

Original Article

Effect of aerobic exercise combined with systematic nursing on psychological status and pregnancy outcomes in patients with gestational hypertension

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Abstract: Objective: To assess the effectiveness of aerobic exercise combined with systematic nursing care on the psychological well-being and pregnancy outcomes of patients with gestational hypertension. Methods: A study was conducted on 200 patients with gestational hypertension treated from May 2023 to May 2024. Patients were assigned to an observation group (n=110), which received aerobic exercise and systematic nursing care, or a control group (n=90), which received standard care. Both groups were monitored until delivery. Pre- and post-intervention comparisons included scores for negative emotions, blood pressure, pregnancy outcomes, neonatal weight, Apgar scores, delivery methods, and patient satisfaction with nursing care. The systolic-to-diastolic peak (S/D) ratio in umbilical blood flow and heat shock protein 70 (HSP70) levels were analyzed, with ROC analysis used to evaluate their predictive value for adverse pregnancy outcomes. Logistic regression was employed to identify independent risk factors for low Apgar scores in neonates. Results: Following the intervention, the observation group showed significantly better blood pressure control and greater reductions in negative emotions compared to the control group (both $P<0.05$). The incidence of adverse pregnancy outcomes was significantly lower, and the rate of vaginal delivery was higher in the observation group (both $P<0.05$). Patients with adverse outcomes had significantly elevated S/D ratios and serum HSP70 levels (both $P<0.05$). The area under the ROC curve (AUC) for predicting pregnancy outcomes was 0.733 for the S/D ratio, 0.817 for HSP70, and 0.916 when combined, indicating strong predictive value. Neonates in the observation group had higher birth weights and Apgar scores (both $P<0.05$). Patient satisfaction with nursing care was also significantly higher in the observation group ($P<0.05$). Conclusion: Combining aerobic exercise with systematic nursing care is effective in improving psychological health, pregnancy outcomes, quality of life, and patient satisfaction in patients with gestational hypertension.

Keywords: Aerobic exercise, systematic nursing care, gestational hypertension, psychological status, pregnancy outcomes

Introduction

Gestational hypertension is a common obstetric condition associated with factors such as malnutrition, placental ischemia, and genetic predisposition. Clinically, it manifests as elevated blood pressure, generalized edema, and proteinuria, with severe cases potentially progressing to coma, convulsions, and cardiopulmonary dysfunction, posing significant risks to

both mother and fetus [1]. The prevalence of hypertension during pregnancy ranges from 5% to 12%, encompassing conditions such as gestational hypertension, preeclampsia-eclampsia, chronic hypertension with superimposed preeclampsia, and pregnancy complicated by chronic hypertension [2].

Hypertension during pregnancy can adversely affect the mother's brain, kidneys, liver, cardio-

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vascular, endocrine, and metabolic systems. It can also result in decreased placental perfusion due to inadequate remodeling of the uterine spiral arteries, leading to insufficient blood and oxygen supply to the placenta and impaired placental function. This can cause fetal growth restriction, intrauterine distress, therapeutic preterm birth, and even maternal and fetal mortality [3]. Additionally, many patients lack awareness and understanding of gestational hypertension, leading to anxiety and depression, which may further elevate blood pressure, cause heart rate instability, and worsen the condition [4].

Research indicates that alongside effective pharmacological treatment, appropriate interventions such as aerobic exercise and lifestyle modifications can improve the physical and mental well-being of patients with gestational hypertension. These measures help build confidence and determination to manage the condition, thus reducing the incidence of adverse pregnancy outcomes like postpartum hemorrhage, neonatal asphyxia, and eclampsia [5]. However, traditional nursing care often falls short in addressing the anxiety, unease, and depression experienced by pregnant women. The professionalism and attitude of nursing staff are crucial for achieving optimal outcomes [6].

Systematic nursing intervention, a modern patient-centered approach, provides comprehensive care tailored to patients' needs and has been increasingly applied to conditions such as asthma, essential hypertension, and cardiovascular diseases [7]. It encompasses not only treatment and symptom management but also psychological support, health education, and overall well-being, leading to more organized and efficient nursing practices. This approach improves patient outcomes and quality of life [8]. Previous studies have shown that applying systematic nursing to pregnant women enhances pregnancy outcomes [9], but its impact on gestational hypertension specifically has not been analyzed.

