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The role of psychosomatic interventions on the immune system and gut microbiome diversity of pregnant women with gestational hypertension

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RESEARCH ARTICLE

ABSTRACT

This study evaluates the impact of psychosomatic interventions on the immune system and microbiome composition of pregnant women diagnosed with gestational hypertension. A case-control study on 200 pregnant women diagnosed with gestational hypertension was conducted between June 2021 and December 2024. The control group ($n = 100$) included pregnant women diagnosed with gestational hypertension and under only pharmacological treatment with antihypertensive drugs such as labetalol. The case group ($n = 100$) received standard care for hypertensive disorders in pregnancy like control group, but in addition to it, we incorporated evidence based psychosomatic medicine to this group. Psychosomatic medicine included stress management, relaxation techniques, and counseling for the study group. Primary outcomes included blood pressure levels, psychological state (SAS and SDS scores), mode of delivery, incidence of complications, neonatal outcomes, patient satisfaction, reductions in inflammatory cytokines (e.g., IL-6, TNF-alpha), and improvements in microbiome diversity. Psychosomatic intervention led to a significant increase in microbiome diversity (Shannon Index, $P < 0.05$). Beta-diversity analysis revealed a distinct separation in microbial community composition between the study and control groups ($P = 0.02$). The case group also showed a reduction in pro-inflammatory cytokines, IL-6 decreased from 40.0 to 28.0 pg mL^{-1} ($P = 0.008$) and TNF-alpha from 25.0 to 18.0 pg mL^{-1} ($P = 0.004$). The case group demonstrated significant improvements in systolic ($P = 0.020$) and diastolic ($P = 0.003$) blood pressures, psychological well-being (SAS, $P = 0.006$; SDS: $P = 0.026$), and delivery outcomes ($P = 0.032$). Complications were significantly lower in the case group ($P = 0.013$), with better neonatal outcomes, including lower rates of intrauterine distress ($P = 0.011$), premature birth ($P = 0.003$), and asphyxia ($P = 0.013$). Emotional resilience, coping confidence, and patient satisfaction were significantly higher in the case group ($P < 0.05$). These findings suggest that psychosomatic medicine may offer a novel approach for managing gestational hypertension through microbiome modulation.

KEYWORDS

psychosomatic medicine, gestational hypertension, gut microbiome, immune modulation

INTRODUCTION

Gestational hypertension has a high clinical incidence worldwide, and many patients progress to preeclampsia, further increasing risks to maternal and fetal health [1]. Beyond the physical symptoms, these conditions are closely linked to psychological stress, anxiety, and depression, which can exacerbate complications [2]. Gestational Hypertension pathophysiology is complex, involving both physical factors (e.g., vascular dysfunction) and psychological stress, which can exacerbate disease progression [3]. Emerging research suggests that the microbiome (the collection of microorganisms in the body) plays a critical role in regulating immune responses, inflammation, oxidative stress and blood pressure [4]. Similarly, psychosomatic medicine, which integrates psychological care with physical health interventions, is gaining recognition for its ability to modulate immune function and improve

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health outcomes. [3] this study aims to evaluate the effects of evidence-based psychosomatic interventions on the immune response and microbiome diversity in pregnant women diagnosed with gestational hypertension, and to determine whether these interventions improve blood pressure control, reduce complications, and enhance neonatal outcomes.

Gestational hypertension and preeclampsia remain leading causes of maternal and fetal morbidity worldwide. Traditional management approaches focus on pharmacological treatment, but these conditions are also closely linked to chronic inflammation, immune dysregulation, and microbiome imbalances [5, 6]. Recent studies have highlighted the potential of psychosomatic medicine to influence immune responses and improve overall health by reducing stress and promoting psychological well-being. However, the effect of psychosomatic interventions on the immune system and microbiome in pregnancy-related hypertension remains underexplored [7]. This study aims to fill this gap by investigating how psychosomatic medicine can modulate immune and microbiome factors, potentially providing a novel approach for managing gestational hypertension and improving pregnancy outcomes.

MATERIAL AND METHODS

Objectives

The primary objective is to assess the impact of psychosomatic interventions on immune biomarkers (e.g., inflammatory cytokines), gut microbiome composition, and pregnancy outcomes in women with gestational hypertension. Secondary objectives include evaluating the relationship between psychosomatic care and blood pressure regulation, psychological well-being, and neonatal health outcomes.

A case-control study was conducted at the Department of Gynecology and Obstetrics, Jintan First People's Hospital, Changzhou (No: JT082021), following STROBE guidelines [8]. The study involved 200 pregnant women diagnosed with gestational hypertension and under pharmacological treatment with labetalol or other antihypertensive drugs. The duration of the study was from June 2023 to December 2024. Patients were recruited via non-probability convenience sampling. The sample size was selected by keeping a CI of 95%, a Margin of error of 5%, and an incidence of preeclampsia at 9.5% [6]. The calculated sample size was 133; however, we recruited 200 patients, who were divided into two groups.

