Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Anxiety and Depressive Symptoms Among Women with a Subsequent Pregnancy Following Pregnancy Loss: A Cross-Lagged Network Analysis

Wenjun Fu
the First Affiliated Hospital of Zhengzhou university
Xiujuan Wang
the First Affiliated Hospital of Zhengzhou university
Nannan Zhang
the First Affiliated Hospital of Zhengzhou university
Ruoming Wang
the First Affiliated Hospital of Zhengzhou university
Zheng Yuan
the First Affiliated Hospital of Zhengzhou university
Qingqing Shao
the First Affiliated Hospital of Zhengzhou university
Ke Zhao
the First Affiliated Hospital of Zhengzhou university
Yali Li
Women & infants Hospital of Zhengzhou
Yuyang Zheng
the First Affiliated Hospital of Zhengzhou university
Guangshuai Li
the First Affiliated Hospital of Zhengzhou university
Liping Han
the First Affiliated Hospital of Zhengzhou university
Juan Ding
dingjuan241@163.com

the First Affiliated Hospital of Zhengzhou university

Research Article

Keywords: Pregnancy loss, Subsequent Pregnancy, Network analysis, Anxiety, Depression

Posted Date: September 25th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10778958/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Background

Women conceiving again after pregnancy loss face substantial risks of anxiety and depression. However, most existing studies are based on total scale scores, making it impossible to identify key symptoms driving the deterioration of psychological status across different gestational stages and limiting the targeted delivery of interventions.

Objective

This study aimed to adopt cross-lagged network analysis to longitudinally identify the core symptoms, bridge symptoms of anxiety and depressive symptoms, as well as their evolutionary patterns across gestation among women with a subsequent pregnancy following pregnancy loss at the symptom level, determine priority intervention targets for different gestational stages, and provide evidence for developing staged, symptom-targeted psychological screening and intervention protocols in obstetric outpatient settings.

Methods

A prospective longitudinal study design was adopted. Women with a subsequent pregnancy following pregnancy loss were recruited by convenience sampling from obstetric outpatient clinics of three hospitals between July 2024 and October 2025. Follow-up assessments were performed at three time-points: the first trimester (T1, gestational weeks 6 ~ 13^{+6}), the second trimester (T2, gestational weeks 18 ~ 28), and the third trimester (T3, gestational weeks 29 ~ 41). Participants completed a general information questionnaire, the Generalized Anxiety Disorder-7 (GAD-7) scale, and the Edinburgh Postnatal Depression Scale (EPDS). IBM SPSS Statistics 27.0 was used for statistical description, and R 4.4.3 was applied to conduct cross-lagged panel network analysis.

Results

A total of 203 participants were enrolled in this study, among whom 177 completed all three follow-up assessments. Cross-sectional network analysis revealed that Trouble relaxing (GAD 4) was the core symptom in the first and third trimesters, with expected influence values of 1.465 and 1.325, respectively. In the second trimester, Feeling sad or miserable (EPDS 8) emerged as the core symptom, with an expected influence value of 1.415. Cross-lagged network analysis indicated that for the T1→T2 interval, the strongest positive association was from Restlessness (GAD 5) to Difficulty controlling worries (GAD 2) with an edge weight of − 0.190, and the strongest negative association was from Thoughts of self-harm (EPDS 10) to Overwhelmed by pressure (EPDS 6) with an edge weight of − 0.349.

For the T2→T3 interval, the strongest positive association existed from Fear of worst-case outcomes (GAD 7) to Trouble relaxing (GAD 4) with an edge weight of 0.248, and the strongest negative association was from Overwhelmed by pressure (EPDS 6) to Difficulty controlling worries (GAD 2) with an edge weight of − 0.149.For the T1→T3 interval, the strongest positive association was from Unprovoked fear/panic (EPDS 5) to Unprovoked anxiety/worry (EPDS 4) with an edge weight of 0.125, and the strongest negative association was from Look forward to things (EPDS 2) to Fear of worst-case outcomes (GAD 7) with an edge weight of − 0.078.

Conclusions

The core symptoms of anxiety and depression among women with a subsequent pregnancy following pregnancy loss change dynamically across gestational stages, and obstetric psychological interventions should adjust targeted symptoms accordingly for each trimester. Fear-related emotions in the first trimester exert long-term predictive effects on anxiety in the third trimester, whereas positive emotions can block the activation of catastrophic thinking. These findings support initiating psychological screening in early pregnancy and emphasizing the cultivation of positive emotions within obstetric clinical practice.

1 Introduction

Pregnancy loss (PL) refers to involuntary pregnancy termination caused by miscarriage, stillbirth, or genetic factors, and it constitutes one of the most common complications of gestation(Cuenca, 2022). Clinically, approximately 50% of pregnancies end in loss before clinical confirmation, and an additional 9%–20% of clinically recognized pregnancies result in miscarriage(Bedaiwy et al., 2023; Mehra, Farooqi, Sriram, & Tunde-Byass, 2024). It is estimated that around 10% of confirmed clinical pregnancies end in early pregnancy loss, and roughly 80% of pregnancy losses occur before the 12th gestational week("ACOG Practice Bulletin No. 200: Early Pregnancy Loss," 2018).

Pregnancy loss is not only a common reproductive health event but also exerts profound and multifaceted adverse effects on women’s physical and mental health(Cuenca, 2022). Physically, pregnancy loss may lead to complications including endometrial injury, intrauterine adhesions, and elevated infection risk, which may further impair subsequent fertility(Vlachou et al., 2024). Evidence indicates that women with a history of miscarriage have a significantly higher risk of developing cardiovascular diseases (including coronary heart disease and stroke) in the future(Mikkelsen et al., 2023). In terms of reproductive outcomes, prior pregnancy loss represents a vital risk factor for adverse subsequent pregnancy outcomes. Women with a history of pregnancy loss face elevated risks of recurrent miscarriage, increased incidence of placenta previa and placental adhesion, as well as adverse perinatal outcomes such as preterm birth and low birth weight(Sun, Mao, Su, & Du, 2023; Vlachou et al., 2024).

Psychologically, the impacts of pregnancy loss are particularly prominent and persistent. Women often perceive pregnancy loss as a traumatic catastrophic event, which may trigger high levels of anxiety, depression, and grief; such psychological symptoms can persist long after physical recovery(Cuenca, 2022). A systematic review and meta-analysis published in 2022 reported that compared with women without pregnancy loss experience, women experiencing perinatal loss had a risk ratio (RR) of 2.14 (95% *CI*: 1.73～2.66) for depressive disorders and an RR of 1.75 (95% *CI*: 1.27～2.42) for anxiety disorders. The standardized mean differences (SMD) for depressive and anxiety symptoms were 0.34 and 0.35 respectively, with all differences statistically significant(Herbert, Young, Pietrusińska, & MacBeth, 2022). A prospective cohort study conducted by Farren et al(Farren et al., 2020). found that one month following early pregnancy loss, 29% of women met screening criteria for post-traumatic stress disorder (PTSD), 24% experienced moderate to severe anxiety, and 11% suffered from moderate to severe depression. Even nine months after loss, the corresponding proportions remained as high as 18%, 17%, and 6%. Furthermore, the influences of pregnancy loss extend to social functioning, potentially deteriorating intimate relationship quality, reducing perceived social support, and impairing self-identity.

For women who conceive again after pregnancy loss, the pregnancy journey, which ought to be full of expectations, is frequently accompanied by complicated psychological experiences. Existing research indicates that these women commonly experience a psychological state characterized by coexisting hope and fear(Chen, Luo, Hong, Pan, & Shen, 2025). Armstrong (Armstrong, 2004) found that 45% of mothers and 23% of fathers in subsequent pregnancies had CES-D scores ≥ 16, suggesting elevated depression risk; 88% of mothers and 90% of fathers reported high stress associated with prior pregnancy loss. Multiple studies consistently confirm that pregnant women with a history of pregnancy loss exhibit significantly higher anxiety and depression levels than nulliparous women without such history. Using data from the China Anhui Birth Defects and Child Development (C-ABC) cohort, Gong et al.(Gong et al., 2013) analyzed 20,308 pregnant women and revealed elevated risks of anxiety and depression in early gestation among women with spontaneous miscarriage history. The risks further increased when the interpregnancy interval was shorter than 6 months, and depression risk increased by 2.511 times for intervals of 7～12 months. A meta-analysis by Hunter et al(Hunter, Tussis, & MacBeth, 2017). incorporating 19 studies with 5,114 pregnant women with prior pregnancy loss and 30,272 controls applied random-effects models. The results showed that perinatal loss yielded an effect size of d = 0.69 (95% *CI*: 0.41～0.97) for anxiety and d = 0.22 (95% *CI*: 0.15～0.30) for depression in subsequent pregnancies, and all differences reached statistical significance. A large-scale prospective cohort study by Reardon and Craver(Reardon & Craver, 2021) further illustrated that women with pregnancy loss history were 35% more likely to receive psychiatric treatment within six months after their first live birth, and approximately 58% of initial psychiatric treatments occurred after pregnancy loss.

Notably, psychological distress among women conceiving after pregnancy loss displays distinct temporal characteristics and stage heterogeneity. The first trimester (especially the critical window of 4～8 weeks of gestation when gestational sac and fetal heartbeat are confirmed via ultrasound) represents the period with the most severe anxiety, closely related to profound uncertainty during the waiting period for confirmation(Bailey et al., 2019; Chen et al., 2025). A feasibility study by Bailey et al.

(Bailey et al., 2019) highlighted that the early gestational waiting phase in subsequent pregnancy following recurrent pregnancy loss constitutes a key window for psychological intervention; nevertheless, clinical support and counseling provided during this period remain extremely limited. Domestic studies have also shown that women with recurrent miscarriage in subsequent pregnancies generally endure heavy fertility-related stress and negative emotions, with significantly higher prevalence of anxiety and depression compared with ordinary pregnant women(Gao, Qin, & Bai, 2022).

Although numerous studies have confirmed elevated levels of anxiety and depression among women with a subsequent pregnancy following pregnancy loss, existing evidence remains insufficient to guide clinical obstetric practice for the following reasons.