In addition to nursing, the patient's ability to self-manage is also critical. Moderate aerobic exercise can improve circulation and metabolism, while relaxation training can enhance quality of life and alleviate anxiety and depression symptoms [10]. Prior research [11] has demonstrated that even basic exercise inter-

ventions can effectively reduce the risk of gestational hypertension. Currently, no studies have evaluated the combined effect of systematic nursing and aerobic exercise on improving psychological status and pregnancy outcomes in patients with gestational hypertension. This study aims to investigate the impact of aerobic exercise combined with systematic nursing care on these outcomes, as reported below.

Materials and methods

Clinical data

A study was conducted on 200 patients with gestational hypertension admitted to Gansu Province Maternal and Child Health Hospital from May 2023 to May 2024. The observation group included 110 patients who received aerobic exercise combined with systematic nursing, while the control group consisted of 90 patients who received conventional nursing care. This study was approved by the Ethics Committee of Gansu Province Maternal and Child Health Hospital and complied with the Declaration of Helsinki. The experimental design is shown in **Figure 1**.

Inclusion Criteria: (1) Patients meeting the diagnostic criteria for gestational hypertension through comprehensive examination; (2) Patients with complete clinical data.

Exclusion Criteria: (1) Patients with primary hypertension; (2) Patients with psychiatric disorders or communication barriers; (3) Patients with severe hepatic or renal dysfunction or malignant tumors; (4) Patients with other infectious or autoimmune diseases.

Nursing interventions

The control group received standard nursing care, which involved informing patients about hospital regulations and explaining the etiology, symptoms, treatment options, and potential complications of gestational hypertension syndrome. Regular monitoring of temperature, blood pressure, and fetal heart rate was performed. The duration of care lasted three months.

The observation group received systematic nursing combined with aerobic exercise, for a three month period, which including the following components:

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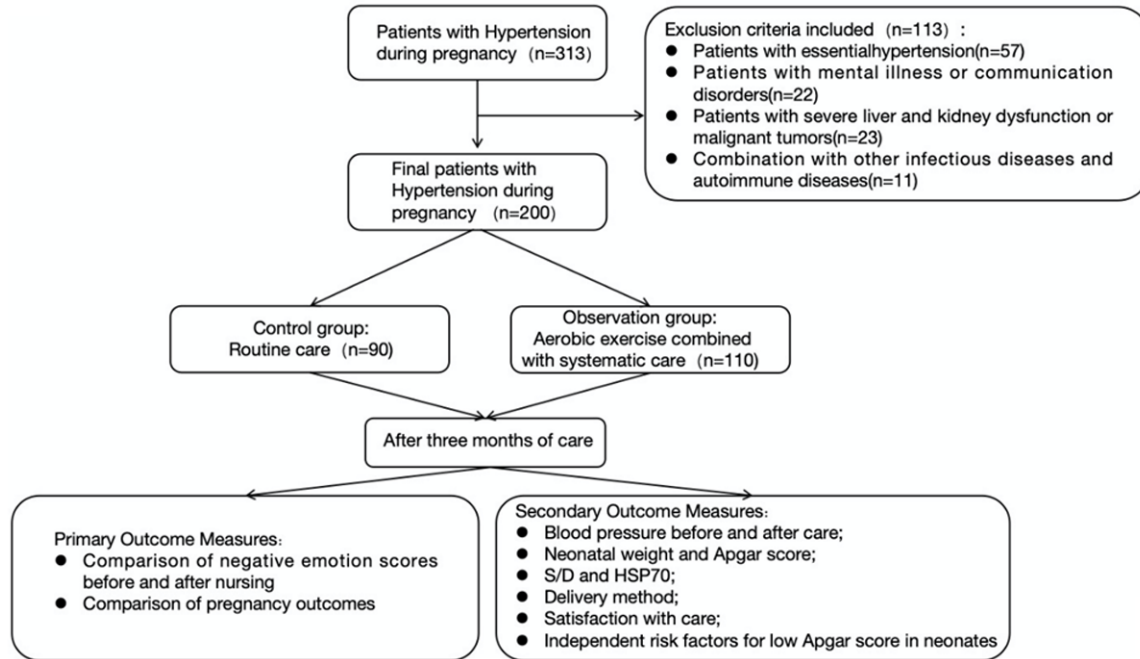


Figure 1. Experimental design.