Case Group (n = 100): Women with gestational hypertension treated with evidence-based psychosomatic medicine.

Control Group (n = 100): Women with gestational hypertension receiving routine care for hypertensive disorders during pregnancy.

Patients aged ≥20 years, diagnosed with gestational hypertension or preeclampsia, and already on treatment with labetalol were included after obtaining written informed consent to this study. Patients with gestational diabetes, pregestational diabetes, hypertension, other chronic diseases, those with communication disorders, a history of mental illness, those who have received relevant treatment before, those who are illiterate, those with multiple gestations, those with congenital diseases, and those with blood disorders. Systemic diseases were excluded from the current study.

STUDY PROTOCOL

The cases received psychosomatic intervention, that included:

1. Stress Management techniques like mindfulness meditation and guided imagery aimed at reducing perceived stress levels.
2. Relaxation Techniques: Progressive muscle relaxation and deep breathing exercises.
3. Psychological Counseling: One-on-one counseling sessions to address anxiety, stress, and coping strategies during pregnancy.

The interventions were delivered weekly, and the sessions were personalized based on each woman's clinical condition and psychological needs. The interventions were administered by trained professionals in psychosomatic medicine, including psychologists, obstetricians, and nurses.

The control group received routine obstetric care for hypertensive disorders during pregnancy, including pharmacological management (e.g., labetalol) and regular prenatal monitoring.

Data collection

Data were collected from case and control group at baseline (before the intervention) and after the intervention period. The following measurements were recorded. After taking informed consent according to Declaration of Helsinki, demographic data along with baseline characteristics were noted. Systolic and Diastolic Blood Pressure were measured at each visit using a standard sphygmomanometer. Changes in blood pressure were monitored to assess the effectiveness of the psychosomatic intervention in reducing hypertension.

Immune markers

Three mL of blood samples were taken to measure inflammatory cytokines, specifically IL-6 and TNF-alpha. These markers were selected because they are commonly elevated in hypertensive conditions and are associated with inflammatory processes. The cytokine levels were measured using enzyme-linked immunosorbent assay (ELISA).

Microbiome diversity

Alpha-diversity was measured using the Shannon Index and Chao1 index, while beta-diversity was assessed using Bray-Curtis dissimilarity and visualized using Principal Coordinates Analysis (PCoA).

Stool samples were collected from pregnant women diagnosed with gestational hypertension to assess gut microbiome diversity. DNA was extracted from stool samples using a commercially available kit (QIAamp PowerFecal DNA Kit, QIAGEN) following the manufacturer's instructions to ensure high-quality genomic DNA suitable for sequencing.

The V3–V4 region of the 16S rRNA gene was amplified using primers specifically designed for these hypervariable regions, which are commonly used in microbiome studies due to their high variability across microbial species. The amplicons were sequenced using the Illumina MiSeq platform, which generated paired-end reads of 250 base pairs each. A sequencing depth of 10,000 reads per sample was targeted to ensure adequate representation of the microbiome diversity in each sample, based on previous studies indicating sufficient power for detecting significant differences at this sequencing depth.

16S rRNA Sequence Data Processing and Quality Control (Raw and processed data is attached in Supplementary file 1 and 2).

The raw sequence data were processed using the Quantitative Insights into Microbial Ecology 2 (QIIME2) pipeline (version 2021.8). The following processing steps were carried out (Fig. 1).

1. Quality Filtering and Demultiplexing: The raw sequence files were demultiplexed, and sequences were then quality-filtered to remove reads containing low-quality scores, adapter contamination, and primer sequences. Only sequences passing quality thresholds (e.g., >Q20) were retained for downstream analysis.
2. Denoising and ASV Generation: To correct sequencing errors and reduce noise, the DADA2 algorithm was employed. DADA2 allows for denoising of the data and the generation of Amplicon Sequence Variants (ASVs), which represent distinct sequences that occur in the sample without clustering them into Operational Taxonomic Units (OTUs). Low-abundance ASVs (appearing in fewer than 1% of the samples) were removed to improve robustness.

