)	(0.24)	(0.24)	(0.19)	(0.22)	(0.20)	(0.14)
County FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.190	0.194	0.241	0.138	0.152	0.175	0.124	0.165	0.148
Observations	527	527	527	527	527	527	527	527	527

OLS estimates are reported, and robust standard errors, clustered at the town level, are presented in parentheses

* $p<0.10$

** $p<0.05$

*** $p<0.01$

Table 4 TOT effect of intervention on maternal mental health (depression, anxiety, stress)

	First stage regression results	Second stage regression results		
		Depression	Anxiety	Stress
	(1)	(2)	(3)	(4)
Number of home visits		0.10	0.08	0.05
		(0.11)	(0.08)	(0.11)
Treatment (1=Yes)	5.09***			
	(0.14)			
Baseline depression scores	Yes	Yes		
Baseline anxiety scores	Yes		Yes	
Baseline stress scores	Yes			Yes
Control variables	Yes	Yes	Yes	Yes
Constant	1.83	3.78	2.75	6.81
	(1.09)	(4.17)	(3.07)	(4.22)
County FE	Yes	Yes	Yes	Yes
R2	0.739	0.189	0.193	0.240
Observations	527	527	527	527

Control variables include maternal characteristics、baby characteristics and household characteristics;OLS estimates are reported, and robust standard errors, clustered at the town level, are presented in parentheses

*$p<0.10$

**$p<0.05$

***$p<0.01$

Local treatment effects on maternal mental health

The lack of significant effects of the mean causal effect of the home visit intervention on maternal depression, anxiety, and stress tendencies may be due to possible adherence problems in this study. Specifically, some pregnant women in the treatment group sample did not receive home visits from CHW as required by the program or had low participation, or those who were willing to receive home visits were often pregnant women with certain traits, resulting in selective bias. To overcome this problem, we evaluated the effect of the number of home visit interventions on the level of maternal mental health (Treatment on the Treated, TOT).

Table 4 reports the results of TOT regressions on the effect of the number of home visits on maternal mental health. Column (1) shows the results of the first stage regression, where "whether the sample was assigned to the treatment group" is the independent variable and "the number of times the sample received from the home visit intervention" is the dependent variable, which shows a high correlation between the two at the 1% significance level and also verifies that the results showed that they were highly correlated at 1% significance level, and also verified the validity of "whether the sample was assigned to the treatment group" as an instrumental variable. And, more importantly, this variable was randomly assigned and was not correlated with other unobservable variables that may affect maternal mental health. Column (2) (3) (4) shows the results of the second stage regression, with coefficients and significance levels indicating that the actual number of home visits received did not have a significant effect on maternal mental health, which is consistent with the ITT regression results.

Heterogeneous effect of the intervention on maternal mental health

Because maternal mental health is closely influenced by family dynamics, this study explores the heterogeneity of intervention effects based on different sources of familial support. In particular, we examine whether the impact

of the home visit intervention on maternal mental health varies depending on support from the husband or from the mother-in-law/mother.

To assess the moderating role of husband support, we used a binary variable derived from participants' responses to whether their husband was the primary person accompanying them to antenatal checkups. The heterogeneity analysis results based on husband support are presented in Table 5. The depression and stress tendency scores were significantly lower in the sample with a husband accompanying antenatal care, with a 0.19 points (1.74 *minus* 1.93) point reduction in the depression tendency score (10% significance level, column 1, row 3) and a 0.08 (1.24 *minus* 1.32) points reduction in the anxiety tendency score (10% significance level, column 2, row 3), a 0.39 (1.45 *minus* 1.84) points reduction in the anxiety tendency score (10% significance level, column 3, row 3). However, Table 5 indicated that none of the home-visiting programs significantly reduce maternal depression, anxiety, or stress scores in the heterogeneous regression analysis with mother-in-law/mother support.

In order to confirm the impact of the treatment on maternal mental health under two conditions of family member support, Table 6 also uses the sample's self-rated marital relationship and mother-in-law-daughter-in-law relationship at the base period. The results are generally consistent with Table 5. According to the regression results in Table 6, the depressive score was decreased by 0.61 (1.15 *minus* 1.76) points (10% significance level, column 1, row 3), and the anxiety score was decreased by 0.52 (0.94 *minus* 1.46) points (10% significance level, column 2, row 3). However, the stress score was not significantly affected by the treatment for the sample with a satisfactory marital relationship. In contrast, there was no significant decrease in depression, anxiety, and stress tendency scores for the sample with satisfactory mother-in-law-daughter-in-law relationships.