Psychological Care [12]: Nurses enhanced communication to address patients' limited understanding of the condition, which often led to excessive worry and anxiety. They listened to patient concerns, assessed psychological states, and provided individualized guidance. Emotional distraction techniques, such as meditation, music therapy, or yoga, were encouraged. Nurses corrected misconceptions about gestational hypertension (PIH) and offered daily life guidelines to stabilize mental states through proper lifestyle behaviors.

Dietary Guidance [13]: Patients were educated on maintaining a balanced diet. For those with significant edema, daily salt intake was restricted to approximately 3 grams. A diet rich in easily digestible, high-protein foods was encouraged.

Positional Guidance [14]: Patients were advised to rest for at least 10 continuous hours in bed and ensure adequate sleep each night. For sleeping, the left lateral position was recommended to reduce pressure on the abdominal aorta and inferior vena cava, promoting venous return and sufficient uteroplacental blood supply, thus helping prevent placental abruption.

Medication Guidance: Patients were instructed to adhere strictly to their medication regimen.

Nurses monitored medication effects, any adverse reactions, and changes in symptoms such as proteinuria, blood pressure, and edema.

Moderate Aerobic Exercise [15]: Patients underwent trial walking exercises to establish their heart rate reserve. The resting heart rate was measured, and the exercising heart rate range was calculated to ensure a moderate intensity (target heart rate: 100-120 beats per minute with smooth breathing, without dyspnea or palpitations). Patients self-monitored their heart rate to regulate the intensity and pace of walking. Aerobic exercise was performed daily, with each session lasting 30 minutes.

Primary outcome measures: Anxiety and Depression: Anxiety and depression levels in both groups were assessed using the Self-Rating Anxiety Scale (SAS) and Self-Rating Depression Scale (SDS) [16]. Each scale contains 20 items, scored from 1 to 4. The standard score is calculated as the sum of item scores multiplied by 1.25, rounded to the nearest integer. Threshold scores are 50 for SAS and 53 for SDS, with higher scores indicating more severe symptoms.

Pregnancy Outcomes: The incidence of adverse pregnancy outcomes, including eclampsia, pre-

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term birth, placental abruption, and postpartum hemorrhage, was recorded and compared between the two groups.

Secondary outcome measures: Blood Pressure: Systolic and diastolic blood pressure measurements were compared between the groups before and one month after the nursing intervention.

Umbilical Blood Flow and heat shock protein 70 (HSP70): The ratio of the end-systolic peak (S) to the end-diastolic peak (D) in umbilical blood flow was evaluated in combination with HSP70 levels. ROC analysis was performed to assess the predictive value of the S/D ratio and HSP70 for adverse pregnancy outcomes.

Neonatal Birth Weight and Apgar Scores [17]: Neonatal birth weight and Apgar scores were compared. Apgar scores range from 0 to 10, with scores of 8-10 considered normal, 4-7 indicating mild asphyxia, and 0-3 indicating severe asphyxia.

Delivery Methods: The modes of delivery, including spontaneous vaginal delivery, assisted vaginal delivery, and cesarean section, were compared between the groups.

Patient Satisfaction: A self-designed questionnaire assessed patient satisfaction with nursing care, categorized into three levels: satisfied, generally satisfied, and dissatisfied.

Statistical methods

Statistical analyses were conducted using SPSS 19.0 software. Categorical data were expressed as numbers and percentages (%) and analyzed using the χ^2 test. Continuous data were presented as mean \pm standard deviation (SD), with comparisons between groups made using independent t-tests. Paired t-tests were used for within-group comparisons before and after the intervention. Post-hoc analyses were performed using LSD/t-tests. A *P*-value <0.05 was considered statistically significant.

Results

Comparison of general data

There were no significant differences in age, BMI, gravidity, parity, amniotic fluid depth at

admission, fetal position, or proportion of assisted vaginal deliveries between the observation and control groups (all $P>0.05$). The rate of natural deliveries was significantly higher in the observation group (58.18%) compared to the control group (30%), while the rate of cesarean sections was significantly lower in the observation group (16.36%) compared to the control group (50%) ($P<0.05$). The incidence of adverse pregnancy outcomes was notably lower in the observation group (19.09%) than in the control group (47.78%) ($P<0.05$). Nursing satisfaction was also significantly higher in the observation group (98.18%) than in the control group (76.67%) ($P<0.05$). See **Table 1**.