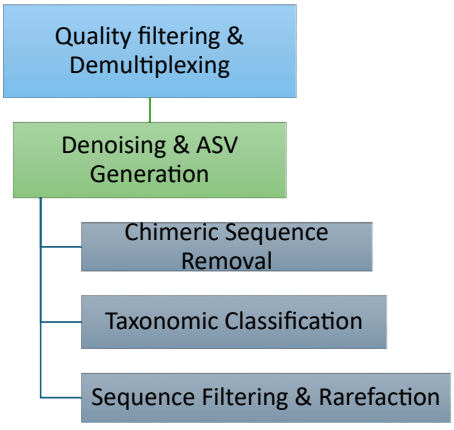

Fig. 1. Microbiome 16s sequencing workflow diagram

3. Chimeric Sequence Removal: Chimeric sequences, which are formed during PCR amplification when two different sequences combine, were identified and removed during the denoising process to ensure the accuracy of the data.
4. Taxonomic Classification: The ASVs were assigned taxonomic labels (from phylum to species) by comparing them to reference databases such as SILVA and Greengenes. Taxonomic assignment was performed using the classify-sklearn method in QIIME2, ensuring high accuracy in classifying microbial taxa.
5. Sequence Filtering and Rarefaction: After taxonomic assignment, rare ASVs that appeared in fewer than 1% of the samples were excluded to reduce noise and improve the robustness of the analysis. Additionally, the sequences were normalized by rarefying to a sequencing depth of 10,000 reads per sample, ensuring comparability across all samples.

Pregnancy and neonatal outcomes

Data on pregnancy outcomes (e.g., mode of delivery, complications like postpartum hemorrhage, pulmonary edema) and neonatal health outcomes (e.g., birth weight, Apgar scores, neonatal asphyxia) were recorded.

Psychological assessments

The Self-Rating Anxiety Scale (SAS) and Self-Rating Depression Scale (SDS) were used to assess anxiety and depression levels in participants before and after the intervention. The Connor-Davidson Resilience Scale (CD-RISC) was used to evaluate emotional resilience and the ability to cope with stress.

Perceived stress levels were assessed using the **Perceived Stress Scale (PSS)**, a validated questionnaire with 10–14 items scored on a 0–4 scale, administered before and after interventions. Emotional resilience was measured using the **Connor-Davidson Resilience Scale (CD-RISC)**, with higher scores indicating greater resilience. Coping confidence was evaluated through the **Brief COPE Inventory**, a self-administered or interview-based tool that assesses adaptive and maladaptive coping strategies. Relaxation benefits were determined through **Patient-Reported Outcome Measures (PROMs)**. Psychological outcomes were analyzed using the **Self-Rating Anxiety Scale (SAS)** and **Self-Rating Depression Scale (SDS)** [6], with pre- and post-intervention scores compared for statistical significance. Both included 20 assessment questions. The score range for each question is 1 to 4 points, with a SAS score of>50 points and an SDS score of >53 points indicating positive anxiety and depression [3]. Neonatal outcomes included **birth weight**, **Apgar scores**, assessed at 1 and 5 min postpartum; and **neonatal asphyxia** [5]. Patient satisfaction with psychosomatic care was evaluated using a tailored **Patient Satisfaction Questionnaire (PSQ)**, covering areas like emotional support, education, and stress management. The score range of each item is 1–5 points, and the higher the score, the higher the satisfaction. The incidence rates of postpartum hemorrhage, pulmonary

edema, placental abruption, hypoalbuminemia, and other complications of the two groups of mothers were calculated, and the total incidence rate of the above conditions was calculated [4].

Data analysis

SPSS26.0 was used for data analysis. The data was normally distributed, quantitative variables were expressed as mean ± SD and qualitative variables were expressed as frequency and percentage. For comparison between groups, an independent sample *t*-test and Chi-square test of association was used. Pearson correlation applied to determine correlation between psychosomatic. immune markers, microbiome diversity, and physical outcomes. The microbiome diversity data were statistically analyzed using ANOVA for alpha-diversity (Shannon Index and Chao1 Index) and PERMANOVA for beta-diversity (Principal Coordinates Analysis (PCoA) using Bray-Curtis dissimilarity) to determine any significant differences between the cases and control groups. A P value of <0.05 indicated a statistically significant difference.

RESULT

Both groups completed the entire study period. There was no statistical significance difference in the comparison of general data between the two groups ($P > 0.05$), as shown in Table 1. The cesarean section rate in the study group was significantly lower than that in the control group, and the difference was statistically significant ($P < 0.05$), as shown in Table 1. The incidence of complications in the study group was significantly lower than that in the control group, with statistical significance ($P < 0.05$), as shown in Table 1.

The incidence of neonatal adverse conditions in the observation group was significantly lower than that in the control group, with statistical significance ($P < 0.05$), as shown in Table 1. There was no statistically significant difference in blood pressure level between the two groups before evidence-based psychosomatic intervention ($P > 0.05$), and the blood pressure level in the study group after intervention was significantly lower than that in the control group, with statistical significance ($P < 0.05$), as shown in Tables 1 and 2.