First, most prior studies rely on total scale scores, which are difficult to translate directly into feasible symptom-targeted intervention strategies for obstetric settings. Traditional research treats anxiety and depression as latent variables and evaluates psychological status by comparing group differences in total scale scores. In contrast, the network theory of psychopathology proposes that anxiety and depression are not syndromes driven by an underlying cause, but causal loop networks in which symptoms activate and maintain one another. Individual symptoms exert distinct roles within such networks: core symptoms strongly drive overall network activation, whereas bridge symptoms serve as critical hubs connecting different symptom clusters (e.g., anxiety and depression)(Borsboom, 2017). Sole reliance on total scores fails to identify which specific symptoms centrally contribute to psychological distress in this population, as well as the cross-dimensional pathways between anxiety and depression. This hinders obstetric clinicians from accurately prioritizing intervention targets from a broad array of symptoms.

Second, there is a lack of in-depth investigation into the longitudinal trajectories of anxiety and depressive symptoms, which impedes the development of staged psychological management protocols for obstetric care. Most available studies adopt a cross-sectional design or single-time-point assessments and cannot capture dynamic changes and causal relationships of symptoms across gestation. The journey of subsequent pregnancy following pregnancy loss spans an extended period, with distinct psychological experiences across gestational milestones, such as fetal heartbeat confirmation in the first trimester, structural anomaly screening in the second trimester, and approaching childbirth in the third trimester. Cross-lagged panel network analysis (CLPN), an emerging longitudinal network approach, estimates predictive effects of symptoms at an earlier time point on all symptoms at a later time point while controlling for autoregressive effects, enabling the identification of causal directions and temporal sequences among symptoms(Wysocki, McCarthy, van Bork, & Cramer, 2025). This method has been successfully applied to research on adolescent bullying and psychopathology(Funkhouser, Chacko, Correa, Kaiser, & Shankman, 2021), as well as anxiety and depression in older adults(Zainal & Newman, 2023), yet it has not been used to examine symptom networks among women with a subsequent pregnancy following pregnancy loss.

In summary, this study aimed to address two research questions using network analytical models: (1) how to identify core anxiety and depressive symptoms among women with a subsequent pregnancy following pregnancy loss to prioritize intervention targets for each gestational stage in obstetric care settings; (2) to evaluate causal associations between anxiety and depressive symptoms using the CLPN model, so as to inform the development of staged, symptom-targeted psychological screening and intervention pathways for obstetric practice.

2 Methods

2.1 Participants

Participants were recruited using convenience sampling among women with a subsequent pregnancy following pregnancy loss attending obstetric outpatient clinics at The First Affiliated Hospital of Zhengzhou University, Xinmi Maternity and Child-Health Hospital, and Zhengzhou Maternity and Child-Health Hospital from July 2024 to October 2025. Women were enrolled in the study after providing informed consent. Follow-up assessments were conducted at three time-points: the first trimester (T1, gestational weeks 6 ~ 13^{+6}), the second trimester (T2, gestational weeks 18 ~ 28), and the third trimester (T3, gestational weeks 29 ~ 41).

Inclusion criteria: Gestational age between 6 and 13^{+6} weeks and aged ≥ 18 years; History of involuntary pregnancy loss (Including miscarriage: occurring before 20 weeks; Recurrent miscarriage: two or more consecutive miscarriages before 20 weeks; Stillbirth: death occurring in utero or during the delivery process after 20 weeks); Receiving regular prenatal examinations in the above hospitals; No previously diagnosed psychiatric disorders such as schizophrenia and bipolar disorder; Provided informed consent and volunteered to participate in the study.

Exclusion criteria: Participants with hearing impairment or communication disorders; Those suffering from severe pregnancy complications, comorbidities or other uncontrolled severe chronic diseases who were clinically assessed as unsuitable to continue pregnancy or unable to complete follow-up; Illiterate individuals who could not understand questionnaire items.

2.2 Sample size

Sample size calculation for network model construction followed the principle that “the sample size should at least equal the number of parameters”(Epskamp & Fried, 2018). The total number of parameters consisted of threshold parameters and pairwise association parameters. The number of pairwise association parameters was calculated using the formula ([n(n-1)/2]), where n represented the number of nodes (threshold parameters). A cross-lagged network model with 17 nodes was constructed in the present study. The number of pairwise association parameters was ([17 (17 − 1)/2] = 136). Thus, the minimum required total sample size was 136 + 17 = 153 participants. After accounting for a 20% rate of invalid questionnaires, the required sample size was 191 cases. Finally, 203 valid participants were

included in this study. The achieved sample size exceeded the minimum requirement and was sufficient for network model estimation.

2.3 Measures

2.3.1 Sociodemographic data

The self-designed general information questionnaire was developed based on research objectives, literature review, group discussions and expert consultation. It collected sociodemographic information of women with a subsequent pregnancy following pregnancy loss, including age, educational level, occupation, household income, medical history, family history, obstetric history and other variables(Luo, Chen, & Shen, 2023; Yang et al., 2024).

2.3.2 Assessment of Anxiety symptoms

7-item Generalized Anxiety Disorder Scale (GAD-7): Developed by Spitzer et al. in 2006(Spitzer, Kroenke, Williams, & Löwe, 2006), this scale contains 7 items rated on a 4-point Likert scale (0 ~ 3 points), ranging from “not at all” to “nearly every day”. The total score ranges from 0 to 21. The optimal cut-off score of 10 yields a sensitivity of 89% and specificity of 82%. In the present study, cut-off values of 5, 10 and 15 were adopted to categorize mild, moderate and severe anxiety symptoms. As an internationally recognized anxiety screening instrument, the GAD-7 features concise items and convenient administration. It has been widely used among perinatal populations with well-established reliability and validity, and the Cronbach’s α coefficient was 0.92, supporting its suitability for longitudinal monitoring of anxiety symptoms in pregnant women.

2.3.3 Assessment of depressive symptoms

Edinburgh Postnatal Depression Scale (EPDS): Initially developed for screening postpartum depression, subsequent studies have verified its satisfactory applicability during pregnancy, making it one of the common tools for detecting perinatal depressive symptoms. Constructed by Cox et al. in 1987, the EPDS consists of 10 items scored on a 4-point scale ranging from 0 to 3. Items 1 and 2 are reverse-scored, while the remaining items adopt forward scoring. Total scores vary from 0 to 30, with higher scores indicating more severe depressive symptoms. Cox recommended a cut-off of 12 or 13 points(Cox, Holden, & Sagovsky, 1987). In this study, the cut-off value of 10 proposed by Lee et al. was adopted(Lee et al., 1998). The Cronbach’s α coefficient of the scale was 0.822, indicating good reliability and validity.

2.4 Data collection

The research team included 12 members: 1 chief nurse specialist, 3 associate chief nurse specialists, 1 associate chief physician, 4 nurse specialists and 3 postgraduate nursing students. Responsibilities were allocated as follows: the chief nurse specialist (graduate supervisor) coordinated with clinical departments to arrange survey schedules. Two associate chief nurse specialists and one associate chief physician were responsible for training investigators and quality control during questionnaire collection. Another associate chief nurse specialist together with four nurse specialists participated in

questionnaire design discussions. Three postgraduate students conducted on-site questionnaire surveys in clinical settings.

Participants were recruited in strict accordance with inclusion and exclusion criteria on a voluntary basis. Questionnaires were administered at three time points: the first, second and third trimesters of pregnancy.

2.5 Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics 27.0 and R 4.4.3 software.

2.5.1 Descriptive analysis

Categorical variables were described using frequencies and percentages. Continuous variables with non-normal distribution were presented as median and interquartile range [M (Q1, Q3)].

2.5.2 Cross-sectional Network Analysis

Symptom network estimation: The network model was constructed based on the extended Bayesian information criterion. Nodes represented symptom items, and edges represented relationships between symptoms. Solid lines indicated positive correlations, and dashed lines indicated negative correlations. Thicker lines denoted stronger associations, whereas thinner lines denoted weaker associations. Centrality estimation: The centralityPlot function in the qgraph package was used to calculate four centrality metrics of the symptom network, including strength, closeness, betweenness, and expected influence, to interpret the central role of each symptom from multiple dimensions. Strength refers to the sum of absolute edge weights between a node and all other nodes; a higher value indicates stronger overall connectivity and greater importance of the node within the network. Expected influence is the sum of edge weights (both positive and negative) linking one node to all remaining nodes in the network. A larger absolute value of expected influence suggests that the node exerts more prominent facilitatory (positive) or inhibitory (negative) effects on other nodes and substantially shapes the overall network functioning(Borsboom & Cramer, 2013; Bringmann et al., 2013). Expected influence was adopted to identify core nodes in the present study. Edge accuracy and node stability tests: The case-dropping bootstrap implemented in the bootnet package was used to compute the correlation stability (CS) coefficient. A CS coefficient < 0.25 indicated that the network structure was substantially affected by sample fluctuation and results might be unreliable; CS > 0.25 represented acceptable stability, CS > 0.5 represented good stability, and CS > 0.7 represented excellent stability. An edge was regarded as stable if its 95% confidence interval (95% CI) was narrow and did not contain zero. Bridge analysis: Bridge analysis was conducted via the networktools package. Bridge strength was calculated to quantify the connectivity of each symptom with other subnetworks; higher bridge strength indicated a more remarkable bridging effect of the corresponding symptom.

2.5.3 Cross-Lagged Network Analysis

Network visualization: The cross-lagged symptom network was visualized using the qgraph package. In cross-lagged network models, nodes represented individual symptoms, and arrows indicated directional associations between symptoms. Red arrows denoted negative associations, and green arrows denoted positive associations; line thickness reflected the magnitude of association strength between two nodes. To clearly visualize cross-lagged edges, autoregressive parameters were set to zero and autoregressive edges were removed. The final visualized network only contained cross-lagged paths. Calculation of centrality metrics: The centrality function in the qgraph package was used to extract out-expected influence (Out-EI) and in-expected influence (In-EI). Out-expected influence reflects the total predictive strength of a node at an earlier time point (T_n) on all other nodes at a subsequent time point (T_{n+1}), representing primary targets for clinical intervention. In-expected influence reflects the total strength with which a node at (T_{n+1}) is predicted by all other nodes at (T_n), serving as key monitoring indicators for early clinical warning. Both metrics were Z-standardized in this study. Edge weight accuracy test via nonparametric bootstrap: A total of 1000 nonparametric bootstrap resamples were generated using the bootnet package. The cross-lagged network was refitted and edge weights were extracted for each resample to compute the 95% *CI* of each edge weight. A cross-lagged path was considered statistically significant if its 95% *CI* excluded zero. Node stability test: To evaluate the reliability of centrality metrics, case-dropping bootstrap with 1000 resamples was performed. Samples were gradually excluded from 0% to 100%, and average correlation coefficients between centrality metrics from subsamples and the original full sample were calculated. The correlation stability (CS) coefficient was then derived. Centrality metrics were regarded as acceptably stable when CS ≥ 0.25.

