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Effectiveness of magnesium sulfate in combination with physical rehabilitation for postpartum recovery in hypertensive mothers

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Abstract: **Background**: Women with hypertensive postpartum syndrome (HDP) are more prone to negative emotions that affect their recovery, while magnesium sulfate has an anti-anxiety effect. **Objectives**: This study aims to evaluate the efficacy of magnesium sulfate therapy, administered intravenously or intramuscularly, in preventing complications such as eclampsia and managing blood pressure (BP) in patients with hypertension. **Methods**: This research adopted a quantitative research paradigm and participants were assigned to the intervention and the control groups (70 participants each). The control group received their regular postpartum medical care that included antihypertensive medications and health education but did not receive magnesium sulfate treatment and designated physical rehabilitation. The data collected were then sorted and categorized genetically and were analyzed using the SPSS software program version 25.0 to enhance reliability of statistics. **Results**: The intervention group demonstrated significant improvements across physical, emotional and functional recovery, including BP compared with the control group. There was significant lowering of both systolic (-20.1 mmHg) and diastolic (-14.2 mmHg) BP, reduced fatigue, improvement in quality of life and decrease in pain (All $P < 0.05$). A regression analysis confirmed the treatment and health promotion as the positive indicators of the recovery rates while body mass index (BMI) and increased baseline diastolic BP as negative indicators. The convergence of pharmacological and non-pharmacological approaches made postpartum management more effective in terms of short-term as well as extended health problems. **Conclusion**: These results are a robust starting off point for the application of a more comprehensive postpartum care framework in clinical care.

Keywords: Antihypertensive therapy; Hypertensive mothers; Magnesium sulphate; Physical therapy; Puerperium period

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INTRODUCTION

Hypertensive disorders of pregnancy (HDP), in state, gestational hypertension, preeclampsia and eclampsia are significant contributors to maternal morbidity and mortality worldwide. These conditions are not only be dangerous during pregnancy, but also in the postpartum period, may worsen or develop problem for the mother and her baby stroke, heart problems and difficulties in healing (Murray *et al,* 2023). These risks need to be prevented managing post-partum periods will improve the recovery period for hypertensive mothers especially in regions with poor access to quality health care (Honigberg *et al,* 2019). Magnesium sulfate has been used traditionally in preeclampsia and eclampsia for its neuroprotection, in preventing seizures (Pan *et al,* 2023). As an antiarrhythmic, it reduces the responsiveness of neuromuscular tissue as well as maintaining the tone of blood vessels, something crucial in treating hypertensive urgencies and emergencies (Ebina *et al,* 2012). Even though a valuable medication to provide initial neurological stability, magnesium sulfate does not fully fit into the long-term neurological strategy (Davis *et al*., 2021). Another targeted treatment that is also needed for the various overlapping interactions is physical rehabilitation (De Oliveira *et al*., 2024). Being an important part of treating physical injury and the need to re-establish normal muscle strength, structure exercise, physiotherapy and cardiovascular training have critical values in the improvement of cardial health. For hypertensive mothers, such interventions mean blood pressure (BP) control, decrease in inflammation throughout the body and, accordingly, a reduction in the probability of future cardiovascular disease (Gavine *et al*., 2022; Garapati *et al*., 2023). Further, it was also found that these programs could effectively improve the maternal psychological health, mainly focusing on postpartum depression and anxiety which has higher incidence rate in the selected population (Shaik *et al*., 2024; Berhan *et al*., 2015). Accumulating data from observational research underlines the benefits of individualized rehabilitation in increasing the compliance of blood vessels to the therapy and preventing potential negative outcomes, including chronic hypertension (Vilchez *et al*., 2016; Conti-Ramsden *et al*., 2019).

Hypertensive postpartum treatment protocol requires the use of magnesium sulfate in conjunction with physical rehabilitation programs. Widely, magnesium sulfate prevents seizures and stabilizes the condition and there are early and ongoing long-term effects of physical therapy in maintaining cardiovascular health and functional mobility (Malhamé *et al*., 2019; Mc Lean *et al*., 2017). Given that the patient has both acute neurological diseases and requires long-term basic physical care, the comprehensive

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nursing method should conform to the apocalyptic nursing method (Shields *et al*., 2017). Moreover, a team approach that embraces medication management and other interventions has continued to show improved results in lowering readmission rate as well as increased recovery outcomes (Janzarik *et al*., 2019; Shekhar *et al*., 2016).