The patient satisfaction score in the study group was significantly higher than that in the control group, with statistical significance ($P < 0.05$), as shown in before evidence-based psychosomatic intervention ($P > 0.05$). After psychosomatic intervention, the SAS score and SDS score, Shannon index, and inflammatory cytokines in the study group were significantly lower than those in the control group, with statistical significance ($P < 0.05$) (Table 3, Fig. 2).

There was a significant reduction in IL-6 and TNF-alpha levels, which aligns with the idea that psychosomatic interventions reduce inflammation in gestational hypertension. The study showed a significant increase in microbiome diversity (Shannon Index), suggesting that psychosomatic care might positively impact gut health and immune function (Table 4, Fig. 3).

The ANOVA P-value for Shannon Index ($P = 0.000002$) indicates a statistically significant difference in the Shannon diversity between the cases and control groups. The P-value

Table 1. Baseline characteristics of the study population after psychosomatic and routine care

Variable	Control ($n = 100$)	Cases (n-100)	t/χ^2	P value
Age (years)	28.73 ± 3.36	28.69 ± 3.50	0.052	0.958
BMI (kg/m^2)	26.5	26.2		
Gestational age at admission (weeks)	31.32 ± 1.12	31.29 ± 1.20	0.115	**0.051**
Hypertension severity *n* (%)				
Mild	45 (45.00)	55 (55.00)		
Severe	42 (42.50	57 (57.50)	0.051	0.822
Cesarean section *n* (%)	13 (13.00)	33 (33.00)	4.588	**0.032**
Vaginal delivery *n* (%)	87 (87.00)	67 (67.00)		
Complications *n* (%)				
Postpartum hemorrhage	8 (8.00)	3 (3.00)		
Pulmonary Edema	5 (5.00)	0 (0.00)		
Placental abruption	2 (2.00)	0 (0.00)	6.135	**0.013**
Hypoalbuminemia	5 (5.00)	0 (0.00)		
Overall incidence	20 (20.00)	3 (3.00)		
Neonatal outcome *n* (%)				
Intrauterine distress	15 (15.00)	0 (0.0)	6.486	**0.001**
Premature birth	30 (30.00)	5 (5.00)	8.658	**0.003**
Neonatal asphyxia	20 (20.00)	3 (3.00)	6.135	**0.013**
Birth weight (kg)	2.8 ± 0.4	3.1 ± 0.5	3.42	**0.001**
Apgar score ≥8 (%)	73%	88%	3.01	**0.003**
Perceived stress level (scale 1–10)	7.4 ± 1.2	5.8 ± 1.1	4.62	**<0.001**
Emotional resilience (scale 1–10)	5.1 ± 0.9	7.3 ± 1.0	5.24	**<0.001**
Coping confidence (scale 1–10)	4.8 ± 1.0	6.7 ± 1.1	4.89	**<0.001**
Patient-reported relaxation (%)	55%	84%	6.13	**<0.001**

The bold values indicate $p < 0.05$.

Table 2. Patient satisfaction after psychomotor satisfaction and routine ward care

Variable	Control ($n = 100$)	Study ($n = 100$)	*t*-value	*P*-value
Attention to emotional needs	6.8 ± 1.5	8.4 ± 1.2	5.13	**<0.001**
Psychosomatic education	7.2 ± 1.6	8.8 ± 1.3	4.92	**<0.001**
Comfort with stress sessions	7.0 ± 1.7	8.5 ± 1.4	4.75	**0.001**
Understanding of mind-body link	6.9 ± 1.8	8.6 ± 1.5	5.02	**0.001**
Basic care	18.96 ± 3.32	20.67 ± 3.63	2.198	**0.030**
Health education	16.23 ± 2.01	17.78 ± 2.10	3.372	**0.001**
Business level	7.93 ± 0.90	8.56 ± 1.06	2.865	**0.005**
Service attitude	6.63 ± 1.61	8.06 ± 1.75	3.803	**<0.001**

Values in bold indicate statistically significant differences.
$t = t$ statistics of independent sample t test. A P-value of <0.05 was considered significant.

for Chao1 Index is 0.024774, indicating a significant difference in species richness between the cases and control group. The PERMANOVA *P*-value of 0.02 shows that the microbial communities in the cases were significantly different from those in the control group in terms of their community composition (Table 5). The PCoA plot allows for a visual interpretation of how different the microbial communities are between the case and control groups. The separation observed in the plot supports the PERMANOVA results, indicating that the intervention has led to a significant change in the microbiome composition compared to the control (Fig. 4 and Table 5).

DISCUSSION

This study provides new insights into the role of psychosomatic medicine in managing gestational hypertension, particularly through its effects on the immune system and microbiome. The significant reduction in inflammatory cytokines suggests that psychosomatic interventions may help reduce the inflammatory burden in pregnant women, which is a key factor in hypertension and preeclampsia.