Comparison of adverse emotion scores before and after nursing intervention

The SAS and SDS scales were used to assess negative emotions before and after the nursing intervention. There were no significant differences in SAS and SDS scores between the two groups prior to the intervention (both $P>0.05$). Following the intervention, both groups showed significant improvements in negative emotion scores, with the observation group exhibiting a greater reduction compared to the control group (both $P<0.05$). See **Figure 2**.

Comparison of blood pressure before and after nursing intervention

After the nursing intervention, the systolic and diastolic blood pressures in the observation group were 115.59 ± 2.44 mmHg and 76.16 ± 2.4 mmHg, respectively, showing significant improvements from pre-intervention levels. In contrast, the control group's post-intervention blood pressure values were 128.43 ± 2.64 mmHg (systolic) and 84.37 ± 2.33 mmHg (diastolic), which were significantly higher than those of the observation group (both $P<0.05$). See **Figure 3**.

Comparison of neonatal birth weight and Apgar scores

Neonatal birth weight and Apgar scores in the observation group were 3.56 ± 0.49 kg and 6.57 ± 0.82 points, respectively, which were significantly higher than those in the control group (2.58 ± 0.54 kg and 6.28 ± 0.66 points) (both $P<0.05$). See **Figure 4**.

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Table 1. Comparison of general data

Factor	Observation Group n=110	Control group n=90	χ^2	P
Age			0.126	0.772
≤ 30	51 (46.36)	44 (48.89)		
> 30	59 (53.64)	46 (51.11)		
BMI (kg/m ²)			0.410	0.522
≤ 23	50 (45.45)	45 (50.00)		
> 23	60 (54.55)	45 (50.00)		
Number of pregnancies			0.002	0.964
≤ 1	73 (66.36)	60 (66.67)		
> 1	37 (33.64)	30 (33.33)		
Number of births			0.099	0.754
≤ 1	86 (78.18)	72 (80.00)		
> 1	24 (21.82)	18 (20.00)		
Amniotic fluid depth (cm)			0.137	0.711
≤ 2	57 (51.82)	49 (54.44)		
> 2	53 (48.18)	41 (45.56)		
Fetal position			0.588	0.746
Head position	61 (55.45)	54 (60.00)		
Breech position	25 (22.73)	20 (22.22)		
Other	24 (21.82)	16 (17.78)		
Delivery Methods				
Natural deliveries	64 (58.18)	27 (30.00)	15.85	0.003
Assisted vaginal deliveries	28 (25.45)	18 (20.00)	0.832	0.362
Cesarean sections	18 (16.36)	45 (50.00)	25.96	< 0.001
The incidence of adverse pregnancy outcomes	21 (19.09)	43 (47.78)	18.72	< 0.001
Eclampsia	8 (7.27)	15 (16.67)	-	-
Preterm birth	8 (6.67)	12 (13.33)	-	-
Placental abruption	5 (4.55)	11 (12.23)	-	-
Postpartum hemorrhage	0	5 (4.55)	-	-
Nursing satisfaction	108 (98.18)	69 (76.67)	22.51	< 0.001
Eclampsia	8 (7.27)	15 (16.67)	-	-
Preterm birth	8 (6.67)	12 (13.33)	-	-
Placental abruption	5 (4.55)	11 (12.23)	-	-
Postpartum hemorrhage	0	5 (4.55)	-	-

Comparison of S/D ratio and HSP70 levels in patients with different pregnancy outcomes

Patients were divided into a normal pregnancy group (n=136) and an adverse pregnancy group (n=64) based on the presence of adverse pregnancy outcomes (**Table 1**). The adverse pregnancy group had significantly higher S/D ratios and serum HSP70 levels during pregnancy (3.75 ± 0.6 and 2.83 ± 0.6 , respectively) compared to the normal pregnancy group (3.25 ± 0.7 and 1.94 ± 0.73) (both $P < 0.05$). See **Figure 5**.

Analysis of predictive value of S/D ratio and HSP70 level for pregnancy outcomes

ROC analysis was performed on the S/D ratio and HSP70 levels for predicting pregnancy outcomes. The AUC for the S/D ratio and HSP70 was 0.733 and 0.817, respectively. However, combining the S/D ratio with serum HSP70 yielded a higher AUC of 0.916 for predicting adverse pregnancy outcomes in patients with gestational hypertension, indicating superior predictive accuracy compared to individual markers. See **Figure 6**.