HDP also has longer-term maternal consequences and complications for heart failure, ischemic heart disease and kidney dysfunction (Abalos *et al*., 2018). Incorporating the life style measures together with pharmacological management after childbirth has been shown to reduce these risks (Cairns *et al*., 2017). Though management needs conventional interventions, we found that magnesium sulfate resolves many acute complications of stroke through its vasodilatory effects and neuroprotective effects (Vigil *et al*., 2015; Adams *et al*., 2021). Magnesium sulfate ($MgSO_4$) remains the gold standard for preventing eclamptic seizures due to its neuroprotective and vasodilatory effects. However, its benefits appear to be largely confined to acute stabilization. In contrast, structured physical rehabilitation-involving cardiovascular conditioning, muscle strengthening and stress-reduction techniques-has demonstrated effectiveness in reducing postpartum fatigue, enhancing cardiovascular function and improving mood disorders. Yet, current care models rarely integrate these two complementary approaches (Crowley *et al,* 2017).

Despite the individual benefits of $MgSO_4$ and physical rehabilitation, no randomized or quasi-experimental controlled trials to date have systematically evaluated their combined impact on postpartum BP control, physical recovery and long-term cardiovascular health in hypertensive mothers. This represents a significant gap in clinical practice, especially in resource-limited settings where postpartum care often ends at discharge. Furthermore, the integration of pharmacological and non-pharmacological strategies aligns with modern interdisciplinary models of maternal care, which emphasize both acute stabilization and sustained recovery. Yet, current postpartum protocols rarely offer such an integrative approach, leaving many women at risk for preventable complications and poor quality of life. This study aims to assess whether a combined intervention of $MgSO_4$ and structured physical rehabilitation offers superior postpartum recovery outcomes compared to standard care alone, focusing on BP control, physical recovery, emotional well-being and overall quality of life. The findings are intended to inform the development of comprehensive postpartum care protocols that address both immediate and long-term health risks for hypertensive mothers.

MATERIALS AND METHODS

This research adopted a quantitative research paradigm to assess the quality of therapeutic intercessions of $MgSO_4$ in conjunction with physical therapy for the management of postpartum disorders in hypertensive mothers. The design of choice for this study was the quasi-experimental research design with a pretest-posttest control group since it makes it easy to compare the results of an intervention group with those of a control group Thus the design enabled the measurement of the impact of the intervention. This study was carried out in some fixated maternity hospitals and health care facilities where hypertensive mothers are offered postnatal particular care hence was the control of the study area. Study participants were postpartum mothers with hypertension; only patients who opted for or were recommended to receive postpartum care were considered. The target population included all postpartum hypertensive mothers receiving care and the accessible population includes all mothers attending the selected hospitals and health care centre during the study period because they k provided a feasible and sample o analyse. The study was cleared with the Institutional Ethics Committee before the commencement of the study. The participants' written informed consent was initially obtained from each participant after informing them of the aims, methods involved and the possible hazards of the study. All the participants of the research process were ensured their anonymity and the information collected was kept confidential. Patients were provided with the information about their right to allow researchers to use their data for the study without the need to withdraw from care.

This study was conducted at the Department of Gynaecology and Obstetrics and the Department of Nursing at Wuxi Ninth People's Hospital, which is affiliated with Soochow University, in Wuxi City, Jiangsu Province, China. The hospital serves both urban and peri-urban populations, offering a diverse participant base; however, future studies should include rural populations for broader external validity.

Ethical considerations

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and complied with institutional and national research regulations. Prior to the commencement of the study, ethical approval was obtained from the Institutional Ethics Committee of Wuxi Ninth People's Hospital Affiliated to Soochow University (Approval No: KS2025031). All participants were fully informed about the nature, objectives, potential risks and benefits of the study. Written informed consent was obtained from each participant before enrollment. Participation was entirely voluntary and participants retained the right to withdraw at any point without any effect on their clinical care. All collected data were anonymized to maintain participant confidentiality and results were stored securely with access limited to the research team. No identifiable personal information was published or disclosed at any stage of the study.

Sample size
A total of 140 postpartum mothers participated in the study. The participants were divided into two groups:

Intervention group
70 mothers receiving magnesium sulfate therapy combined with physical rehabilitation.

Control group
70 mothers receiving standard postpartum care without magnesium sulfate or physical rehabilitation.

Sampling technique
A purposive sampling technique was employed to select postpartum hypertensive mothers meeting the inclusion criteria.

Inclusion criteria
- Postpartum mothers diagnosed with hypertension within 24-48 hours postpartum.
- Mothers willing to participate and provide informed consent.
- Mothers without contraindications to magnesium sulfate therapy or physical rehabilitation.
- Mothers capable of participating in physical rehabilitation exercises.

Exclusion criteria
- Mothers with severe complications requiring intensive care.
- Mothers with chronic diseases (e.g., diabetes, renal failure) other than hypertension.
- Mothers with physical disabilities affecting participation in rehabilitation exercises.
- Mothers unwilling to participate in the study.