In addition, this study examined the variety of CHW home visit on maternal mental health in terms of fundamental maternal, infant, and family traits. The basic characteristic factors included maternal age, maternal education level, and whether the pregnant woman worked. More specifically, the interaction terms of the intervention variables with these basic characteristic variables were included in the regression analysis, but none of them were significant (See Appendix A for details).

Discussion

To the best of our knowledge, this is the first large-scale randomized controlled trial evaluating the effectiveness of a home-visiting program on maternal mental health in rural China. We evaluated the average treatment effect and treatment on the treated effect of the intervention

Table 5 Heterogeneity effect: Family support

	Depression	Anxiety	Stress	Depression	Anxiety	Stress
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	1.74**	1.24*	1.45*	0.02	0.14	-0.04
	(0.78)	(0.63)	(0.86)	(0.52)	(0.35)	(0.51)
Husband accompanying antenatal care (1=Yes)	1.43*	0.86	1.48			
	(0.76)	(0.67)	(0.91)			
Treatment * Husband accompanying antenatal care	-1.93*	-1.32*	-1.84*			
	(0.98)	(0.77)	(1.01)			
Mother-in-law/mother accompanying antenatal care (1=Yes)				-2.25**	-0.86	-2.06**
				(1.04)	(0.77)	(0.94)
Treatment * Mother-in-law/mother accompanying antenatal care				3.42*	1.76	2.14
				(1.85)	(1.38)	(1.77)
Baseline depression scores	Yes			Yes		
Baseline stress scores		Yes			Yes	
Baseline anxiety scores			Yes			Yes
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Constant	3.65	2.77	6.51*	5.23	3.50	7.76*
	(3.91)	(2.69)	(3.84)	(4.05)	(2.70)	(4.05)
County FE	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.192	0.194	0.243	0.195	0.194	0.243
Observations	527	527	527	527	527	527

Control variables include maternal characteristics、baby characteristics and household characteristics; OLS estimates are reported, and robust standard errors, clustered at the town level, are presented in parentheses

*$p<0.10$

**$p<0.05$

***$p<0.01$

Table 6 Heterogeneity effect: Family relationship

	Depression	Anxiety	Stress	Depression	Anxiety	Stress
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	1.15*	0.94**	0.57	-0.13	-0.02	-0.46
	(0.66)	(0.46)	(0.71)	(1.15)	(0.77)	(0.95)
Husband and wife satisfactory relationship（1=Yes）	-0.65	0.26	-1.32			
	(0.78)	(0.60)	(0.86)			
Treatment * Husband and wife satisfactory relationship	-1.76*	-1.46*	-0.93			
	(0.95)	(0.74)	(1.08)			
Mother-in-law and daughter-in-law satisfactory relationship（1=Yes）				-1.57	-0.84	-2.40***
				(1.01)	(0.70)	(0.80)
Treatment * Mother-in-law and daughter-in-law satisfactory relationship				0.80	0.53	0.83
				(1.33)	(0.94)	(1.14)
Baseline depression scores	Yes			Yes		
Baseline anxiety scores		Yes			Yes	
Baseline stress scores			Yes			Yes
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Constant	5.05	3.12	8.26**	5.32	3.59	9.15**
	(4.10)	(2.76)	(3.86)	(4.02)	(2.84)	(3.97)
County FE	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.194	0.194	0.245	0.192	0.193	0.253
Observations	526	526	526	527	527	527

Control variables include maternal characteristics、baby characteristics and household characteristics; OLS estimates are reported, and robust standard errors, clustered at the town level, are presented in parentheses

* $p<0.10$

** $p<0.05$

*** $p<0.01$

on tendencies of depression, anxiety, and stress among postnatal women. We also evaluated the heterogeneity of effects among subgroups with different characteristics, using data from 79 townships in rural northwestern China. The intervention implementation was completed in cooperation with the provincial Health Commission where the research team is based.

The baseline data indicated that over 20% of the participating pregnant women showed any tendencies of depression, about 24% of them have tendencies of anxiety, and about 11%-13% have tendencies of feeling stressed. The prevalence is higher when compared with the findings of a meta-analysis conducted in China [30], but slightly lower than research conducted in other developing countries [31, 32].