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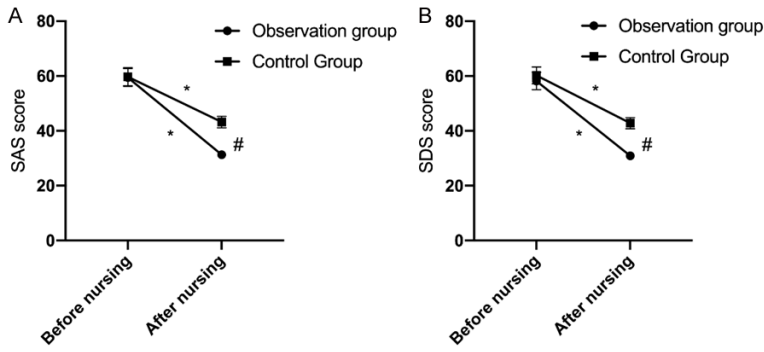


Figure 2. Comparison of negative emotion scores between the two groups. A: Comparison of SAS scores. B: Comparison of SDS scores. Note: * indicates a significant difference within the group before and after intervention ($P < 0.05$); # indicates a significant difference between groups after intervention ($P < 0.05$).

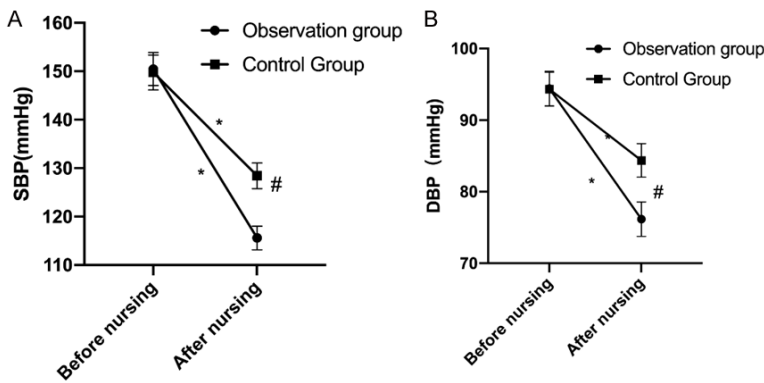


Figure 3. Comparison of blood pressure before and after nursing intervention in both groups. A: Comparison of systolic blood pressure. B: Comparison of diastolic blood pressure. Note: * indicates a significant difference within the group before and after intervention ($P < 0.05$); # indicates a significant difference between groups after intervention ($P < 0.05$).

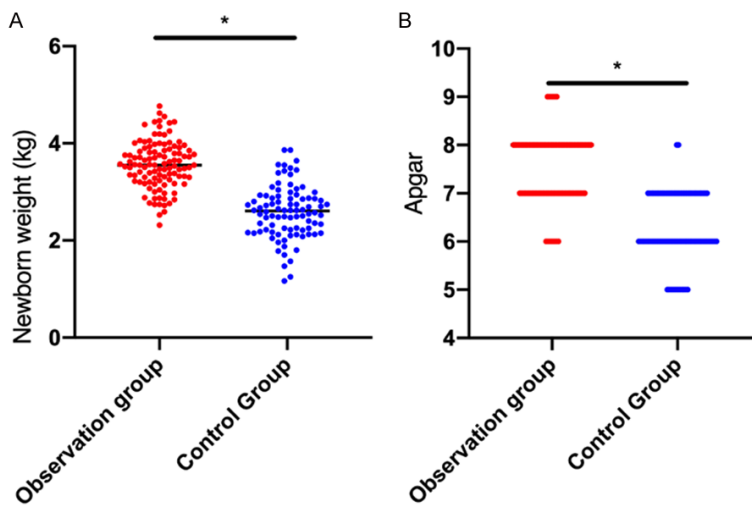


Figure 4. Comparison of neonatal birth weight and Apgar scores between the two groups. A: Comparison of neonatal birth weight. B: Comparison of neonatal Apgar scores. Note: * indicates $P < 0.05$.