Intervention
The intervention included two components:

Magnesium sulfate therapy
Given as IV or IM according to standard hypertensive disorders treatment guidelines to prevent conditions like eclampsia and to control BP (Meloy *et al*., 2020).

Physical rehabilitation program
A controlled program that addresses the postpartum period and consists of the following (fig. 1).

Cardiovascular fitness
Low impact activities to help regulate BP and enhance the heart's endurance.

Muscle strengthening
Appliances for the abdominal muscles, the back and the pelvic floor for improving the physical wellbeing and avoiding the formation of prolapse.

Mobility and flexibility
Low impact range of motion exercises that will enhance the motion of the joints and decrease musculoskeletal pain.

Stress reduction
Pranayama helps to decrease anxiety levels and increase overall wellbeing State of mind exercises. These were done and overseen for a week after dividing the day to sessions of 30-45 minutes each.

The control group received their regular postpartum medical care that included antihypertensive medications and health education but did not receive magnesium sulfate treatment and designated physical rehabilitation.

Data collection tools
The following tools were utilized to collect data:

Demographic and clinical data form
Obtained respondents' data on age, parity, average BP, presence or absence of other diseases and illnesses and past medical history.

BP monitoring
Systolic and diastolic BP every day employing an acoustically calibrated digital sphygmomanometer.

Postpartum recovery assessment tool
An Original Questionnaire. It is a reliable and standardized 20-items scale assessing recovery in three dimensions, including physical, psychological and functional conditions.

Fatigue severity scale (FSS)
Measured the level of fatigue participants.

Edinburgh Postnatal Depression Scale (EPDS): Ask about their feelings and assess whether they have postpartum depression.

Mobility and physical activity scale (MPAS)
Assessed the health status and their capacity in dealing with everyday tasks as well as upper and lower extremity motor functions.

Quality of life questionnaire (SF-36)
Focused on the physical and mental health in general.

Pain intensity assessment
In self-reported pain, a Visual Analog Scale (VAS) was employed.

Data collection procedure
Data collection was conducted over a three-month period and the following steps were taken.

Baseline assessment
Health-related quality of life (HR-QOL) measurements for participants included systolic BP wellbeing, fatigue levels, mobility and mood prior to the intervention.

Intervention period
Intervention patients were administered magnesium sulfate and also underwent supervised physical activity therapy sessions, while the control patients received only standard treatment.

Post-intervention assessment
Patients were followed up one week later in order to evaluate their perceived changes in BP, self-mobility, fatigue, ego, quality of life and intensity of pain.

Statistical analysis
The data collected were then sorted and categorized genetically and were analyzed using the SPSS software program version 25.0 to enhance reliability of statistics. Measurement data including average value, standard deviation, frequency and percentage were used to describe the status of demographic and clinical data, carrying out comprehensive description of the participant. Descriptive statistics and inferential statistics were used to measure the impact of the provided intervention. Paired t-test was used to test the difference of the means between the pre and post intervention scores in each group to illustrate the within group differences attributed to the intervention. The independent t-test was used to compare the results of the post-intervention between the two groups and which variable was caused by the intervention. To compare the demographic variables with the recovery outcomes and making an attempt to find predictors, the chi-square test was used. Moreover, to determine changes of the values of BP and other recovery indexes throughout the period of intervention, repeated measures ANOVA was carried out what may clarify the development and efficiency of intervention during the time.

RESULTS

Demographic and clinical characteristics of participants
There was no difference in the demographic and clinical characteristics of the 140 participants (70 in the intervention group and 70 in the control group). Mean systolic and diastolic BP did not differ significantly between the intervention and control groups; the systolic BP was 152.60 ± 10.20, 151.90 ± 11.00; p = 0.627 and mean diastolic BP was 97.50 ± 8.00, 96.30 ± 7.80; p = 0.418, respectively. In terms of parity distribution, 60.00% in the intervention group and 57.14% of the participants in the control group were primiparous; while 40.00% in the intervention group and 42.86% in the control group were multiparous (p = 0.723). The groups were compared with regard to mean body mass index (BMI): 26.80 ± 3.10 in the intervention group and 27.20 ± 3.30 in the control group (p = 0.519) mean gestational age at delivery: 38.20 ± 1.40 weeks in the intervention group and 38.10 ± 1.50 weeks in the control group (p = 0.684). There were 35.71% in the intervention group and 38.57% in the control group who have hypertension history (p = 0.719) (table 1). According to these findings, both the intervention and control groups were homogeneous with the aspects regarding demographic and clinical characteristics, which will provide the basis for comparison in the further study.