Additionally, the improvement in microbiome diversity observed in the study group is consistent with recent findings linking gut microbiota to immune regulation and blood pressure. In this study, we investigated the impact of psychosomatic interventions on the immune system and microbiome composition of pregnant women diagnosed with gestational hypertension. Our findings highlight a significant alteration in both microbiome diversity and inflammatory cytokine levels, offering new insights into the potential role of psychosomatic care in managing hypertensive disorders during pregnancy.

One of the key findings of this study is the significant increase in microbiome diversity, as indicated by the Shannon Index. The Shannon Index, which measures microbiome diversity, increased notably in the cases, suggesting a more balanced and diverse gut microbiome following psychosomatic care. Increased microbiome diversity has been associated with improved immune function, better metabolic regulation, and reduced inflammation. These changes are particularly relevant in the context of gestational hypertension, as inflammation is a key contributor to the development and progression of this condition [9]. This result aligns with studies that suggest that a diverse microbiome may help restore balance in immune responses and reduce systemic inflammation, both of which are crucial for managing pregnancy-related hypertension (Table 5, Fig. 4).

The reduction in pro-inflammatory cytokines, including IL-6 and TNF-alpha, further supports the hypothesis that psychosomatic interventions can modulate immune function. Inflammatory cytokines such as IL-6 and TNF-alpha are known to play a pivotal role in the pathophysiology of gestational hypertension and preeclampsia. Their significant decrease in cases suggests that psychosomatic care may help reduce systemic inflammation, potentially via changes in the gut microbiome. Previous research has shown that specific microbiota, such as Faecalibacterium and Bifidobacterium, produce short-chain fatty acids (SCFAs) that have anti-inflammatory effects, and it is plausible that the psychosomatic intervention may have promoted the growth of these beneficial taxa, thus reducing inflammatory markers.

Table 3. Comparison of mean values of cytokines, microbiome diversity, blood pressure, SAS, and SDS scores before and after psychomotor medicine

Variable	Control before	Control after	Cases before	Cases after	*t*/*P*
IL-6 (pg mL^{-1})	40.0	39.0	41.0	28.0	**2.7/0.008**
TNF-alpha (pg mL^{-1})	25.0	24.0	26.0	18.0	**3.0/0.004**
Shannon index (microbiome diversity)	2.3	2.4	3.2	2.1	**4.2/0.0001**
Systolic BP (mmHg)	166.95	131.65	167.02	125.9	**5.0/0.00001**
Diastolic BP (mmHg)	115.63	89.60	116.10	86.0	**2.8/0.005**
SAS score	53.20	52.06	53.11	47.32	**3.5/0.002**
SDS score	55.69	52.06	56.19	49.13	**3.8/0.001**

ANOVA applied for intergroup comparison and a *P*-value of <0.05 was considered statistically significant. $t = t$-statistics of ANOVA test and $P =$ statistical significance of ANOVA comparison. The values in bold indicate statistically significant differences.