Discussion

Hypertensive disorders during pregnancy commonly present with symptoms such as fundus changes, hypertension, and proteinuria, with severe cases potentially progressing to eclampsia, posing significant risks to maternal and fetal health. Many patients lack sufficient knowledge about these conditions, leading to anxiety regarding disease progression and fetal well-being. This anxiety can result in poor sleep, low mood, and other symptoms that negatively impact treatment outcomes. These emotional factors can cause significant fluctuations in blood pressure, exacerbating the condition and increasing the risk of mortality [18, 19]. Therefore, in addition to active symptom management, nursing interventions play a crucial role in alleviating negative emotions and regulating blood pressure, highlighting their substantial clinical importance. However, traditional nursing approaches are relatively limited and often fail to provide comprehensive, individualized care, leading to suboptimal outcomes. This study compared the effects of traditional nursing with a systematic nursing model combined with aerobic exercise in patients with gestational hypertension.

The results of this study demonstrate that systematic nursing combined with aerobic exercise effectively reduces anxiety and depression in patients with gestational hypertension, while also improving blood pressure control. This may be due to the fact that patients with gestational hypertension often experience significant

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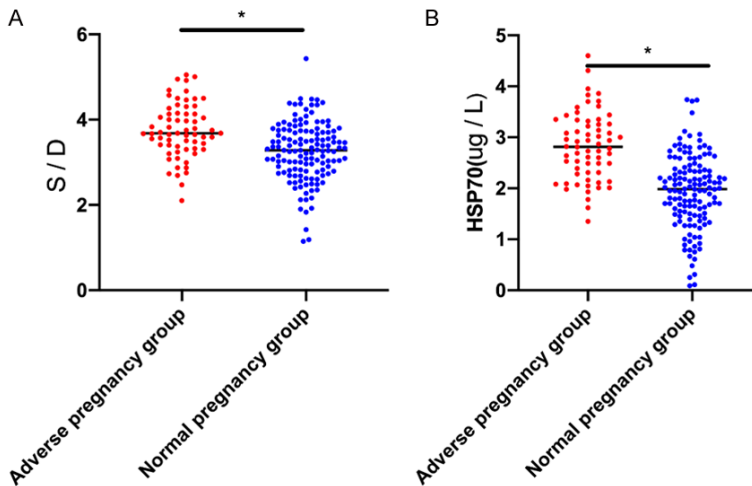


Figure 5. Comparison of S/D ratio and HSP70 in patients with different pregnancy outcomes. A: Comparison of S/D ratio. B: Comparison of HSP70 level. * indicates $P < 0.05$.

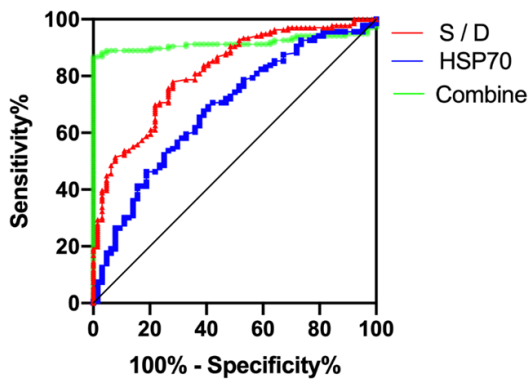


Figure 6. Analysis of the predictive value of S/D ratio and HSP70 level for pregnancy outcomes.

anxiety and stress because of a lack of understanding about their condition and concerns over medication use. Such emotional disturbances can significantly influence blood pressure, worsening the condition and creating a vicious cycle that negatively affects disease prognosis and pregnancy outcomes [20, 21]. In contrast, the traditional nursing model provides less targeted support for mental health, making it difficult to alleviate anxiety and depression effectively.

In the observation group of this study, systematic nursing interventions included targeted health education to enhance patients' understanding of the disease and alleviate fears, thus promoting relaxation, a positive outlook, and better adherence to treatment. The nurs-

ing model also incorporated psychological care, such as music relaxation therapy and guided conversation, which directly affect the cerebral cortex and limbic system, improving physiological state, enhancing emotional well-being, reducing negative emotions, and stabilizing mood. Additionally, moderate aerobic exercise helped regulate bodily functions, alleviating anxiety and depression, thereby further enhancing the effectiveness of nursing interventions [22].

Previous studies have shown that engaging in aerobic exercise for 30-60 minutes, two to seven times per week during pregnancy, significantly reduces the risk of hypertensive disorders, gestational hypertension, and cesarean sections. The proposed mechanism involves the reduction of inflammation, oxidative stress, and endothelial dysfunction, though further research is needed for confirmation [23, 24].