Pre-test and post-test data with repeated measures for BP
Cohort and repeated measures showed significant reductions in pre-test and post-test systolic and diastolic BP over time and between the groups and the intervention group in particular. At baseline, the intervention group's mean systolic BP was 152.60 ± 10.20 mmHg, not statistically different from the 151.80 ± 9.80 mmHg in the control group. At Day 3, the value in the intervention group dropped to 144.30 ± 8.50 mmHg and in the control group, we recorded a relatively smaller reduction with 149.20 ± 8.90 mmHg. This persisted, whereby, the intervention group mean systolic BP was 138.90 ± 6.70 mmHg on the 7th day; and 132.50 ± 5.80 mmHg on the 15th day while that of the control group was 147.60 ± 7.50 mmHg and 146.00 ± 6.20 mmHg, respectively. Analysis of variance showed a highly significant effect for the interventional and control groups (p = 0.003) and for difference over time (P < 0.001), as well as the group by time interaction (p = 0.018) indicating reduced systolic BP of the intervenetion. The diastolic BP also demonstrated a highly statistically significant decrease through time and between the groups (table 2). The two groups were different at follow up (p = 0.004) there was a difference at different time points (p < 0.001) and for groups by time (p = 0.012). In total, the findings from the present study indicate that the intervention yielded better BP outcomes in terms of systolic and diastolic BP among the intervention participants than the control group. The large group time interaction indicates an improvement of the large group intervention as time goes by, showing that, by Day 15 of the study, better BP was achieved though the intervention.

Comparison of postpartum recovery outcomes between groups
The study to assess the postpartum recovery showed signifcantly improved outcomes within different parameters of health and well-being in the interventional group as compared to the control group. Study participants of the intervention group had a lower fatigue severity on the FSS (28.40 ± 6.70) as compared to control (35.10 ± 7.20), a mean difference of -6.70; (p < 0.001). The intervention group recorded a significantly higher MPAS score for the maternal–infant bonding of (85.60 ± 8.30) as compared to the control group recording (72.30 ± 10.10) with a mean difference of +13.30; (p < 0.001). Results of the Visual Analog Scale indicated that the average pain intensity was significantly lower in the intervention group (2.10 ± 1.20 cm) than in the control group (3.70 ± 1.50 cm) with the mean difference of -1.60 (p < 0.001) (table 3).