We find that the home-visiting program did not have significant effects on maternal health outcomes on average in terms of tendencies of depression, anxiety, and stress. According to our analysis, this is likely due to the compliance of our sample and inadequate dosage of home visits. Numerous studies have demonstrated that the effectiveness of home visiting largely depends on the content, executive, and dose [33, 34]. However, the overall compliance rate of 65% was relatively low compared with programs with significant effects [35, 36]. Despite the influence of the pandemic, the lack of continuity and motivation among the CHWs may also contribute to low compliance rates, such as inadequate supervision and management [37, 38] and insufficient incentives [39].

Despite the insignificant average treatment effect, the heterogeneity of effects was found among subgroups with different characteristics, particularly among households with stronger spousal support. This finding can be explained both theoretically and empirically. According to Bronfenbrenner's (1980) theory of social ecological systems, individual behavior can be significantly influenced by the family environment they live in, especially the behavior of the husband [40]. Empirically, our finding aligns with previous studies that have emphasized the importance of family relationships for maternal mental health [41, 42]. When husbands care for their pregnant wives, they can offer additional emotional support and evidence-based prenatal care, which helps produce a greater impact of the program [43, 44]. Interestingly, when the primary supporter was the mother-in-law or mother, the heterogeneous effects of the intervention disappeared. This underscores the crucial role of husband involvement, as their support seems to complement the intervention more effectively than that of the mother-in-law or mother.

Several limitations should be acknowledged when considering our results. First, the data come primarily from a rural location in a northwest Chinese province, and the sample is not nationally representative, therefore external

validity is insufficient. Using data from multiple provinces to examine the effects of home visit interventions on rural maternal mental health in the future could make the findings more representative. Second, our intervention was designed as a preventive measure for the general population, rather than as a treatment for severe mental disorders. Future research should address this gap by developing specialized interventions tailored to meet the needs of this vulnerable group, involving trained mental health professionals. Additionally, we must consider the potential bias introduced by the Hawthorne effect, where participants may alter their behavior due to the awareness of being observed, which could affect the outcomes of our intervention.

Conclusion

Although the home-visiting program delivered by CHWs did not lead to statistically significant improvements in overall maternal mental health outcomes, the intervention showed meaningful benefits in specific family contexts: it significantly reduced symptoms of depression and stress among pregnant women whose husbands accompanied them to antenatal care, and among those with satisfactory marital relationships. These findings suggest that while the general effect may be limited, the intervention holds practical value when integrated with family support mechanisms. Strengthening the psychosocial component of home visits and actively involving key family members—particularly husbands—can enhance the effectiveness of such programs. Future maternal health interventions should consider combining individualized counseling with broader family engagement to build a more holistic support system for pregnant women in low-resource settings.

Abbreviations

WHO	World Health Organization
LMICs	Low- and Middle-Income Countries
CHWs	Community Health Workers
DASS-21	Depression, Anxiety, and Stress Scales-21

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12884-025-08297-2.

Supplementary Material 1.

Acknowledgements

We are grateful to all respondents who participated in this study and the enumerators for data collection efforts.

Authors' contributions

Jie Yang: Project administration, Conceptualization, Methodology, Writing-review & editing, Funding acquisition. Nan Wang: Conceptualization, Investigation, Formal analysis, Writing – original draft. Baowei Li: Data curation, Investigation. Zhuo Liu、Jingchun Nie: Data curation, Investigation. Yaojiang Shi: Writing-review & editing. All authors critically reviewed and revised the manuscript. All authors contributed to and have approved the final manuscript.

Funding

This research was funded by the 111 Project (Grant No. B16031); Soft Science Research Project of Xi'an Science and Technology Plan (Grant No. 23RKYJ0053); Major project of National Social Science Foundation (Grant No. 21&ZD112); Research on the Intervention Effect and Mechanism of Applying Computer-Assisted Learning to Reduce the Digital Divide between Urban and Rural Areas and Ethnic Groups for Students in Rural Poverty-stricken Areas and Ethnic Areas in Northwest China (Grant No. 71933003); Humanities and Social Science Research Project of Ministry of Education (Grant No. 22YJC840023); Excellent Graduate Training Program of Shaanxi Normal University (Grant No. LHRCTS23019).