3 Results

3.1 Follow-up Completion Status and Reasons for Lost Contact

Data collection was conducted in three hospitals in Henan Province, including one Grade A tertiary general hospital and two maternal and child health hospitals. A total of 203 valid questionnaires were collected in the first trimester. In the second trimester, 193 pregnant women completed the survey, with 10 participants lost to follow-up, corresponding to a loss-to-follow-up rate of 4.93%. In the third trimester, 177 pregnant women finished the survey; 26 participants were lost to follow-up, yielding a loss-to-follow-up rate of 12.81%. Reasons for loss to follow-up are presented in Fig. 1. Cross-sectional network analysis was performed on all valid questionnaires collected at each time point. Referring to established practices in relevant longitudinal studies(Qi, Ye, Sun, Zhen, & Zhou, 2023), cross-lagged network analysis was only conducted on data from the 177 pregnant women who completed all three waves of follow-up.

3.2 Descriptive statistics

A total of 203 women with a subsequent pregnancy following pregnancy loss were enrolled in this study. The median age [M (Q1, Q3)] of participants at the first, second and third trimesters was 32.00 (28.00,

34.00) years, 32.00 (27.00, 34.00) years, and 32.00 (27.50, 34.00) years, respectively. The sociodemographic characteristics of participants are shown in Table 1.

Table 1
Demographic characteristics of participants at each follow-up time point (%)

Category	T1(n = 203)	T2(n = 193)	T3(n = 177)
Age (years)			
<35	79.31(161/203)	79.27(153/193)	78.53(139/177)
≥ 35	20.69(42/203)	20.73(40/193)	21.47(38/177)
Ethnicity			
Han	98.52(200/203)	98.45(190/193)	98.31(174/177)
Ethnic minorities	1.48(3/203)	1.55(3/193)	1.69(3/177)
Educational level			
Junior high school or below	21.67(44/203)	21.76(42/193)	22.03(39/177)
Senior high school or technical secondary school	18.23(37/203)	17.10(33/193)	16.95(30/177)
Junior college	25.62(52/203)	26.42(51/193)	27.12(48/177)
Bachelor’s degree	28.57(58/203)	28.50(55/193)	27.12(48/177)
Postgraduate and above	5.91(12/203)	6.22(12/193)	6.78(12/177)
Occupation			
Unemployed	23.65(48/203)	23.32(45/193)	22.60(40/177)
Employed	76.35(155/203)	76.68(148/193)	77.40(137/177)
Monthly per capita household income (CNY)			
≤ 4 000	33.99(69/203)	33.68(65/193)	33.90(60/177)
4 001 ~ 8 000	39.41(80/203)	38.86(75/193)	38.98(69/177)
≥ 8 001	26.60(54/203)	27.46(53/193)	27.12(48/177)
Pregnancy intention			
Intended pregnancy	65.52(133/203)	64.25(124/193)	64.97(115/177)
Unintended pregnancy	34.48(70/203)	35.75(69/193)	35.03(62/177)
Mode of conception			
Spontaneous conception	85.71(174/203)	86.53(167/193)	85.88(152/177)
Assisted reproductive technology	14.29(29/203)	13.47(26/193)	14.12(25/177)
Number of prior miscarriages			

Category	T1(n = 203)	T2(n = 193)	T3(n = 177)
1	49.75(101/203)	49.22(95/193)	49.72(88/177)
≥ 2	50.25(102/203)	50.78(98/193)	50.28(89/177)
Uterine and ovarian dysfunction			
No	93.60(190/203)	93.26(180/193)	93.22(165/177)
Yes	6.40(13/203)	6.74(13/193)	6.78(12/177)

3.3 Cross-sectional networks

The cross-sectional network for the first trimester exhibited satisfactory overall stability and accuracy, with a CS value of 0.517 (Fig. 2A). Network results revealed (Fig. 3A) that the strongest positive correlation was observed between Difficulty controlling worries (GAD 2) and Excessive worrying (GAD 3), with a correlation coefficient of 0.850 (Figure S1). Trouble relaxing (GAD 4) served as both a core symptom (Fig. 4A) and a bridge symptom, with an expected influence of 1.465 (Table S1) and a bridge strength of 1.496 (Table S1).

The cross-sectional network for the second trimester exhibited satisfactory overall stability and accuracy, with a CS value of 0.363 (Fig. 2B). Network results revealed (Fig. 3B) that the strongest positive correlation was observed between Feeling sad or miserable (EPDS 8) and Unhappy and prone to crying (EPDS 9), with a correlation coefficient of 0.828 (Figure S4). Feeling sad or miserable (EPDS 8) served as the core symptom (Fig. 4B), with an expected influence of 1.415 (Table S3); Restlessness (GAD 5) acted as the bridge symptom, with a bridge strength of 1.578 (Table S4).

The cross-sectional network for the third trimester exhibited satisfactory overall stability and accuracy, with a CS value of 0.514 (Fig. 2C). Network results revealed (Fig. 3C) that the strongest positive correlation was observed between Nervous, anxious or on edge (GAD 1) and Difficulty controlling worries (GAD 2), with a correlation coefficient of 0.871 (Figure S7). Trouble relaxing (GAD 4) served as both the core symptom (Fig. 4C) and the bridge symptom, with an expected influence of 1.325 (Table S5) and a bridge strength of 1.602 (Table S6).

3.4 Cross-Lagged Network Analysis

Figure 5 shows cross-lagged networks of anxiety and depressive symptoms among women with a subsequent pregnancy following pregnancy loss. Panels A, B and C represent cross-lagged networks for T1→T2, T2→T3 and T1→T3, respectively.

The T1→T2 cross-lagged network exhibited satisfactory overall accuracy and stability. The correlation stability (CS) coefficients for in-expected influence and out-expected influence were both 0.281, exceeding the threshold of 0.25. The strongest positive association was from Restlessness (GAD 5) to Difficulty controlling worries (GAD 2) with an edge weight of − 0.190, and the strongest negative association was from Thoughts of self-harm (EPDS 10) to Overwhelmed by pressure (EPDS 6) with an

edge weight of − 0.349(Table S8). As shown in Fig. 6A,Thoughts of self-harm (EPDS 10) had the highest out-expected influence (Z = − 2.27), and Overwhelmed by pressure (EPDS 6) had the highest in-expected influence (Z = − 2.87) (Table S9).

For the T2→T3 cross-lagged network, good overall accuracy and stability were observed. The CS coefficient of in-expected influence was 0.596, and the CS coefficient of out-expected influence was 0.438; both values were greater than 0.25. The strongest positive association existed from Fear of worst-case outcomes (GAD 7) to Trouble relaxing (GAD 4) with an edge weight of 0.248, while the strongest negative association was from Overwhelmed by pressure (EPDS 6) to Difficulty controlling worries (GAD 2) with an edge weight of − 0.149(Table S11). As shown in Fig. 6B, Fear of worst-case outcomes (GAD 7) showed the highest out-expected influence (Z = 2.092), and Thoughts of self-harm (EPDS 10) exhibited the highest in-expected influence (Z = − 2.331) (Table S12).

In the T1→T3 cross-lagged network, acceptable overall accuracy and stability were demonstrated. The CS coefficient for in-expected influence was 0.360, and the CS coefficient for out-expected influence was 0.438, both above 0.25. The strongest positive association was from Unprovoked fear/panic (EPDS 5) to Unprovoked anxiety/worry (EPDS 4) with an edge weight of 0.125, and the strongest negative association was from Look forward to things (EPDS 2) to Fear of worst-case outcomes (GAD 7) with an edge weight of − 0.078(Table S14). As shown in Fig. 6C, Unprovoked fear/panic (EPDS 5) had the highest out-expected influence (Z = 2.633), and Unhappy with sleep difficulty (EPDS 7) had the highest in-expected influence (Z = 1.495) (Table S15).

4 Discussion

4.1 Dynamic Changes and Potential Mechanisms of Stage-Specific Core Symptoms

This study found that Trouble relaxing served as the core symptom in the first and third trimesters (EI were 1.465 and 1.325, respectively), while Feeling sad or miserable dominated in the second trimester (EI = 1.415), presenting a dynamic evolutionary pattern of anxiety → depression → anxiety. Several recent systematic reviews have demonstrated that women with a history of pregnancy loss exhibit prominent anxiety symptoms during subsequent pregnancy, particularly in the first and third trimesters, which is consistent with the core anxiety symptoms identified in the present study(Shen, Luo, Wei, & Chen, 2025; Williamson, Moffitt, Broadbent, Neumann, & Hamblin, 2023). However, most previous studies only analyzed total scale scores and failed to identify specific core symptoms throughout gestation(Stefana, Mirabella, Gigantesco, Calamandrei, & Camoni, 2026). Based on the expected influence indicator of network analysis, this study further revealed that the somatic anxiety symptom Trouble relaxing acts as the core driving symptom in the first and third trimesters, providing targeted evidence for precise psychological intervention in high-risk pregnant populations.

The transition of core symptoms from anxiety to depression in the second trimester, represented by Feeling sad or miserable, may be attributed to the unique psychological characteristics of this gestational stage. The second trimester is a critical period when fetal movements become gradually perceptible and the sense of pregnancy reality is significantly enhanced. For women with prior pregnancy loss, this perceptual change may reactivate negative grief memories related to previous adverse pregnancy outcomes, thereby elevating depressive symptoms to the core position of the symptom network(Gower, Luddington, Khosa, Thaivalappil, & Papadopoulos, 2023). Prospective clinical evidence further indicates that a history of stillbirth increases the susceptibility to anxiety and depression in subsequent pregnancy, and the gradual perception of fetal movement in the second trimester can further aggravate grief-related negative emotions(Fogarty, Heazell, Munk, & Hay, 2024). In addition, Mazza et al. performed a network analysis of prenatal depression, anxiety and temperament across different gestational trimesters and verified the structural heterogeneity of symptom networks during pregnancy. Nevertheless, their study excluded women with a history of pregnancy loss and did not adopt a cross-lagged longitudinal design to explore the predictive relationships between symptoms, making it impossible to clarify the dynamic transition mechanism of core perinatal symptoms(Mazza et al., 2024).