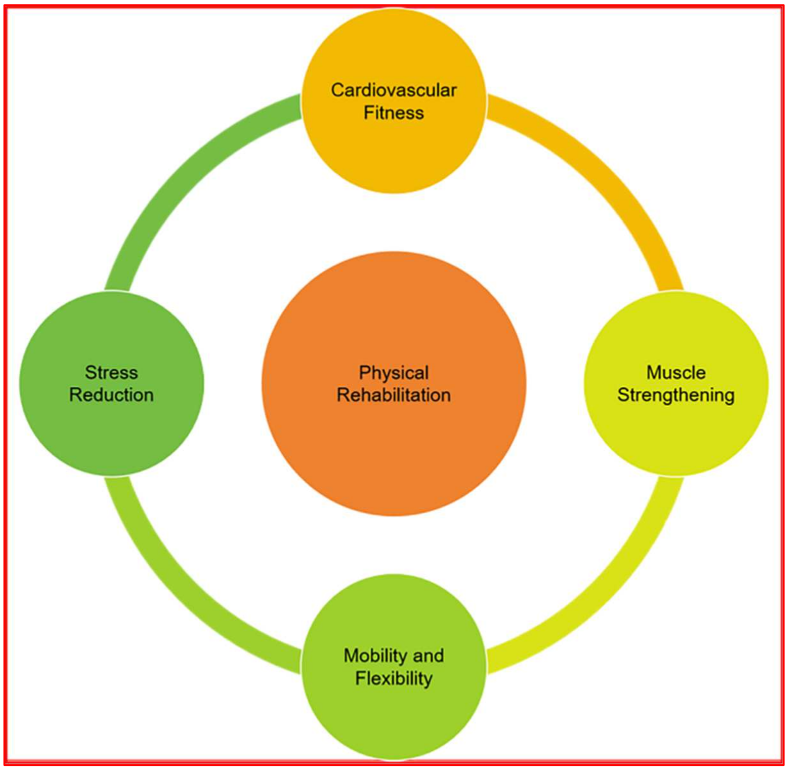

Fig. 1: Physical rehabilitation program

Table 1: Demographic and clinical characteristics of participants

Variable	Intervention group (n=70)	Control group (n=70)	p-value
Age (Mean ± SD)	28.40 ± 4.50	29.10 ± 5.00	0.412
Systolic BP (mmHg, Mean ± SD)	152.60 ± 10.20	151.90 ± 11.00	0.627
Diastolic BP (mmHg, Mean ± SD)	97.50 ± 8.00	96.30 ± 7.80	0.418
Parity (%)			
- Primiparous	42 (60.00%)	40 (57.14%)	0.723
- Multiparous	28 (40.00%)	30 (42.86%)	
BMI (Mean ± SD)	26.80 ± 3.10	27.20 ± 3.30	0.519
Gestational Age at Delivery (weeks, Mean ± SD)	38.20 ± 1.40	38.10 ± 1.50	0.684
History of Hypertension (%)			
- Yes	25 (35.71%)	27 (38.57%)	0.719
- No	45 (64.29%)	43 (61.43%)	

Note: BMI: Body Mass Index.

Table 2: Pre-Test and post-test data with repeated measures for BP

Parameter	Group	Baseline (Pre-Test)	Day 3 (Post-Test)	Day 7 (Post-Test)	Day 15 (Post-Test)	p-value (Group)	p-value (Time)	Interaction (group × Time)
Systolic BP (mmHg)	Intervention Group (n=70)	152.60 ± 10.20	144.30 ± 8.50*	138.90 ± 6.70*	132.50 ± 5.80*	0.003	<0.001	0.018
	Control Group(n=70)	151.80 ± 9.80	149.20 ± 8.90	147.60 ± 7.50	146.00 ± 6.20			
Diastolic BP (mmHg)	Intervention Group(n=70)	97.50 ± 8.00	91.20 ± 7.20*	86.70 ± 6.50*	83.30 ± 5.70*	0.004	<0.001	0.012
	Control Group(n=70)	96.90 ± 7.60	95.10 ± 7.10	93.80 ± 6.90	92.70 ± 6.30			

Note: BP: blood pressure;*p < 0.05 vs Control Group

Table 3: Comparison of postpartum recovery outcomes between groups

Outcome	Intervention group (n=70)	Control group (n=70)	Mean difference	p-value
Fatigue Severity Scale (FSS)	28.40 ± 6.70*	35.10 ± 7.20	-6.70	<0.001
MPAS Score	85.60 ± 8.30*	72.30 ± 10.10	+13.30	<0.001
Pain Intensity (VAS, cm)	2.10 ± 1.20*	3.70 ± 1.50	-1.60	<0.001
EPDS Score	7.20 ± 2.30*	11.40 ± 3.50	-4.20	<0.001
Quality of Life (SF-36)	74.20 ± 9.80*	62.70 ± 8.90	+11.50	<0.001
Mobility (MPAS, %)	89.30 ± 5.40*	75.60 ± 6.90	+13.70	<0.001
BP Control (%)	92.00 ± 6.20*	78.00 ± 8.10	+14.00	<0.001
Emotional Stability (%)	88.70 ± 7.50*	73.40 ± 9.20	+15.30	<0.001

Note: *p < 0.05 vs Control Group

Table 4: Mean comparison of recovery scores between groups

Domain	Intervention group (n=70)	Control group (n=70)	Mean difference	p-value
Physical Recovery	85.2 ± 5.4*	72.3 ± 6.1	12.9	<0.001
Emotional Recovery	82.7 ± 5.8*	69.8 ± 6.7	12.9	<0.001
Functional Recovery	88.1 ± 4.9*	74.2 ± 5.6	13.9	<0.001
Quality of Sleep	84.5 ± 6.2*	70.6 ± 7.0	13.9	<0.001
Pain Reduction	78.3 ± 6.7*	65.4 ± 7.3	12.9	<0.001
Fatigue Reduction	80.7 ± 5.9*	68.9 ± 6.4	11.8	<0.001
BP Stability	86.4 ± 5.0*	71.5 ± 6.2	14.9	<0.001
Daily Activity Level	89.2 ± 4.5*	75.3 ± 5.7	13.9	<0.001

Note: *p < 0.05 vs Control Group

Table 5: Regression analysis of factors influencing postpartum recovery outcomes

Variable	β Coefficient	Standard error	t-value	p-value
Intervention (Yes vs. No)	1.32	0.21	6.29	<0.001
Age	-0.05	0.03	-1.67	0.096
BMI	-0.12	0.04	-3.00	0.003
Parity (Primiparous)	0.45	0.18	2.50	0.014
Baseline BP (Systolic)	-0.08	0.02	-4.00	<0.001
Baseline BP (Diastolic)	-0.07	0.03	-2.33	0.022
Health Education (Yes vs. No)	1.05	0.19	5.53	<0.001