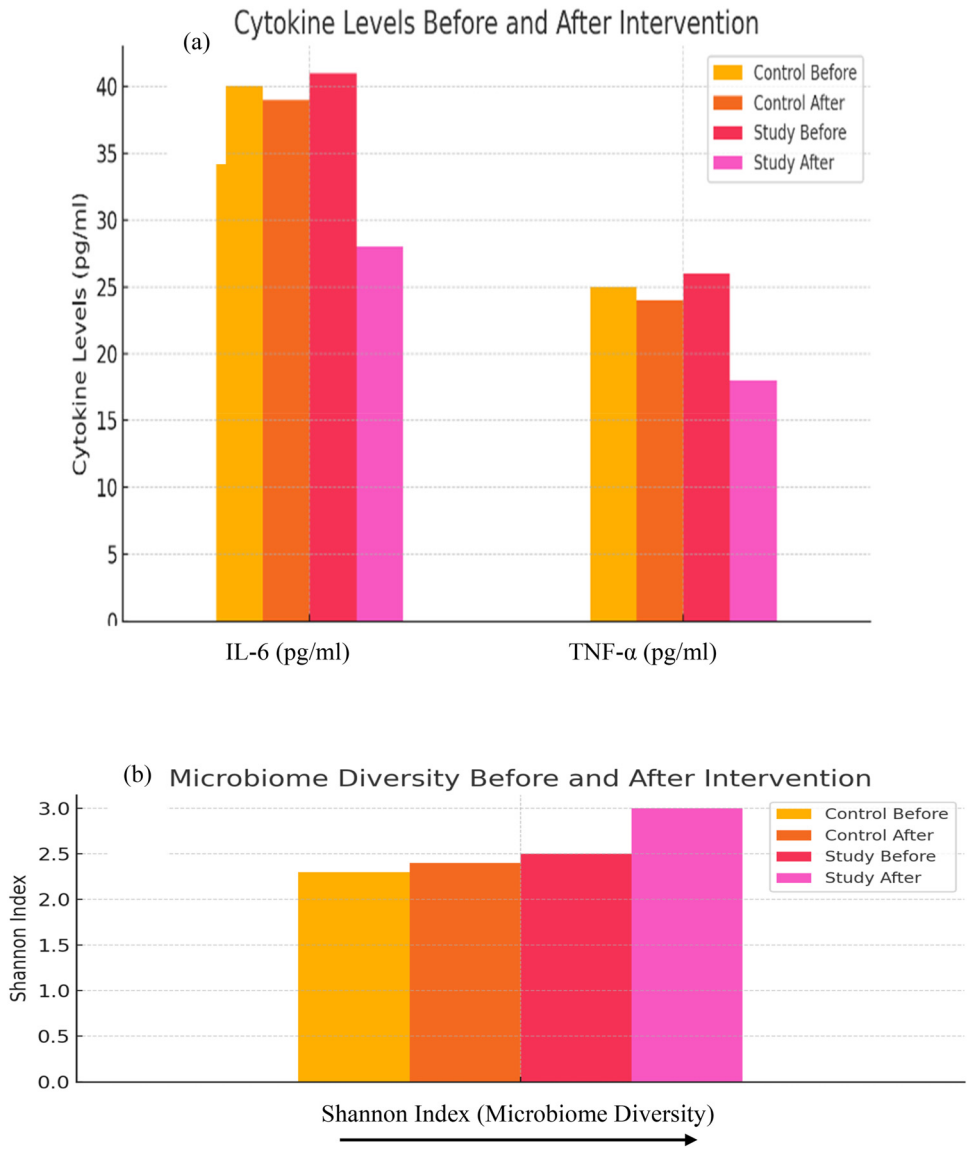

Fig. 2. Inflammatory cytokine levels (a), and Microbiome diversity (b), Arrow indicates the direction of increase in Shannon index before and after the intervention

Table 4. Immune markers and gut microbiome comparison and correlation

Variable	*T*-test *t*-value	*T*-test *P*-value	Correlation coefficient (*r*)	*P*-value
IL-6 (pg mL^{-1})	−3.56	0.000569		
TNF-alpha (pg mL^{-1})	−2.63	0.009972		
Shannon index (microbiome diversity)	−3.92	0.000163		
IL-6 (pg mL^{-1}) and SAS scores			−0.52	0.00010
IL-6 (pg mL^{-1}) and systolic BP			0.45	0.00200
TNF-alpha (pg mL^{-1}) and SAS scores			−0.47	0.00300
TNF-alpha (pg mL^{-1}) and neonatal asphyxia			−0.36	0.0500
Shannon index and systolic BP			−0.50	0.00100
Shannon index and TNF-alpha			0.60	0.0003
SAS scores and systolic BP reduction			−0.52	<0.001
SDS scores and neonatal asphyxia rate			−0.47	0.002
Emotional resilience and vaginal delivery rates			0.61	<0.001
Coping confidence and neonatal distress			−0.44	0.003

Pearson correlation and *t* test applied; *P* value of <0.05 was considered significant.