4.2 Interpretation of Longitudinal Prediction Pathways and Their Psychological Mechanisms

Cross-lagged network analysis revealed three key longitudinal prediction pathways. The positive predictive effect of Restlessness on Uncontrollable worry from T1 → T2 (edge weight = 0.190) reflects the transmission of anxiety from somatic to cognitive manifestations. This finding is consistent with the meta-analysis by Jacobson and Newman, which confirmed based on longitudinal studies that anxiety predicts subsequent depression, and such predictive effect remains significant after controlling for baseline depression levels(Jacobson & Newman, 2017). For women with a subsequent pregnancy after pregnancy loss, somatic anxiety in early gestation (Restlessness) may represent a physiological arousal response to prior pregnancy loss trauma. As pregnancy progresses, this somatic anxiety gradually transforms into a sense of uncontrollability regarding pregnancy outcomes, forming a transmission chain from somatic to cognitive symptoms(Beaumont et al., 2025; Thomas et al., 2021).

The positive predictive effect of Catastrophic thinking on Trouble relaxing from T2 → T3 (edge weight = 0.248) demonstrates the reverse driving effect of cognitive anxiety on somatic anxiety, creating a cycle from cognitive to somatic symptoms. This cyclic transmission pattern of somatic → cognitive → somatic symptoms aligns with the core assumption of network theory that symptoms activate and reinforce one another, while bearing specific implications for women pregnant again after pregnancy loss. Catastrophic thinking in the second trimester may stem from repetitive rumination and self-attribution regarding the causes of prior loss. Such cognitive patterns further exacerbate somatic anxiety as delivery approaches in late gestation, leading to a vicious cycle(Stefana et al., 2026).

The long-term positive predictive effect of Panic on Uncontrolled anxiety or worry from T1 → T3 (edge weight = 0.125) further indicates that fear in early pregnancy is not a transient reaction, but an important

source that affects anxiety status throughout gestation. The longitudinal study conducted by Gómez-Gómez et al. among 3082 Spanish perinatal women reported high stability of GAD-7 scores across three follow-up time points (r = 0.69 ~ 0.72), suggesting considerable stability of anxiety in the perinatal period, which supports our long-term prediction results. Nevertheless, their study did not enroll women with a history of pregnancy loss, nor did it explore longitudinal predictive associations between individual symptoms, and thus failed to identify the key transmission pathway from fear to anxiety(Gómez-Gómez et al., 2024).

4.3 Independent Characteristics of Thoughts of Self-Harm and Its Clinical Implications

Cross-lagged network analysis in this study identified a unique longitudinal pathway of negative symptom progression among women with a subsequent pregnancy after pregnancy loss. The strongest negative association from T1 → T2 was the inhibitory effect of Thoughts of self-harm on Overwhelmed by pressure (edge weight = -0.349), while from T2→ T3, Overwhelmed by pressure negatively predicted Uncontrollable worry (edge weight = -0.149). Together, they formed a specific symptom chain of Thoughts of self-harm — Overwhelmed by pressure — Uncontrollable worry, reflecting a distinct pattern of psychological symptom progression in this high-risk population compared with low-risk pregnant women. This finding challenges conventional understanding and confirms that thoughts of self-harm during pregnancy are largely independent and can emerge without severe feelings of being overwhelmed by pressure. It also highlights a major limitation of conventional screening relying on total scale scores: using only GAD-7 and EPDS cut-off values may miss hidden high-risk women who score positively on the self-harm item but have mild overall symptom burden(Reid, Pratt, Edge, & Wittkowski, 2022). Early activation of thoughts of self-harm in the first trimester disrupts psychological compensation and normal stress regulation, which may subsequently trigger cognitive anxiety and loss of control in late pregnancy, acting as a key preceding risk factor for psychological disturbance across gestation(Shen et al., 2025). Most prior studies have focused on positive comorbidity between perinatal anxiety and depression, with limited attention to negative inhibitory relationships and longitudinal symptom changes in high-risk groups(Williamson et al., 2023). This study adds evidence on the unique symptom network features of women pregnant again after pregnancy loss and improves understanding of the dynamic mechanisms of perinatal psychological symptoms. Clinically, the EPDS item 10 assessing thoughts of self-harm should be screened separately at every antenatal visit regardless of total GAD-7 and EPDS scores. Timely crisis assessment and early intervention for screen-positive individuals, with specialist referral when needed, can effectively block adverse symptom cascades and strengthen mental health care for high-risk pregnant women(Rodriguez-Cabezas & Clark, 2018).

4.4 Protective Effect of Positive Emotion and Its Clinical Significance

The negative predictive effect of Looking forward to things on Catastrophic thinking from T1 → T3 (edge weight = -0.078) indicates that positive emotions inhibit the activation of catastrophic thinking. This

finding supports the broaden-and-build theory of positive emotions, which proposes that positive emotions broaden cognitive scope and build enduring resources to counteract the consolidation of negative cognitive patterns(Roth, Bencker, Lorenz, & Laireiter, 2024). For women with a subsequent pregnancy after pregnancy loss, Looking forward to things may reflect positive expectations for the ongoing pregnancy and confidence in fetal health. Such positive cognitive resources can buffer the activation of catastrophic thinking(Shen et al., 2025; Williamson et al., 2023) This result offers new directions for non-pharmacological obstetric interventions. Integrating positive psychological components into routine antenatal counseling, encouraging women to focus on fetal movement and participate in health education sessions, may enhance positive expectations regarding pregnancy outcomes and exert protective effects(Firrahmawati et al., 2025).

4.5 Implications for Obstetric Clinical Practice

Taken together, the findings of this study yield the following key implications for obstetric practice.

First, shift psychological screening forward to the first antenatal visit in early pregnancy. Routine obstetric psychological screening is currently mostly implemented in the second trimester, for example during the 20 ~ 24 week anatomy scan. Evidence from this study suggests that initiating screening as late as the second trimester may miss the optimal window for intervention(Waqas et al., 2022). For pregnant women with a history of pregnancy loss, GAD-7 and EPDS screening is recommended at the initial visit (6 ~ 8 weeks of gestation). Particular attention should be paid to Panic (EPDS 5) and Trouble relaxing (GAD 4). Women with elevated scores on these items should be enrolled in psychological follow-up in early pregnancy even if their total scale scores do not reach clinical cut-offs(Bailey et al., 2019).

Second, monitor item-level scores of stage-specific core symptoms alongside conventional total scale screening. Trouble relaxing (GAD 4) should be prioritized in the first and third trimesters, whereas Feeling sad or miserable (EPDS 8) should be emphasized in the second trimester. Further psychological assessment or shortened follow-up intervals should be considered for women with high scores on these items regardless of total scale thresholds(Talask, Lemos, da Costa, Nardi, & de Carvalho, 2022). This strategy requires no additional screening instruments and only assigns greater clinical weight to selected items within existing antenatal workflows, making it highly feasible.

Third, deliver prospective interventions based on longitudinal predictive pathways. When obstetric clinicians identify prominent Restlessness in early pregnancy, this symptom should not be dismissed as a common pregnancy discomfort. Instead, it should be recognized as a precursor to subsequent Uncontrollable worry. Early interventions such as relaxation training and mindfulness-based stress reduction are recommended to block positive symptom transmission. Similarly, cognitive behavioral interventions should be initiated promptly when Catastrophic thinking emerges in the second trimester, to prevent its escalation of Trouble relaxing in late pregnancy(Zeng et al., 2025).

Fourth, establish a dedicated assessment protocol for thoughts of self-harm. For women with prior pregnancy loss, the Thoughts of self-harm item (EPDS 10) should be assessed separately at every

antenatal visit, independent of overall GAD-7 and EPDS total scores. A crisis assessment should be activated immediately for women who endorse this item, with referral to psychiatric or psychological crisis services when indicated. This procedure serves as a mental safety screen in obstetric clinics and helps avoid missing high-risk individuals(Reid et al., 2022).

Fifth, value non-pharmacological interventions that foster positive emotions. Positive psychological strategies can be integrated into routine antenatal counselling, such as encouraging women to notice fetal movement, attend pregnancy health education sessions, and join peer support groups. These measures may strengthen positive expectations regarding pregnancy outcomes and suppress catastrophic thinking(Firrahmawati et al., 2025). Such interventions can be delivered by obstetricians or midwives without specialized psychological staff, supporting good accessibility and scalability.

In conclusion, this study is the first to adopt cross-lagged network analysis to characterize dynamic changes in anxiety and depressive symptom networks among women with a subsequent pregnancy after pregnancy loss. It provides evidence-based guidance for obstetric care to shift from cut-off-based total scale screening toward staged, symptom-targeted precise mental health management. All proposed measures can be implemented within current obstetric service frameworks without substantial increases in workforce or equipment, supporting favorable clinical translation.