Furthermore, the study demonstrated that systematic nursing combined with aerobic exercise significantly reduced the incidence of adverse pregnancy outcomes in patients with gestational hypertension. The observation group had a higher proportion of natural deliveries, as well as increased neonatal birth weight and Apgar scores, compared to the control group. It was observed that excessive concern for fetal health can lead to mental tension, disrupting the central nervous system and directly affecting both maternal and fetal health. In the traditional nursing model, which provides only standardized routine care for pregnant women without specific interventions targeting emotions, blood pressure, and lifestyle, there is often no significant improvement in pregnancy outcomes.

In contrast, the systematic nursing approach used in the observation group helped patients relax both physically and mentally by addressing psychological, postural, and dietary needs in combination with scientifically guided exercise. This approach alleviated anxiety and depression, effectively inhibited catecholamine

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secretion, and reduced its concentration, promoting regular uterine contractions, improving fetal oxygen utilization, and decreasing the incidence of adverse pregnancy outcomes. These findings suggest that systematic nursing combined with aerobic exercise can significantly improve pregnancy outcomes for patients with gestational hypertension. Additionally, nursing satisfaction in the observation group was notably higher than in the control group.

The study also evaluated the S/D ratio and HSP70 levels in patients with different pregnancy outcomes. Previous research has shown that the ultrasound umbilical artery S/D ratio, as a hemodynamic indicator, can monitor placental function. In gestational hypertension, inadequate vascular infiltration in the placenta leads to an elevated S/D ratio, resulting in placental ischemia and hypoxia, which adversely affect maternal and fetal outcomes [25]. HSP70, a stress protein, helps prevent cellular component alterations under stress conditions and is elevated during systemic inflammation, oxidative stress, preeclampsia, and hepatic injury. It reflects the severity of tissue damage, regulates placental hemodynamics, and is associated with pregnancy complications [26]. Prior studies have indicated that placental vascular endothelial damage and necrosis of endometrial stromal cells in gestational hypertension patients exacerbate stress responses, leading to increased serum HSP70 levels and adverse pregnancy outcomes [27].

Our study found that patients with adverse pregnancy outcomes had significantly higher S/D ratios and serum HSP70 levels during pregnancy compared to those with normal pregnancy outcomes. ROC analysis demonstrated that both the S/D ratio and serum HSP70 have high predictive value for determining pregnancy outcomes.

It is important to emphasize that the Apgar score is a key indicator for assessing neonatal asphyxia, reflecting the long-term effects of various factors and the intrauterine environment on the fetus and its postnatal condition. A low Apgar score is associated with a higher risk of neonatal death [28, 29]. Previous studies [30] have shown that an Apgar score below 7 at 5 minutes after birth is linked to lower cognitive function, neurological deficits, and even academic performance issues at age 16. Significant

risk factors for a low Apgar score at 5 minutes include non-cephalic fetal position, prolonged labor, meconium-stained amniotic fluid, labor induction, and low birth weight.

The findings of this study demonstrate that combining systematic nursing care with aerobic exercise effectively improves neonatal Apgar scores and birth weight. Prior research [31] had reported that perinatal mortality increases by 1 to 3 times in cases of mild oligohydramnios and by 4 to 7 times in cases of severe oligohydramnios. Another study [32] found that breech presentation, compared to cephalic presentation, is independently associated with a higher risk of stillbirth, and breech-presenting fetuses are more likely to require cardiopulmonary resuscitation at birth. The peak systolic blood flow velocity of the middle cerebral artery has also been shown to have predictive value for adverse pregnancy outcomes [33]. These studies support our results, and this study is the first to confirm that aerobic exercise combined with systematic nursing can reduce the risk of low Apgar scores in newborns of patients with gestational hypertension.

This study does have some limitations. First, the sample size was small, necessitating further analysis through large-scale, multicenter studies. Second, the study did not include clinical data from early pregnancy (e.g., pre-pregnancy body mass index) or records of anesthesia methods and medications used during delivery. The potential influence of these factors on pregnancy outcomes remains unclear, but future research will aim to collect more comprehensive data to achieve more accurate results. In conclusion, aerobic exercise combined with systematic nursing care effectively maintains psychological health, improves pregnancy outcomes, and enhances the quality of life for patients with gestational hypertension, resulting in higher nursing satisfaction.

Disclosure of conflict of interest

None.

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