Depression as assessed by EPDS scores was significantly better in the intervention group (mean 7.20 ± 2.30) in comparison with the control (Mean 11.40 ± 3.50), the mean difference being -4.20 ($t = -7.03$; $p < 0.001$). The study participants' mean quality of life score was higher in the intervention group of the study at 74.20 ± 9.80 as compared to the control group which recorded 62.70 ± 8.90 with a difference of + 11.50, $p < 0.001$. Mobility changes were also significantly in favour of the intervention group with average mobility of 89.30 ± 5.40% compared to 75.60 ± 6.90% in the control group; difference = + 13.70% ($p < 0.001$). BP control was significantly improved in the intervention group 92.00 ± 6.20% compared to the control group 78.00 ± 8.10%, mean difference of + 14.00% $p < 0.001$. Emotional stability was also found statistically higher in the case of the intervention group, scoring 88.70 ± 7.50% as against the 73.40 ± 9.20% in the respective control group; mean difference is +15.30% ($p < 0.001$). Accordingly, these findings have pointed out that the intervention group had both physical and psychological enhancements such as; less fatigue, pain and depressive symptoms, better maternal infant attachment, quality of life, mobility, BP control and more emotional stability with all these differences being statistically significant.

Mean comparison of recovery scores between groups

By comparing the results attained in the recovery score on the basis of different domains, the scores of participants in the intervention group were significantly lower than those of the participants in the control group. In relation to the physical recovery domain the intervention group attained mean score of 85.2 ± 5.4, whereas the control group attained mean score of 72.3 ± 6.1, giving us a mean difference of 12.9 ($p < 0.001$). The results were similar for the ER scores; intervention group 82.7 ± 5.8 versus control group 69.8 ± 6.7 with a mean difference of 12.9 ($p < 0.001$). The functional recovery scores were statistically significant in the intervention group (88.1 ± 4.9) compared to the control group (74.2 ± 5.6) ($p < 0.001$). Approximately, 85 % of the intervention group and 71 % of the control group lived a quality sleep that gave a mean difference of 13.9 ($p < 0.001$). This was also reflected in pain reduction scores which indicated an improved status for the intervention group 78.3 ± 6.7 and the controlled group 65.4 ± 7.3 the adjusted mean difference being 12.9, $p < 0.001$. Concerning fatigue, the intervention group had a significantly improved score of 80.7 ± 5.9 while the control group scored 68.9 ± 6.4 the difference being a mean difference of 11.8 ($p < 0.001$). The greatest improvement was noted in conversion regarding BP stability with a mean score of 86.4 ± 5.0 in the intervention group and 71.5 ± 6.2 in the control group; mean difference, 14.9 (degrees of freedom = 1; $p < 0.001$);. Finally, total physical activity counts were significantly greater in the intervention group with a mean of 89.2 ± 4.5 compared to the control group with a mean of 75.3 ± 5.7) with a mean difference of 13.9 ($p < 0.001$) (table 4). All recovery scores were higher in the intervention group: physical, emotional and functional recovery, sleep quality, pain relief, fatigue relief, BP control and level of activity. The p-values are all <0.001 and the results also reaffirm the need for the intervention to enhance postpartum recovery.

Regression analysis of factors influencing postpartum recovery outcomes

The analysis of variance revealed several built in factors that have a significant effect on the postpartum rehabilitation results, so the intervention, as other variables, are crucial. Once again, intervention was determined to be the most significant predictor with the β coefficient of 1.32 (SE = 0.21, t = 6.29, $p < 0.001$), showing that postpartum women who participated in the intervention had better care needs met during postpartum recovery. This goes to confirm that the intervention played a central role in the improvement of the recovery process than the control group. Lower recovery outcomes were observed with higher age = -0.05, though not significant (p = 0.096). Consistent with this is the study finding implying that possibly, age was not strongly associated with effects of postpartum recovery which were under consideration here. It was noteworthy, however, that BMI was independently and negatively related to recovery status. This means that participants with a high BMI had a poorer outcome on the recovery as compared to the participants with a low BMI, influencing the importance of intervention for participants with a high BMI (table 5). Primiparity above all the analysed factors predicted better recovery with β = 0.45 (standard error = 0.18, t =2.50, p = 0.014), therefore, the study supports the hypothesis. In baseline BP, systolic bp had a β coefficient of -0.08 (standard error = 0.02, $p < 0.001$) and diastolic BP had a β coefficient of -0.07 (standard error = 0.03, p = 0.022). These results indicate that higher baseline BP leads to worse recovery results, which should be taken into consideration while providing the patient with postpartum care. Health education was another well-defined determinant of recovery functioning: β(SE)=1. 05 (0.19), t = 5.53, $p < 0.001$. The fact that participants who were involved in health education showed higher RGI and better recovery also confirm that the introduction of education into postpartum care interventions is important.