5 Conclusion

The core targets of anxiety and depressive symptoms among women with a subsequent pregnancy following pregnancy loss vary dynamically across gestational stages. Trouble relaxing acts as the core symptom in the first and third trimesters, whereas Feeling sad or miserable dominates in the second trimester, suggesting that obstetric psychological interventions should adjust targeted symptoms according to gestational weeks. Longitudinal analyses show that Restlessness in the first trimester predicts the activation of Difficulty controlling worries in the second trimester; Fear of worst-case outcomes in the second trimester drives the exacerbation of Trouble relaxing in the third trimester. The negative predictive effect of Thoughts of self-harm on Overwhelmed by pressure indicates that this symptom may exist independently of general stress perception and requires dedicated obstetric assessment. Furthermore, the long-term predictive effect of Unprovoked fear/panic in early pregnancy on Unprovoked anxiety/worry in the third trimester, together with the negative predictive effect of Look forward to things on Fear of worst-case outcomes, support the implementation of psychological screening starting from the first trimester in obstetric settings and highlight the potential protective role of fostering positive emotions to halt deterioration of the symptom network

6 Strengths and limitations

The strengths of this study lie in targeting women with a subsequent pregnancy following pregnancy loss and adopting cross-lagged panel network analysis to identify core anxiety and depressive symptoms as well as their longitudinal evolutionary patterns, thereby providing a theoretical basis for

trimester-specific targeted psychological interventions in obstetrics. Nevertheless, the present study has several limitations. First, the sample size was relatively limited, mainly due to the specific characteristics of the study population. Women with subsequent pregnancy following pregnancy loss represent a distinct subgroup in obstetric outpatient settings; participants needed to be enrolled in early pregnancy and complete three longitudinal follow-up assessments, resulting in a narrow recruitment window. In addition, some women are sensitive to topics related to the subsequent pregnancy after experiencing pregnancy loss and show low willingness to participate, making it challenging to recruit eligible candidates. Future studies may expand the sample size via multi-center designs and extended recruitment periods to verify the stability of the network structures observed here. Second, all symptoms were assessed using self-reported questionnaires, which may introduce reporting bias. Further validation of these findings using multi-source approaches, such as clinical interviews and partner reports, is warranted. Third, this study only explored the structural characteristics of symptom networks and did not systematically analyze external factors contributing to network formation and changes. Discussions regarding influencing factors were largely speculative and based on previous literature rather than direct evidence from the current sample. Accordingly, future work will focus on refining the methodological framework integrating network analysis with influencing factor analysis.

Declarations

Acknowledgments

We thank all the individuals who participated in this study for their cooperation.

Authors' contributions

W.J.F : Writing – review & editing, Writing – original draft, Methodology, Data curation, Conceptualization. **X. J.W:** Writing – review & editing, Writing – original draft, Methodology, Data curation, Formal analysis. **N.N.Z :** Writing – review & editing, Investigation. Writing – original draft, Formal analysis. **R.M.W:** Writing – review & editing, Writing – original draft, Methodology, Data curation, Formal analysis. **Z.Y:** Writing – review & editing, Investigation. Writing – original draft. **Q.Q.S:** Writing – review & editing, Investigation. Data curation, Formal analysis. **K.Z:** Writing – Review & editing, Investigation. **Y.L.L:** Writing – Review & editing, Investigation. **L.L:** Writing – Review & editing, Investigation. **Y.Y.Z:** Writing – Review & editing, Investigation. **G.S.L:** Writing – Review & editing, Investigation. **L.P.H:** Writing – Review & editing, Investigation. **J.D:** Writing – review & editing, Writing – original draft, Methodology, Data curation, Formal analysis.

Funding

This study was funded by Key Scientific Research Project Plan of Colleges and Universities in Henan Province (26A320048); Key Scientific Research Project Plan of Colleges and Universities in Henan Province (26A320054); Henan Provincial Key Science and Technology Research Project(262102310056); Medical Science and Technology Project of Henan Province (SBGJ202103077).

Data Availability Declaration

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

Ethical approval and consent to participate

All procedures in this study were in accordance with the Declaration of Helsinki. Ethical approval was obtained from the Ethics Committee of the First Affiliated Hospital of Zhengzhou University (2024-KY-1569-002). Informed consent was obtained from all study participants: research assistants first explained the study details verbally to ensure participants fully understood the aims, risks, and rights, then provided paper consent documents for participants to read through independently. Only participants who voluntarily signed the written consent document were enrolled in the study.

Competing interests

The authors have no conflict of interest to report.

References

1. ACOG Practice Bulletin No. 200: Early Pregnancy Loss. (2018). *Obstet Gynecol, 132*(5), e197-e207. doi:10.1097/aog.0000000000002899
2. Armstrong, D. S. (2004). Impact of prior perinatal loss on subsequent pregnancies. *J Obstet Gynecol Neonatal Nurs, 33*(6), 765–773. doi:10.1177/0884217504270714
3. Bailey, S. L., Boivin, J., Cheong, Y. C., Kitson-Reynolds, E., Bailey, C., & Macklon, N. (2019). Hope for the best …but expect the worst: a qualitative study to explore how women with recurrent miscarriage experience the early waiting period of a new pregnancy. *BMJ Open, 9*(5), e029354. doi:10.1136/bmjopen-2019-029354
4. Beaumont, J., Smith, D., Bailey, E., Barron, R., Tomlinson, E., & Heazell, A. E. P. (2025). Psychological Distress, Post-Traumatic Stress and Emotional Suppression in a Pregnancy After a Perinatal Death: A Longitudinal Survey. *Bjog, 132*(10), 1469–1480. doi:10.1111/1471-0528.18212
5. Bedaiwy, M. A., Fayek, B., Yang, E. C., Iews, M. S., Elgendi, M., Abdelkareem, A. O., et al. (2023). Prevalence, causes, and impact of non-visualized pregnancy losses in a recurrent pregnancy loss population. *Hum Reprod, 38*(5), 830–839. doi:10.1093/humrep/dead040
6. Borsboom, D. (2017). A network theory of mental disorders. *World Psychiatry, 16*(1), 5–13. doi:10.1002/wps.20375
7. Borsboom, D., & Cramer, A. O. (2013). Network analysis: an integrative approach to the structure of psychopathology. *Annu Rev Clin Psychol, 9*, 91–121. doi:10.1146/annurev-clinpsy-050212-185608
8. Bringmann, L. F., Vissers, N., Wichers, M., Geschwind, N., Kuppens, P., Peeters, F., et al. (2013). A network approach to psychopathology: new insights into clinical longitudinal data. *PLoS ONE, 8*(4), e60188. doi:10.1371/journal.pone.0060188

9. Chen, B., Luo, X., Hong, X., Pan, W., & Shen, Q. (2025). Resilient journeys amidst uncertainty: a qualitative study of women's experiences in subsequent pregnancies following pregnancy loss. *BMC Pregnancy Childbirth, 25*(1), 964. doi:10.1186/s12884-025-08073-2
10. Cox, J. L., Holden, J. M., & Sagovsky, R. (1987). Detection of postnatal depression. Development of the 10-item Edinburgh Postnatal Depression Scale. *Br J Psychiatry, 150*, 782–786. doi:10.1192/bjp.150.6.782
11. Cuenca, D. (2022). Pregnancy loss: Consequences for mental health. *Front Glob Womens Health, 3*, 1032212. doi:10.3389/fgwh.2022.1032212
12. Epskamp, S., & Fried, E. I. (2018). A tutorial on regularized partial correlation networks. *Psychol Methods, 23*(4), 617–634. doi:10.1037/met0000167
13. Farren, J., Jalmbrant, M., Falconieri, N., Mitchell-Jones, N., Bobdiwala, S., Al-Memar, M., et al. (2020). Posttraumatic stress, anxiety and depression following miscarriage and ectopic pregnancy: a multicenter, prospective, cohort study. *Am J Obstet Gynecol, 222*(4), 367.e361-367.e322. doi:10.1016/j.ajog.2019.10.102
14. Firrahmawati, L., Wasityastuti, W., Kandarina, B. J. I., Marti, E., Chandra, L. A., & Sulistianingsih, A. (2025). The efficacy of collaborative psychological interventions in reducing anxiety levels in pregnant women: a systematic review and meta-analysis. *BMC Pregnancy Childbirth, 25*(1), 431. doi:10.1186/s12884-025-07523-1
15. Fogarty, S., Heazell, A. E. P., Munk, N., & Hay, P. (2024). Swedish massage as an adjunct approach to Help suppOrt individuals Pregnant after Experiencing a prior Stillbirth (HOPES): a convergent parallel mixed-methods single-arm feasibility trial protocol. *Pilot Feasibility Stud, 10*(1), 67. doi:10.1186/s40814-024-01499-z
16. Funkhouser, C. J., Chacko, A. A., Correa, K. A., Kaiser, A. J. E., & Shankman, S. A. (2021). Unique longitudinal relationships between symptoms of psychopathology in youth: A cross-lagged panel network analysis in the ABCD study. *J Child Psychol Psychiatry, 62*(2), 184–194. doi:10.1111/jcpp.13256
17. Gao, R., Qin, L., & Bai, P. (2022). Self-Reported Depression among Chinese Women with Recurrent Pregnancy Loss: Focusing on Associated Risk Factors. *J Clin Med, 11*(24). doi:10.3390/jcm11247474
18. Gómez-Gómez, I., Domínguez-Salas, S., Rodríguez-Muñoz, M. F., Rodríguez-Domínguez, C., Gómez-Baya, D., & Motrico, E. (2024). Psychometric Properties of the Online Version of the General Anxiety Disorder-7 (GAD-7): A Longitudinal Study in Pregnant and Postpartum Spanish Women. *Psicothema, 36*(3), 227–235. doi:10.7334/psicothema2023.293
19. Gong, X., Hao, J., Tao, F., Zhang, J., Wang, H., & Xu, R. (2013). Pregnancy loss and anxiety and depression during subsequent pregnancies: data from the C-ABC study. *Eur J Obstet Gynecol Reprod Biol, 166*(1), 30–36. doi:10.1016/j.ejogrb.2012.09.024
20. Gower, S., Luddington, J., Khosa, D., Thaivalappil, A., & Papadopoulos, A. (2023). Subsequent pregnancy after stillbirth: a qualitative narrative analysis of Canadian families' experiences. *BMC*