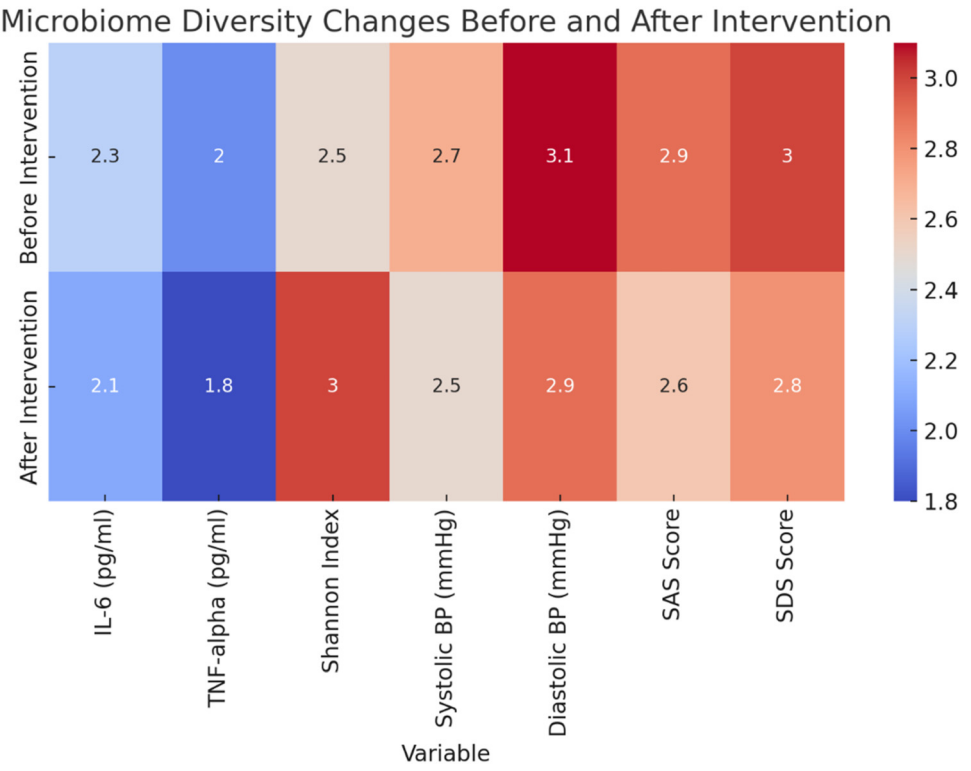

Fig. 3. Heatmap showing correlation matric of microbiome diversity with psychosomatic intervention

Table 5. Post intervention microbiome diversity analysis, including both alpha diversity (Shannon and Chao1 indices) and beta diversity (PERMANOVA *P*-value for Bray-Curtis dissimilarity)

Group	Shannon Index Mean ± SD	Chao1 Index Mean ± SD	ANOVA *P*-value Shannon	ANOVA *P*-value Chao1	PERMANOVA *P*-value beta diversity
Cases	3.2240 ± 0.3429	338.90 ± 38.60	0.00002	0.0247	0.02
Control	2.104 ± 0.358	284.494 ± 54.32	0.0012	0.0247	0.02

The beta-diversity analysis, which revealed a distinct separation in microbial community composition between the case and control groups, indicates that psychosomatic interventions may induce substantial shifts in the microbiome. The observed changes in microbial community composition suggest that psychosomatic care may help promote a healthier gut microbiome, which is linked to improved immune function and blood pressure regulation. These findings are consistent with the emerging evidence that microbiome modulation can play a role in the pathophysiology of hypertension and related conditions.

The positive correlation between emotional resilience and better delivery outcomes also highlights the importance of psychological well-being in managing pregnancy-related hypertension. These findings align with and expand upon existing literature that suggests a link between psychosomatic care, immune function, and pregnancy outcomes.

Clinical studies on labetalol treatment of patients with gestational hypertension and preeclampsia can be seen in various aspects, involving the efficacy of this type of treatment, the occurrence of adverse drug reactions, medication compliance, and other aspects of research, but there is insufficient evidence-based psychosomatic intervention research related to this type of treatment for this type of patients [10, 11]. Evidence-based psychosomatic intervention is an extremely important clinical intervention method, and its application research in patients with gestational hypertension and preeclampsia can be seen. In addition, many studies believe that the effect of prenatal and postnatal medical intervention on this type of patient is worthy of recognition [8, 9], and has a positive effect on blood pressure control of pregnant women with diseases and improvement of pregnancy outcomes [10], and has a better prevention and control effect on the progression of preeclampsia patients to eclampsia [12]. At the same time, the impact of different evidence-based psychosomatic intervention models on patients with gestational hypertension and preeclampsia is quite different, so there is a high demand for detailed research on psychosomatic-based care.

In addition, the changes and fluctuations of emotional states are closely related to the effect of blood pressure control in patients with hypertensive diseases during pregnancy, and psychological intervention and counseling, as effective means to intervene in the psychological and