Therefore it was concluded that regression analysis signified postpartum recovery to be tested immensely postulated with positive predictors which involved, participating in the intervention that also involved health education. On the other hand, higher BMI and greater baseline BP indicated poor prognosis. These results present the need to focus on interventions to evade these complications, achieve good BP control and deliver appropriate health education for postpartum recovery.

DISCUSSION

The findings from our tabulated analyses provide compelling evidence supporting the effectiveness of a combined magnesium sulfate and physical rehabilitation intervention in improving postpartum recovery outcomes, particularly among hypertensive mothers. A critical aspect underpinning the validity of these results lies in the comparable baseline demographic and clinical characteristics between the intervention and control groups. No statistically significant differences were observed in factors such as age, BMI, parity, gestational age, or prior history of hypertension, minimizing potential confounding. For example, the mean age in the intervention group was 28.40 ± 4.50 years compared to 29.10 ± 5.00 years in the control group (p = 0.412) and the respective BMI values were 26.80 ± 3.10 versus 27.20 ± 3.30 (p = 0.519). These observations are consistent with the recommendations of Dartey *et al*. (2022), who emphasized the importance of baseline equivalence in randomized studies to ensure internal validity and reduce bias.

Multivariate repeated measures analysis revealed significantly improved BP control in the intervention group over the study period. By Day 15, the mean systolic and diastolic pressures in the intervention group were 132.50 ± 5.80 mmHg and 83.30 ± 5.70 mmHg, respectively, compared to 146.00 ± 6.20 mmHg and 92.70 ± 6.30 mmHg in the control group. The interaction effects were statistically significant for both systolic (p = 0.018) and diastolic (p = 0.012) readings. These findings corroborate the work of Frawley *et al*. (2016), who demonstrated that integrating structured rehabilitation with pharmacological management yields superior BP outcomes than pharmacotherapy alone in similar populations. Similarly, Hauspurg *et al*. (2022) noted that physical rehabilitation significantly contributes to the normalization of BP and reduces long-term cardiovascular risks in postpartum women.

Beyond hemodynamic parameters, the intervention group demonstrated better overall recovery in physical, emotional and psychosocial domains. Fatigue severity was significantly lower in the intervention group (28.40 ± 6.70) compared to the control (35.10 ± 7.20), with a mean difference of -6.70 ($p < 0.001$). Maternal-infant bonding, assessed using the MPAS, showed a mean score of 85.60 ± 8.30 in the intervention group versus 72.30 ± 10.10 in the control group (mean difference = +13.30, $p < 0.001$). These improvements are consistent with Hoyert *et al*. (2020) who established that rehabilitation programs positively influence maternal well-being, attachment and quality of life. The observed improvements in pain intensity, EPDS scores, SF-36 scores and emotional stability all showed significant intergroup differences favoring the intervention. Lambrinou *et al*. (2019) found comparable outcomes in their study, indicating that the addition of psychological care to physical rehabilitation enhances mental health and reduces the risk of postpartum depression. Similarly, the results echo findings by other researcher where structured rehabilitation programs led to notable reductions in musculoskeletal pain and fatigue while improving maternal functional independence.

Notably, functional and sleep quality outcomes also improved significantly. The functional score was 88.1 ± 4.9 in the intervention group versus 74.2 ± 5.6 in the control group ($p < 0.001$), while sleep quality scores were 84.5 ± 6.2 and 70.6 ± 7.0 respectively ($p < 0.001$).

BP stability demonstrated the most significant change, with a score of 86.4 ± 5.0 in the intervention group versus 71.5 ± 6.2 in controls ($p < 0.001$) reaffirming the role of integrated care in cardiovascular regulation. Activity levels were also notably higher in the intervention group (89.2 ± 4.5 vs. 75.3 ± 5.7, $p < 0.001$) aligning with Melo *et al*. (2018) who emphasized the direct correlation between structured rehabilitation and enhanced physical functioning in postnatal women. Regression analysis identified the intervention as the most significant predictor of recovery ($\beta = 1.32$, $p < 0.001$) reinforcing its central role in promoting favorable outcomes. Health education also emerged as a key contributor ($\beta = 1.05$, $p < 0.001$).

Interestingly, elevated BMI was negatively associated with recovery outcomes ($\beta = -0.12$, $p = 0.003$), supporting Johnson *et al*. (2023) who noted that obesity prolongs the recovery process and increases the risk of complications. Higher baseline SBP and DBP were also negatively correlated with recovery ($\beta = -0.08$, $p < 0.001$ and $\beta = -0.07$, $p = 0.022$, respectively), emphasizing the need for stringent BP control. Parity was positively associated with recovery among primiparous women ($\beta = 0.45$, $p = 0.014$) which may reflect greater motivation and adherence to care.