Pregnancy Childbirth, 23(1), 208. doi:10.1186/s12884-023-05533-5

21. Herbert, D., Young, K., Pietrusińska, M., & MacBeth, A. (2022). The mental health impact of perinatal loss: A systematic review and meta-analysis. *J Affect Disord, 297*, 118–129. doi:10.1016/j.jad.2021.10.026
22. Hunter, A., Tussis, L., & MacBeth, A. (2017). The presence of anxiety, depression and stress in women and their partners during pregnancies following perinatal loss: A meta-analysis. *J Affect Disord, 223*, 153–164. doi:10.1016/j.jad.2017.07.004
23. Jacobson, N. C., & Newman, M. G. (2017). Anxiety and depression as bidirectional risk factors for one another: A meta-analysis of longitudinal studies. *Psychol Bull, 143*(11), 1155–1200. doi:10.1037/bul0000111
24. Lee, D. T., Yip, S. K., Chiu, H. F., Leung, T. Y., Chan, K. P., Chau, I. O., et al. (1998). Detecting postnatal depression in Chinese women. Validation of the Chinese version of the Edinburgh Postnatal Depression Scale. *Br J Psychiatry, 172*, 433–437. doi:10.1192/bjp.172.5.433
25. Luo, X., Chen, B., & Shen, Q. (2023). Psychological distress in subsequent pregnancy among women with a history of pregnancy loss: A latent profile analysis. *Midwifery, 127*, 103845. doi:https://doi.org/10.1016/j.midw.2023.103845
26. Mazza, M., Brisi, C., Veneziani, G., Lisci, F. M., Sessa, I., Balocchi, M., et al. (2024). A Network Analysis of Perinatal Depression, Anxiety, and Temperaments in Women in the First, Second, and Third Trimesters of Pregnancy. *J Clin Med, 13*(13). doi:10.3390/jcm13133957
27. Mehra, V. M., Farooqi, S., Sriram, P., & Tunde-Byass, M. (2024). Diagnosis and management of early pregnancy loss. *Cmaj, 196*(34), E1162-e1168. doi:10.1503/cmaj.231489
28. Mikkelsen, A. P., Egerup, P., Kolte, A. M., Westergaard, D., Torp-Pedersen, C., Nielsen, H. S., & Lidegaard, Ø. (2023). Pregnancy Loss and the Risk of Myocardial Infarction, Stroke, and All-Cause Mortality: A Nationwide Partner Comparison Cohort Study. *J Am Heart Assoc, 12*(15), e028620. doi:10.1161/jaha.122.028620
29. Qi, J., Ye, Y., Sun, R., Zhen, R., & Zhou, X. (2023). Comorbidity of posttraumatic stress disorder and depression among adolescents following an earthquake: A longitudinal study based on network analysis. *J Affect Disord, 324*, 354–363. doi:10.1016/j.jad.2022.12.119
30. Reardon, D. C., & Craver, C. (2021). Effects of Pregnancy Loss on Subsequent Postpartum Mental Health: A Prospective Longitudinal Cohort Study. *Int J Environ Res Public Health, 18*(4). doi:10.3390/ijerph18042179
31. Reid, H. E., Pratt, D., Edge, D., & Wittkowski, A. (2022). Maternal Suicide Ideation and Behaviour During Pregnancy and the First Postpartum Year: A Systematic Review of Psychological and Psychosocial Risk Factors. *Front Psychiatry, 13*, 765118. doi:10.3389/fpsyt.2022.765118
32. Rodriguez-Cabezas, L., & Clark, C. (2018). Psychiatric Emergencies in Pregnancy and Postpartum. *Clin Obstet Gynecol, 61*(3), 615–627. doi:10.1097/grf.0000000000000377
33. Roth, L. H. O., Bencker, C., Lorenz, J., & Laireiter, A. R. (2024). Testing the validity of the broaden-and build theory of positive emotions: a network analytic approach. *Front Psychol, 15*, 1405272.

doi:10.3389/fpsyg.2024.1405272

34. Shen, Q., Luo, X., Wei, M., & Chen, B. (2025). Latent trajectories of anxiety and depression among women during subsequent pregnancy following pregnancy loss. *J Adv Nurs, 81*(4), 1875–1883. doi:10.1111/jan.16378
35. Spitzer, R. L., Kroenke, K., Williams, J. B., & Löwe, B. (2006). A brief measure for assessing generalized anxiety disorder: the GAD-7. *Arch Intern Med, 166*(10), 1092–1097. doi:10.1001/archinte.166.10.1092
36. Stefana, A., Mirabella, F., Gigantesco, A., Calamandrei, G., & Camoni, L. (2026). Stable structure, shifting links: How depression-anxiety symptom networks reconfigure from pregnancy to postpartum. *Eur Psychiatry, 69*(1), e40. doi:10.1192/j.eurpsy.2026.10181
37. Sun, H., Mao, J., Su, X., & Du, Q. (2023). Impact of spontaneous abortion history and induced abortion history on perinatal outcomes of singleton pregnancies. *BMC Public Health, 23*(1), 2360. doi:10.1186/s12889-023-17264-5
38. Talask, G., Lemos, V. d. C. O. d., da Costa, R. T., Nardi, A. E., & de Carvalho, M. R. (2022). Overview of the Network Approach and Contributions to Clinical Research and Practice. *Revista Interamericana de Psicología/Interamerican Journal of Psychology, 56*(3), e1662. doi:10.30849/ripijp.v56i3.1662
39. Thomas, S., Stephens, L., Mills, T. A., Hughes, C., Kerby, A., Smith, D. M., & Heazell, A. E. P. (2021). Measures of anxiety, depression and stress in the antenatal and perinatal period following a stillbirth or neonatal death: a multicentre cohort study. *BMC Pregnancy Childbirth, 21*(1), 818. doi:10.1186/s12884-021-04289-0
40. Vlachou, F., Iakovou, D., Daru, J., Khan, R., Pepas, L., Quenby, S., & Iliodromiti, S. (2024). Fetal loss and long-term maternal morbidity and mortality: A systematic review and meta-analysis. *PLoS Med, 21*(2), e1004342. doi:10.1371/journal.pmed.1004342
41. Waqas, A., Koukab, A., Meraj, H., Dua, T., Chowdhary, N., Fatima, B., & Rahman, A. (2022). Screening programs for common maternal mental health disorders among perinatal women: report of the systematic review of evidence. *BMC Psychiatry, 22*(1), 54. doi:10.1186/s12888-022-03694-9
42. Williamson, S. P., Moffitt, R. L., Broadbent, J., Neumann, D. L., & Hamblin, P. S. (2023). Coping, wellbeing, and psychopathology during high-risk pregnancy: A systematic review. *Midwifery, 116*, 103556. doi:10.1016/j.midw.2022.103556
43. Wysocki, A., McCarthy, I., van Bork, R., & Cramer, A. O. J. (2025). Cross-lagged panel networks. *advances.in/psychology, 2*, e739621. doi:10.56296/aip00037
44. Yang, X., Mu, F., Zhang, J., Yuan, L., Zhang, W., Yang, Y., & Wang, F. (2024). Reproductive factors and subsequent pregnancy outcomes in patients with prior pregnancy loss. *BMC Pregnancy Childbirth, 24*(1), 219. doi:10.1186/s12884-024-06422-1
45. Zainal, N. H., & Newman, M. G. (2023). A cross-lagged prospective network analysis of depression and anxiety and cognitive functioning components in midlife community adult women. *Psychol Med, 53*(9), 4160–4171. doi:10.1017/s0033291722000848

46. Zeng, G., Niu, J., Zhu, K., Li, F., Li, L., Gao, K., et al. (2025). Effects of non-pharmacological interventions on depressive and anxiety symptoms in pregnant women: a systematic review and network meta-analysis. *eClinicalMedicine, 79*, 103011. doi:10.1016/j.eclinm.2024.103011