Data availability

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

We followed the principles of the Declaration of Helsinki and received ethical approval from the Institutional Review Board of Shaanxi Normal University and Xi'an Jiaotong University of China (No: 2020 – 1240) on 08/03/2019.
Each eligible participant received a consent form with information regarding program objectives, procedures, potential risks, benefits, and an explanation of privacy protection. They were also informed that they can choose to withdraw from this program if they feel uncomfortable. After obtaining their written informed consent, we include the participants in the program.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 23 February 2024 / Accepted: 26 September 2025
Published online: 29 December 2025

References

1. World Health Organization. Maternal and child mental health. Available online at: https://www.who.int/mental_health/maternal-child/maternal_mental_health/en/. Accessed 29 Mar 2019.
2. Field T. Prenatal depression effects on early development: a review. Infant Behav Dev. 2011;34(1):1–14. https://doi.org/10.1016/j.infbeh.2010.09.008.
3. Lund C, Schneider M, Davies T, Nyatsanza M, Honikman S, Bhana A, Joska J. Task sharing of a psychological intervention for maternal depression in Khayelitsha, South africa: study protocol for a randomized controlled trial. Trials. 2014;15(1):457. https://doi.org/10.1186/1745-6215-15-457.
4. Loch AA, Chianca C, Alves TM, Freitas EL, Hortêncio L, Andrade JC, Rössler W. Poverty, low education, and the expression of psychotic-like experiences in the general population of São Paulo, Brazil. Psychiatry Res. 2017;253:182–8. https://doi.org/10.1016/j.psychres.2017.03.052.
5. Lancaster CA, Gold KJ, Flynn HA, Yoo H, Marcus SM, Davis MM. Risk factors for depressive symptoms during pregnancy: A systematic review. Am J Obstet Gynecol. 2010;202(1):5–14. https://doi.org/10.1016/j.ajog.2009.09.007.
6. Packer CH, Pilliod RA, Chatroux LR, Caughey AB, Valent AM. Increased rates of adverse perinatal outcomes in women with gestational diabetes and depression. J Maternal-Fetal Neonatal Med. 2021;34(23):3862–6. https://doi.org/10.1080/14767058.2019.1701647.
7. Tripathy P, Nair N, Barnett S, Mahapatra R, Borghi J, Rath S, Rath S, Gope R, Mahto D, Sinha R, Lakshminarayana R, Patel V, Pagel C, Prost A, Costello A. Effect of a participatory intervention with women's groups on birth outcomes and maternal depression in Jharkhand and Orissa, india: A cluster-randomised controlled trial. Lancet. 2010;375(9721):1182–92. https://doi.org/10.1016/S0140-6736(09)62042-0.
8. Bennett I, Schott W, Krutikova S, Behrman JR. Maternal mental health and child growth and development in four low and middle income countries. J