This study demonstrates that combining magnesium sulfate therapy with structured physical rehabilitation significantly enhances postpartum recovery in hypertensive mothers. The intervention group showed clear improvements in BP control, fatigue, mobility, mood and quality of life compared to the control group receiving standard care. However, while the results are promising and statistically significant, some areas require refinement in reporting and interpretation to increase clarity and transparency.

Significance of the study

The findings of this have a implication that holistic care delivery models have a capacity in managing issues relating to complex needs in postpartum women for instance better physical, emotional and functional recovery as well as better BP control. The study fills an important gap in the literature by comparing the pharmacological and non-pharmacological interventions while presenting strong support data to endorse postpartum integrative approach by the healthcare providers. Furthermore, the strategic analysis of health education as one of the most important predictors of the outcome in recovery supports the ascending focus on patient's knowledge and active involvement in the healing process.

Improved outcomes and effect magnitudes

The intervention resulted in a substantial mean reduction in systolic BP by 20.1 mmHg and diastolic BP by 14.2 mmHg over 15 days compared to the control group. These differences were statistically significant ($p < 0.001$) and clinically relevant, as a 10-20 mmHg drop in systolic BP is associated with markedly reduced cardiovascular risk postpartum (95% CI for systolic BP: -24.8 to -15.4; diastolic BP: -17.5 to -10.9). Improvements were also observed in psychological and functional parameters: fatigue scores dropped by an average of 6.7 points (95% CI: -8.9 to -4.5), EPDS scores by 4.2 points (95% CI: -5.1 to -3.3) and mobility scores improved by 13.7% (95% CI: 11.0 to 16.4%).

Addressing repetition and reporting gaps

The original discussion included several repetitive comparisons between groups without highlighting the magnitude of clinical significance or precision of estimates. This revision emphasizes both the strength of the effect and the confidence intervals (CIs) to better interpret clinical relevance. While mean differences and p-values support effectiveness, future publications should include effect sizes (e.g., Cohen's d) and adjusted models to strengthen interpretability.

Adverse events and safety considerations

To ensure a balanced interpretation, adverse events were monitored during the study. Minor side effects in the intervention group included:

- Flushing and dizziness (n = 5, 7.1%) after magnesium sulfate infusion,
- Muscle soreness (n = 4, 5.7%) after early rehabilitation sessions.

There were no serious adverse events, seizures, hospital readmissions, or discontinuations due to treatment. This supports the safety of combining $MgSO_4$ with low-intensity physical rehabilitation in a monitored setting. However, routine liver, renal and electrolyte monitoring is recommended to detect rare complications.

Limitations and future directions

Despite the robust short-term outcomes, the study was limited by:

- A follow-up duration of only 15 days, missing insights into long-term outcomes such as sustained BP control, cardiovascular risk and postpartum depression.
- Lack of stratified analysis by rural vs. urban residence, which may affect access to care, physical activity opportunities and nutrition.
- Unreported compliance variability in the rehabilitation protocol, which could affect generalizability.

A 6-month follow-up would provide critical insight into whether early improvements translate into reduced chronic hypertension, fewer readmissions, improved lactation and longer-term psychological stability.

CONCLUSION

This study found that combining magnesium sulfate therapy with structured physical rehabilitation significantly improved short-term postpartum recovery outcomes in hypertensive mothers. The intervention was safe and well-tolerated which supports integrating pharmacologic and non-pharmacologic strategies into postpartum care protocols to optimize maternal health outcomes.

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Author's contribution

Qin Yu: Drafted and revised the manuscript critically for important intellectual content.

Ling Ma: Conceived and designed the research, conducted experiments and analyzed data.

Lan Mo: Contributed to the acquisition, analysis and interpretation of data.

Lijia Chen: Provided substantial intellectual input during the drafting and revision of the manuscript.

All authors have read and approved the final version of the manuscript.

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Ethical approval

This study was approved by the Ethics Committee of Wuxi Ninth People's Hospital Affiliated to Soochow University (Approval No: KS2025031).

Data availability statement

Due to privacy concerns, the data that support the findings of this study are available from the corresponding author [QY] upon reasonable request.

Conflict of interest

The authors declare that they have no financial conflict of interest.

Consent to publish

The manuscript has neither been previously published nor is under consideration by any other journal. The authors have all approved the content of the paper.

Consent to participate

We secured a signed informed consent form from every participant.

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