Figures

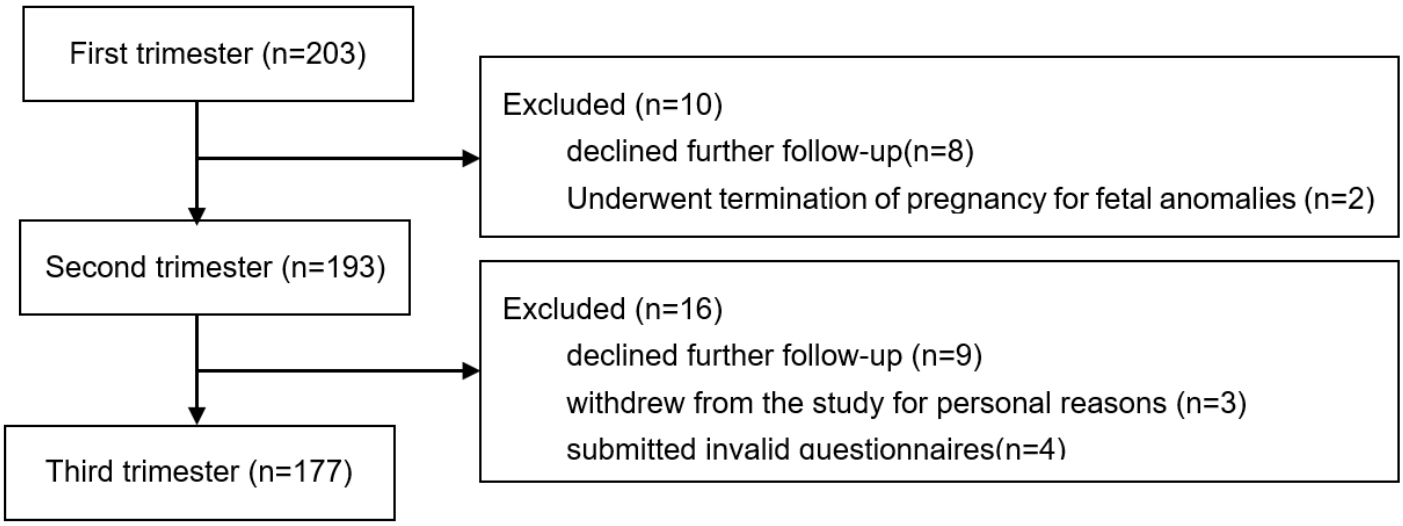


Figure 1

Participant follow-up status at different time points

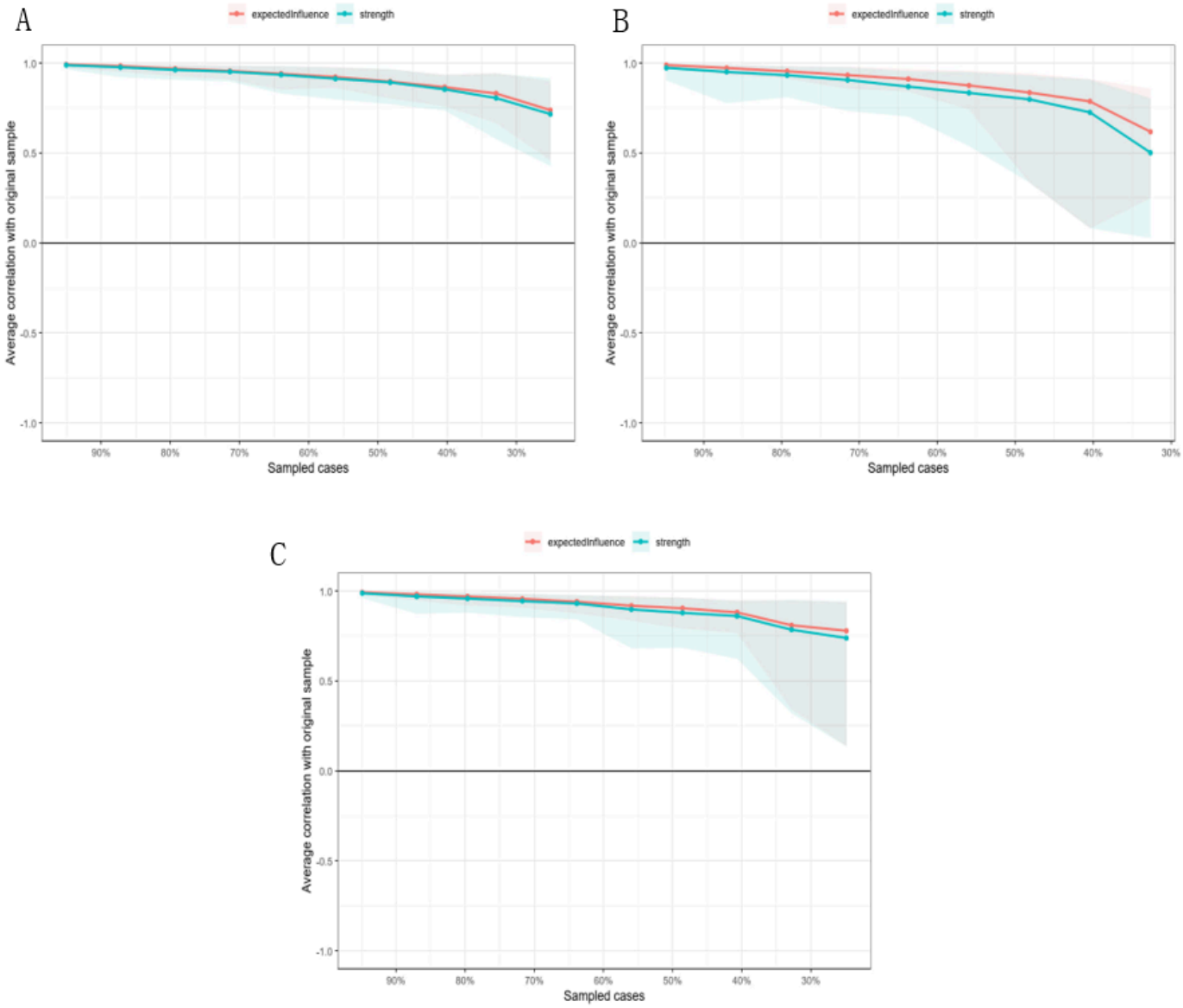


Figure 2

Stability plots of the anxiety and depressive symptom networks among women with a subsequent pregnancy following pregnancy loss

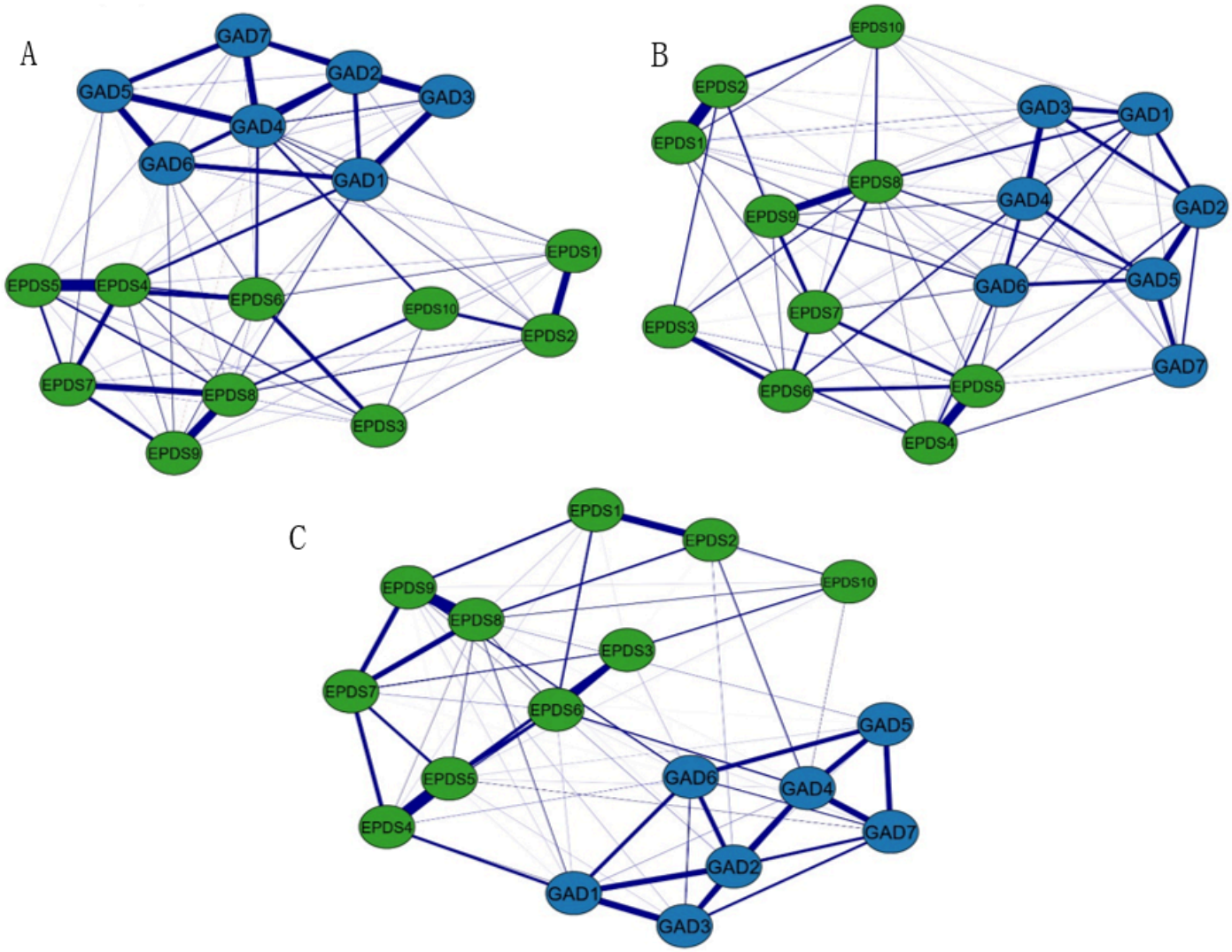


Figure 3

Cross-sectional networks of anxiety and depressive symptoms among women with a subsequent pregnancy following pregnancy loss

Notes: Thicker edges indicate stronger associations between symptoms. GAD 1: Nervous, anxious or on edge; GAD 2: Difficulty controlling worries; GAD 3: Excessive worrying; GAD 4: Trouble relaxing; GAD 5: Restlessness; GAD 6: Irritability; GAD 7: Fear of worst-case outcomes; EPDS 1: Able to laugh and see fun; EPDS 2: Look forward to things; EPDS 3: Unnecessary self-blame; EPDS 4: Unprovoked anxiety/worry; EPDS 5: Unprovoked fear/panic; EPDS 6: Overwhelmed by pressure; EPDS 7: Unhappy with sleep difficulty; EPDS 8: Feeling sad or miserable; EPDS 9: Unhappy and prone to crying; EPDS 10: Thoughts of self-harm

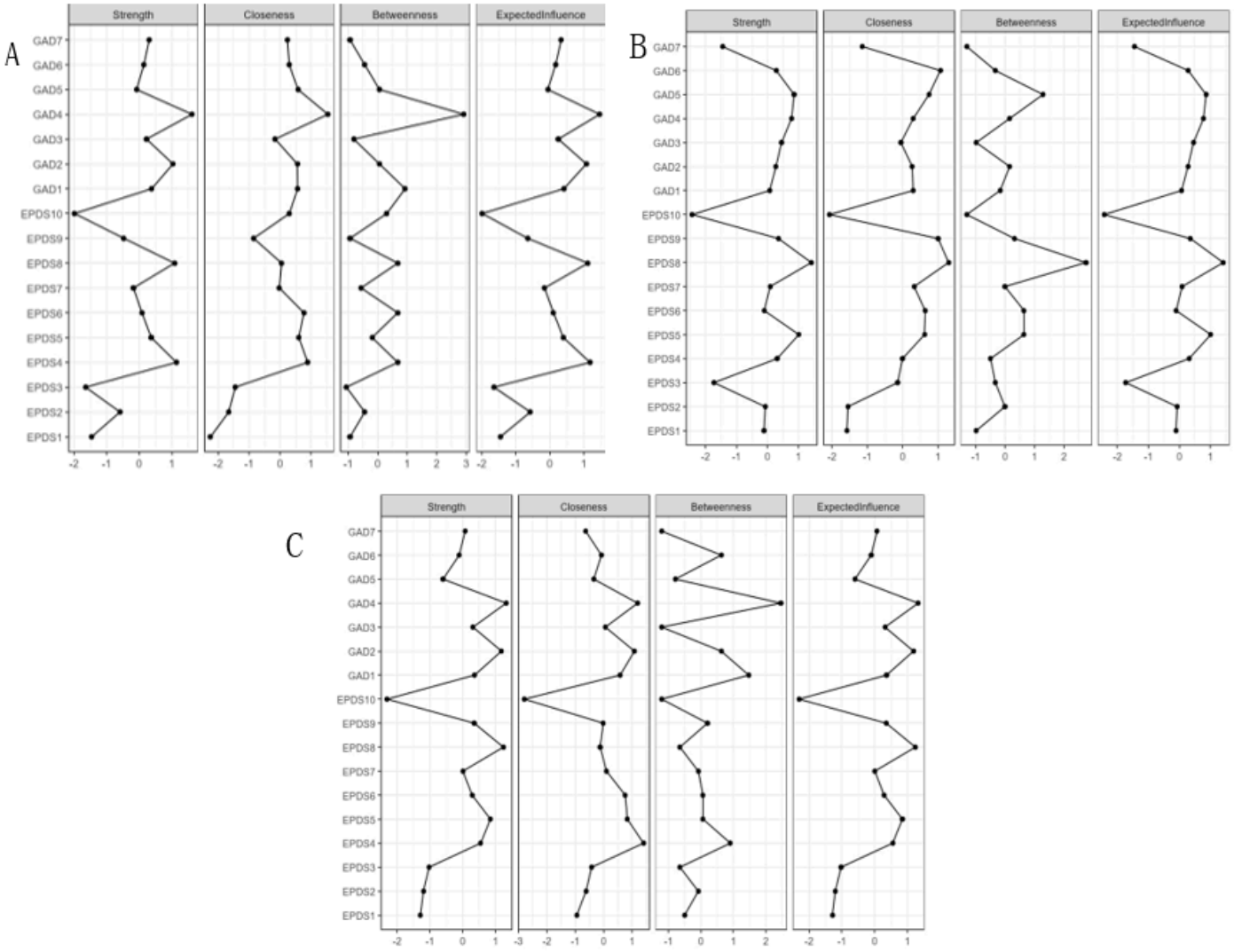


Figure 4

Centrality plots of the anxiety and depressive symptom networks among women with a subsequent pregnancy following pregnancy loss