Epidemiol Commun Health. 2016;70(2):168–73. https://doi.org/10.1136/jech-2014-205311.
9. Herba CM, Glover V, Ramchandani PG, Rondon MB. Maternal depression and mental health in early childhood: an examination of underlying mechanisms in low-income and middle-income countries. Lancet Psychiatry. 2016;3(10):983–92. https://doi.org/10.1016/S2215-0366(16)30148-1.
10. Nisar A, Yin J, Waqas A, Bai X, Wang D, Rahman A, Li X. Prevalence of perinatal depression and its determinants in Mainland china: A systematic review and meta-analysis. J Affect Disord. 2020;277:1022–37. https://doi.org/10.1016/j.jad.2020.07.046.
11. Bo HX, Yang Y, Zhang DY, Zhang M, Wang PH, Liu XH, et al. The prevalence of depression and its association with quality of life among pregnant and postnatal women in china: A multicenter study. Front Psychiatry. 2021;12. https://doi.org/10.3389/fpsyt.2021.656560.
12. Qi W, Zhao F, Liu Y, Li Q, Hu J. Psychosocial risk factors for postpartum depression in Chinese women: A meta-analysis. BMC Pregnancy Childbirth. 2021;21(1):174. https://doi.org/10.1186/s12884-021-03657-0.
13. Chen XD, Jiang WW. Factors influencing maternal postpartum depression in rural areas and suggestions for interventions. China Public Health Manage. 2017;33(06):877–9. https://doi.org/10.19568/j.cnki.23-1318.2017.06.042.
14. Jiang Q, Guo Y, Zhang E, Cohen N, Ohtori M, Sun A, Dill S-E, Singh MK, She X, Medina A, Rozelle SD. Perinatal mental health problems in rural china: the role of social factors. Front Psychiatry. 2021;12:2188. https://doi.org/10.3389/fpsyt.2021.636875.
15. Wan EY, Moyer CA, Harlow SD, Fan Z, Jie Y, Yang H. Postpartum depression and traditional postpartum care in china: role of Zuoyuezi. Int J Gynecol Obstet. 2009;104(3):209–13. https://doi.org/10.1016/j.ijgo.2008.10.016.
16. Xue Y, Wang CQ, Zhu Y. Forecast of the gap between urban and rural health resources in China from the perspective of healthy China action. Chin Hosp Manage. 2019;39(12):17–9.
17. Bliznashka L, Yousafzai AK, Asheri G, Masanja H, Sudfeld CR. Effects of a community health worker delivered intervention on maternal depressive symptoms in rural Tanzania. Health Policy Plann. 2021;36(4):473–83. https://doi.org/10.1093/heapol/czaa170.
18. Stansert-Katzen L, Baker V, Tomlinson M, Rotheram-Borus MJ. Community health workers impact on maternal and child health outcomes in rural South Africa – a non-randomized two-group comparison study. BMC Public Health. 2020;20:1404. https://doi.org/10.1186/s12889-020-09468-w.
19. Rahman A, Fisher J, Bower P, Luchters S, Tran T, Yasamy MT, Saxena S, Waheed W. Interventions for common perinatal mental disorders in women in low- and middle-income countries: A systematic review and meta-analysis. Bull World Health Organ. 2013;91(8):593–l601. https://doi.org/10.2471/BLT.12.109819.
20. Serdar CC, Cihan M, Yücel D, Serdar MA. Sample size, power and effect size revisited: simplified and practical approaches in pre-clinical, clinical and laboratory studies. Biochemia Med. 2021;31(1):0–0. https://doi.org/10.11613/BM.2021.010502.
21. Dong N, Maynard R, PowerUp!. A tool for calculating minimum detectable effect sizes and minimum required sample sizes for experimental and quasi-experimental design studies. J Res Educational Eff. 2013;6(1):24–67. https://doi.org/10.1080/19345747.2012.673143.
22. Lovibond PF, Lovibond SH. The structure of negative emotional states: comparison of the depression anxiety stress scales (DASS) with the Beck depression and anxiety inventories. Behav Res Ther. 1995;33(3):335–43. https://doi.org/10.1016/0005-7967(94)00075-U.
23. Wang Y, Gao Q, Liu J, et al. Translation and validation of the Chinese version of the maternal postpartum stress scale. BMC Pregnancy Childbirth. 2023;23:685. https://doi.org/10.1186/s12884-023-05990-y.
24. Wang K, Shi HS, Geng FL, Zou LQ, Tan SP, Wang Y, Neumann DL, Shum DH, Chan RC. Cross-cultural validation of the depression anxiety stress Scale-21 in China. Psychol Assess. 2016;28(5):e88–100. https://doi.org/10.1037/pas0000207.
25. Chang F, Fan X, Zhang Y, Tang B, Jia X. Prevalence of depressive symptoms and correlated factors among pregnant women during their second and third trimesters in Northwest rural china: a cross-sectional study. BMC Pregnancy Childbirth. 2022;22(1):38. https://doi.org/10.1186/s12884-021-04340-0.
26. Jiang Q, Zhang E, Cohen N, et al. Postnatal mental health, breastfeeding beliefs, and breastfeeding practices in rural China. Int Breastfeed J. 2022;17:60. https://doi.org/10.1186/s13006-022-00504-6.
27. Beaufort IN, De Weert-Van Oene GH, Buwalda VAJ, de Leeuw JRJ, Goudriaan AE. The Depression, anxiety and stress scale (DASS-21) as a screener for depression in substance use disorder inpatients: a pilot study. Eur Addict Res. 2017;23(5):260–8. https://doi.org/10.1159/000485182.