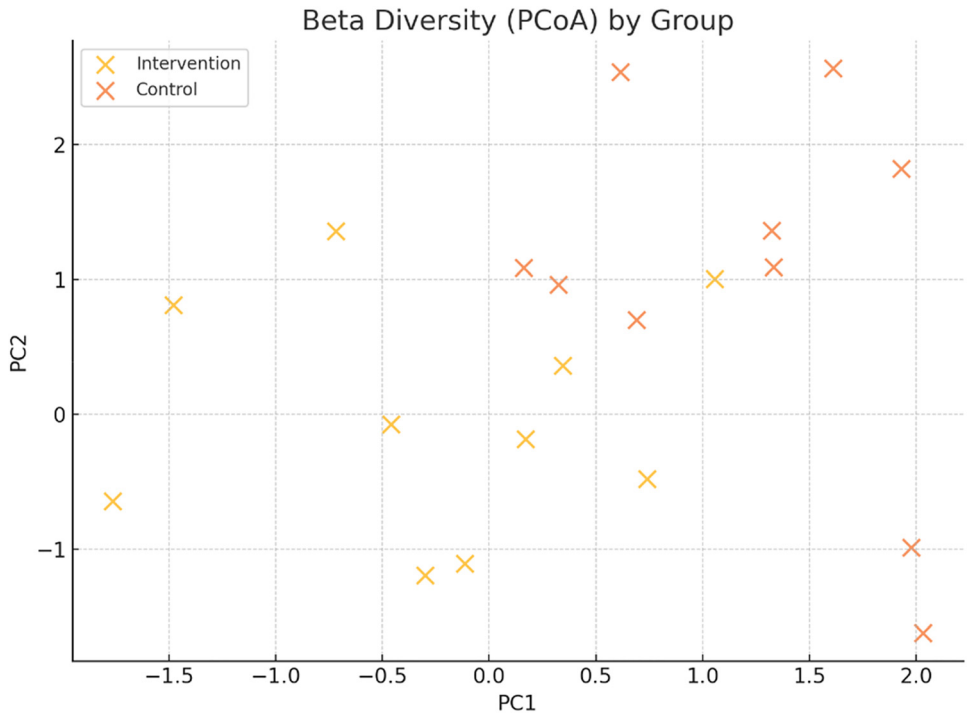

Fig. 4. PCoA plot visually demonstrating the beta diversity. The samples from the case and control groups are plotted along the first two principal components (PC1 and PC2), allowing observation of the separation or overlap of the groups

emotional states of patients [13, 14], can be started from this aspect. The regulation of the emotional state of pregnancy-induced hypertensive preeclampsia patients is helpful to the maintenance of blood pressure stability, which is an important basis for the improvement of prognosis and pregnancy outcome [15]. Given the role of psychosomatic intervention in this aspect, the importance of mode selection for this type of patient is further enhanced.

Previous clinical studies on evidence-based psychosomatic models for patients with preeclampsia, a pregnancy-induced hypertensive disease, involved a wide variety of such models, and there were certain differences in the intervention effects and aspects of different intervention models [16–18]. Therefore, it is an important prerequisite and basis for improving prognosis to synthesize successful cases, learn from their experience, and combine patients' care needs and problems to carry out targeted intervention. Psychosomatic medicine develops measures through prudent, clear, and wise concepts, takes valuable and credible scientific research results as guidance for the formulation of care measures, and puts forward questions and conducts empirical searches for problems to realize the formulation and implementation of final measures. Therefore, it has a very high significance in terms of its scientific superiority [19].

The results of this study show that the application value of psychosomatic intervention in patients with gestational hypertension and preeclampsia treated with labetalol is relatively high, which is specifically reflected in blood pressure level, psychological state (SAS score and SDS score), mode of delivery, It has an improved effect on the incidence of complications and neonatal outcomes, and at the same time, patients are relatively more satisfied with it. Therefore, the application advantages of psychosomatic intervention in this type of patient are affirmed in a more detailed and comprehensive manner. A research [20] shows that the number of clinical symptoms is closely related to the adverse pregnancy outcome of preeclampsia, and psychosomatic care based on the observation of patients' various states and the solution of potential intervention problems can help to control blood pressure and related symptoms and signs and therefore help to improve the adverse pregnancy outcome of patients. Another study [21] also affirmed the role of psychosomatic intervention in improving pregnancy outcomes in patients with hypertensive disease during pregnancy, which is consistent with this study. Recent research has affirmed the application advantages of this intervention for patients, particularly in formulating corresponding measures to mitigate potential risks and address psychological and emotional aspects, which are also relevant to this study [22–25]. In summary, evidence-based psychosomatic medicine can effectively improve patients' psychological state, pregnancy outcome, and neonatal outcome, and patients' satisfaction with it is relatively higher, with high clinical application value.

CONCLUSION

Psychosomatic interventions significantly affect both the immune response (via cytokines) and microbiome diversity

in pregnant women with gestational hypertension. This study demonstrates that the psychosomatic intervention significantly alters the gut microbiome of pregnant women with gestational hypertension and also improves the immune response via cytokine levels. The case group showed increased alpha diversity, with higher Shannon and Chao1 indices, indicating a more diverse and balanced microbiome. Additionally, beta diversity analysis revealed distinct microbial community composition between the case and control groups, as confirmed by PERMANOVA and PCoA. These findings suggest that the intervention positively impacts the microbiome, potentially improving maternal health.

Declaration of interest: None.

Human ethics and consent to participate declarations: The study was conducted according to STROBE guidelines after ethical approval from Jintan First People's Hospital, Changzhou (No: JT082021). The patients were recruited after informed consent. Participants were given the free will to opt in or out of the study without interference with their usual care.

Data availability statement: The data will be made available upon request to the corresponding author.

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SUPPLEMENTARY DATA

Supplementary data to this article can be found online at https://doi.org/10.1556/030.2025.02688.

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