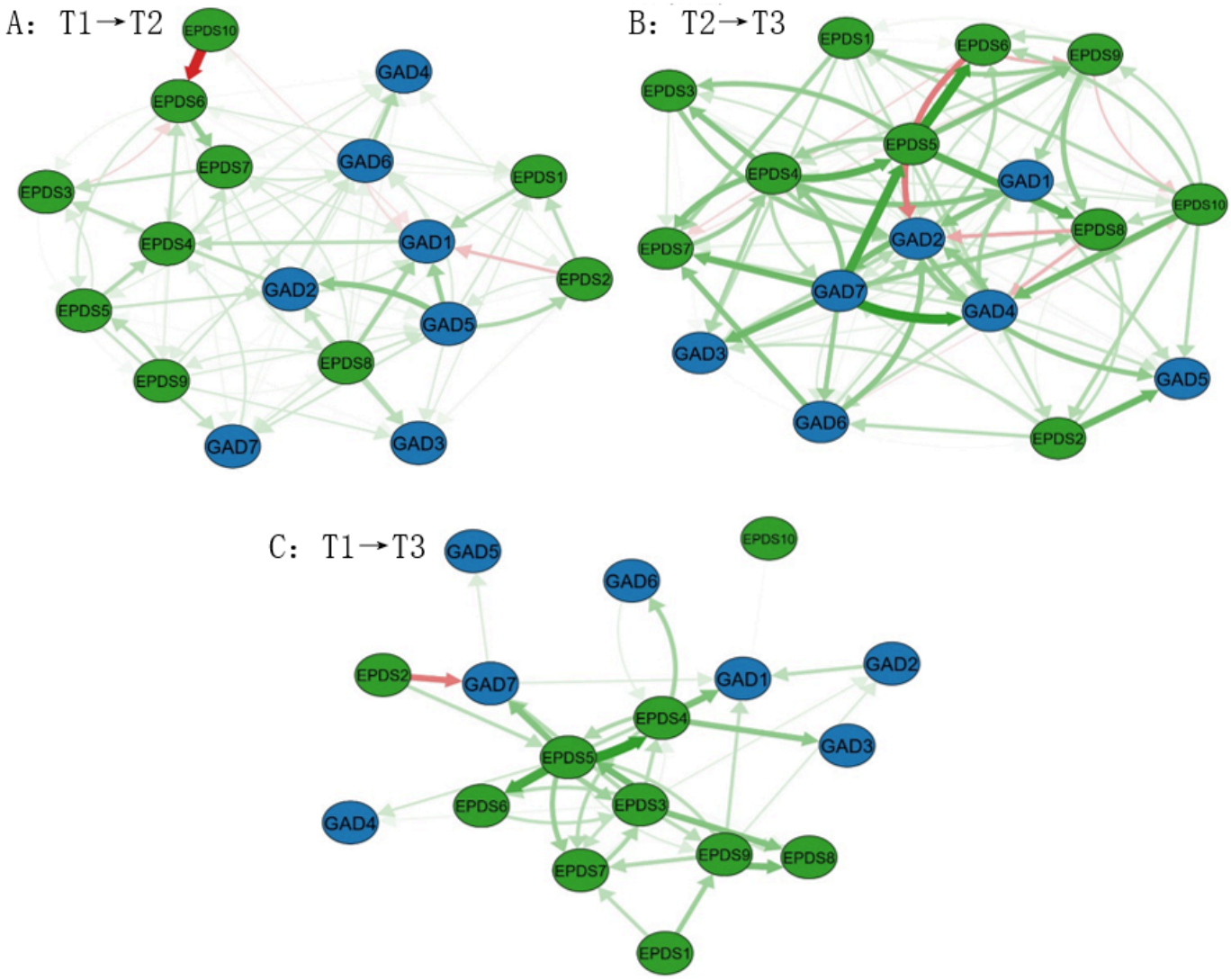


Figure 5

Cross-lagged networks of anxiety and depressive symptoms among women with a subsequent pregnancy following pregnancy loss

Notes: Green edges indicate positive associations between nodes, and red edges indicate negative associations. GAD 1: Nervous, anxious or on edge; GAD 2: Difficulty controlling worries; GAD 3: Excessive worrying; GAD 4: Trouble relaxing; GAD 5: Restlessness; GAD 6: Irritability; GAD 7: Fear of worst-case outcomes; EPDS 1: Able to laugh and see fun; EPDS 2: Look forward to things; EPDS 3: Unnecessary self-blame; EPDS 4: Unprovoked anxiety/worry; EPDS 5: Unprovoked fear/panic; EPDS 6: Overwhelmed by pressure; EPDS 7: Unhappy with sleep difficulty; EPDS 8: Feeling sad or miserable; EPDS 9: Unhappy and prone to crying; EPDS 10: Thoughts of self-harm

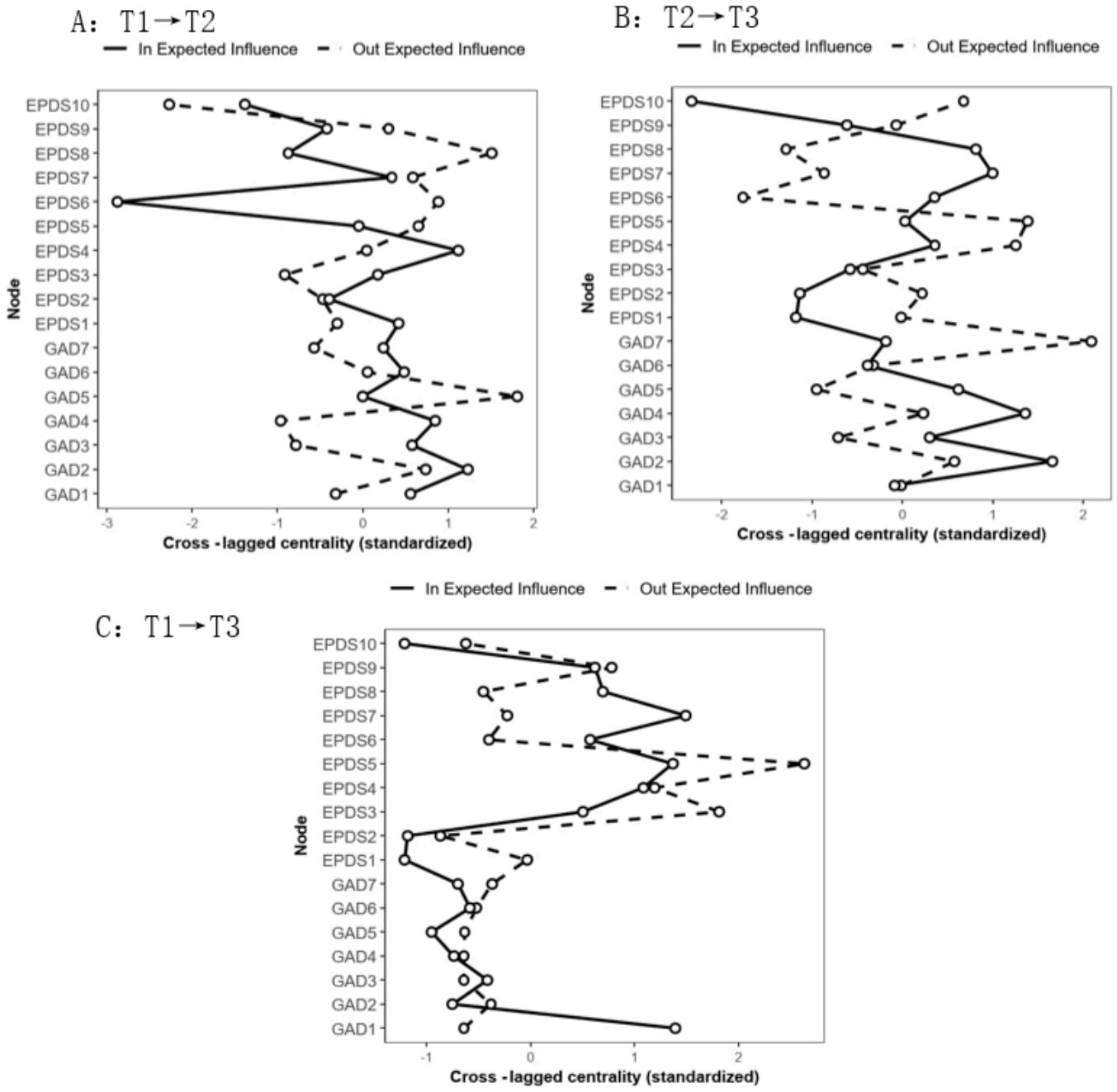


Figure 6

Centrality plot of cross-lagged network for anxiety and depressive symptoms among women with a subsequent pregnancy following pregnancy loss

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Supplementary.docx
- SupplementarySociodemographicdata.docx