28. Bottesi G, Ghisi M, Altoè G, Conforti E, Melli G, Sica C. The Italian version of the depression anxiety stress Scales-21: factor structure and psychometric properties on community and clinical samples. Compr Psychiatr. 2015;60:170–81. https://doi.org/10.1016/j.comppsych.2015.04.005.
29. Sinclair SJ, Siefert CJ, Slavin-Mulford JM, Stein MB, Renna M, Blais MA. Psychometric evaluation and normative data for the depression, anxiety, and stress scales-21 (DASS-21) in a nonclinical sample of U.S. Adults. Eval Health Prof. 2012;35(3):259–79. https://doi.org/10.1177/0163278711424282.
30. Mu TY, Li YH, Pan HF, Zhang L, Zha DH, Zhang CL, Xu RX. Postpartum depressive mood (PDM) among Chinese women: a meta-analysis. Archives Women's Mental Health. 2019;22(2):279–87. https://doi.org/10.1007/s00737-018-0885-3.
31. Sheeba B, Nath A, Metgud CS, Krishna M, Venkatesh S, Vindhya J, Murthy GVS. Prenatal depression and its associated risk factors among pregnant women in bangalore: a hospital based prevalence study. Front Public Health.2019;7. https://www.frontiersin.org/articles/10.3389/fpubh.2019.00108.
32. Suárez-Rico BV, Estrada-Gutierrez G, Sánchez-Martínez M, Perichart-Perera O, Rodríguez-Hernández C, González-Leyva C, Osorio-Valencia E, Cardona-Pérez A, Helguera-Repetto AC, Espino y Sosa S, Solis-Paredes M, Reyes-Muñoz E. Prevalence of depression, anxiety, and perceived stress in postpartum Mexican women during the COVID-19 lockdown. Int J Environ Res Public Health. 2021;18(9):4627. https://doi.org/10.3390/ijerph18094627.
33. Mancini JA, Marek LI. Sustaining community-based programs for families: conceptualization and measurement. Fam Relat. 2004;53(4):339–47. https://doi.org/10.1111/j.0197-6664.2004.00040.
34. Paulsell D, Patricia DG, Lauren S. Supporting replication and scale-up of evidence-based home visiting programs: assessing the implementation knowledge base. Am J Public Health. 2014;104(9):1624–32. https://doi.org/10.2105/AJPH.2014.301962.
35. Bhutta ZA, Lassi ZS, Pariyo G, Huicho L. Global experience of community health workers for delivery of health related millennium development goals: A systematic review, country case studies, and recommendations for integration into National health systems. Global Health Workforce Alliance. 2010;1(249):61.
36. Lewin S, Munabi-Babigumira S, Glenton C, Daniels K, Bosch-Capblanch X, van Wyk BE, Odgaard-Jensen J, Johansen M, Aja GN, Zwarenstein M, Scheel IB. Lay health workers in primary and community health care for maternal and child health and the management of infectious diseases. Cochrane Database Syst Rev. 2010;3CD004015. https://doi.org/10.1002/14651858.CD004015.pub3.
37. Nkosi-Gondwe T, Robberstad B, Blomberg B, Phiri KS, Lange S. Introducing post-discharge malaria chemoprevention (PMC) for management of severe anemia in Malawian children: A qualitative study of community health workers' perceptions and motivation. BMC Health Serv Res. 2018;18(1). https://doi.org/10.1186/s12913-018-3791-5.
38. Lister H, White M, Govender P. Community health workers lensed through a South African backdrop of two peri-urban communities in KwaZulu-Natal. Afr J Disabil. 2017;6(1):1–8. https://doi.org/10.4102/ajod.v6i0.294.
39. Schleiff MJ, Aitken I, Alam MA, Damtew ZA, Perry H. B. Community health workers at the dawn of a new era: 6. Recruitment, training, and continuing education. Health Res Policy Syst. 2021;19(3):113. https://doi.org/10.1186/s12961-021-00757-3.
40. Bronfenbrenner U. Developmental Psychology. (Book reviews: the ecology of human Development). Science. 1980;207:634–5.
41. Aktas S, Yesilcicek Calik K. Factors affecting depression during pregnancy and the correlation between social support and pregnancy depression. Iran Red Crescent Med J. 2015;17(9):e16640. https://doi.org/10.5812/ircmj.16640.
42. le Roux KW, Almirol E, Rezvan PH, le Roux IM, Mbewu N, Dippenaar E, Stansert-Katzen L, Baker V, Tomlinson M, Rotheram-Borus MJ. Community health workers impact on maternal and child health outcomes in rural South Africa – a non-randomized two-group comparison study. BMC Public Health. 2020;20:1404. https://doi.org/10.1186/s12889-020-09468-w.
43. Abdollahpour S, Ramezani S, Khosravi A. Perceived social support among family in pregnant women. Int J Pediatr. 2015;3(21):879–88. https://doi.org/10.22038/ijp.2015.4703.

44. Mamuroh L,. S., Nurhakim F. Relationship between husband support and pregnancy control in pregnant women Sukawening Puskesmas Garut. J Maternity Care Reproductive Health. 2019;2(1):51–6. https://doi.org/10.36780/jmcrh.v2i1.58.