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*Article*

# The Impact of Physical Activity on Maternal and Fetal Well-being During Pregnancy

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## ABSTRACT

**Background**: Physical activity during pregnancy has been increasingly recognized for its role in promoting maternal and fetal health, yet inconsistencies remain regarding optimal intensity and its effects on perinatal outcomes. Sedentary lifestyles during gestation are associated with elevated risks of gestational diabetes, excessive weight gain, and adverse fetal outcomes. **Objective**: To evaluate the impact of moderate-intensity physical activity on maternal health indicators and fetal well-being during pregnancy. **Methods**: A prospective cohort study was conducted on 100 pregnant women between 12 and 24 weeks of gestation recruited from antenatal clinics. Participants were divided into two groups: a physically active group (n=50) engaging in moderate aerobic activity for at least 30 minutes, five times per week, and a sedentary group (n=50) with no structured exercise. Maternal variables included gestational weight gain, incidence of gestational diabetes, and blood glucose levels. Fetal outcomes assessed were birth weight and incidence of preterm birth. Statistical analysis was performed using t-tests and chi-square tests, with adjustments for confounding factors. **Results**: The physically active group demonstrated significantly lower gestational weight gain (9.5 ± 3.2 kg vs. 13.2 ± 4.1 kg, $p<0.001$) and improved glycemic profiles ($p=0.002$). Birth weights were higher (3.4 ± 0.5 kg vs. 3.1 ± 0.6 kg, $p=0.005$), and preterm birth incidence was lower in the active group (4% vs. 12%). **Conclusion**: Moderate physical activity during pregnancy contributes to favorable maternal and neonatal outcomes, supporting its inclusion in routine prenatal care.

**Keywords**: Pregnancy, Physical Activity, Gestational Diabetes, Birth Weight, Maternal Health, Preterm Birth

## INTRODUCTION

Pregnancy is characterized by a wide spectrum of physiological, metabolic, and psychological adaptations that support fetal growth and maternal well-being (1). These transformations, while essential for sustaining a healthy gestation, can also predispose the expectant mother to complications such as excessive weight gain, gestational diabetes mellitus (GDM), hypertensive disorders, and mental health challenges (2). The role of maternal health in shaping fetal outcomes has been extensively emphasized, underscoring the necessity of identifying modifiable factors that contribute positively to both maternal and fetal trajectories (3). Among such factors, physical activity has emerged as a promising, non-pharmacological intervention that aligns with modern preventive obstetric care guidelines (4).

Regular physical activity has long been known to improve cardiovascular efficiency, metabolic regulation, and psychological stability. Within the context of pregnancy, it plays a particularly pivotal role in mitigating excessive gestational weight gain, enhancing insulin sensitivity, and improving psychological health and delivery outcomes (5). A growing body of literature now supports these claims. For instance, meta-analyses have demonstrated that prenatal exercise significantly reduces the risk of GDM and hypertensive disorders of pregnancy while simultaneously optimizing neonatal parameters such as birth weight and gestational age at delivery (6,7). Despite these findings, ambiguities remain about the appropriate intensity, frequency, and types of exercise suitable for pregnant women. Concerns about fetal hypoxia, miscarriage risk, and uterine contractions often lead to hesitancy among clinicians and patients alike,

contributing to a persistently low uptake of physical activity in pregnancy (8). Emerging evidence is beginning to counter these concerns, suggesting that moderate-intensity aerobic exercise is not only safe but beneficial for most pregnancies when contraindications are absent (9). Controlled studies have found favorable maternal outcomes including reduced GDM prevalence, improved gestational weight control, and even shorter labor durations in physically active women (10). Likewise, fetal benefits such as reduced preterm birth incidence and higher birth weights—both crucial indicators of neonatal health—have been reported (11). Despite these advances, knowledge gaps persist, particularly in low- and middle-income contexts where baseline physical activity levels and maternal morbidity patterns differ substantially from those in high-income settings (12). Additionally, there remains a lack of consensus on how maternal comorbidities, such as obesity or thyroid dysfunction, may modify the response to physical activity interventions (13).

This study seeks to address these gaps by systematically evaluating the effect of moderate physical activity on both maternal and fetal outcomes during the second trimester of pregnancy. Specifically, it compares maternal weight gain and gestational diabetes incidence, as well as fetal growth parameters such as birth weight and preterm birth rates, between women engaged in regular moderate-intensity exercise and those leading sedentary lifestyles. By doing so, it contributes to the growing evidence base supporting physical activity as a core component of prenatal care, with the potential to inform clinical guidelines and health promotion strategies worldwide (14). The primary objective of this study is to determine whether moderate aerobic activity during pregnancy leads to statistically significant improvements in maternal and fetal health outcomes compared to sedentary behavior.

## MATERIALS AND METHODS

The present study employed a prospective cohort design to investigate the effects of moderate physical activity on maternal and fetal health outcomes during pregnancy. This design was selected to allow for temporal assessment of exposure (exercise) and subsequent outcomes, facilitating a clearer understanding of potential causal relationships. The study was conducted in prenatal clinics affiliated with the University of Lahore, Pakistan, from March to September 2023, a period that ensured adequate recruitment and follow-up within the defined gestational window.

Pregnant women attending routine antenatal visits were screened for eligibility between 12 and 24 weeks of gestation. Inclusion criteria were defined as healthy women aged 18 to 40 years, with a singleton intrauterine pregnancy confirmed by ultrasonography, and no history of chronic illnesses. Women were excluded if they had pre-existing hypertension, diabetes mellitus, cardiovascular disease, renal impairment, or any obstetric complication contraindicating physical activity. Participants were selected through consecutive sampling, ensuring that all eligible women presenting during the recruitment window were offered participation. Written informed consent was obtained from each participant after a thorough explanation of the study's purpose, procedures, risks, and benefits. Confidentiality and the right to withdraw at any time without affecting clinical care were emphasized. All data were de-identified and stored securely to protect participant privacy. Participants were divided into two cohorts based on self-reported physical activity status, confirmed and monitored by follow-up logs and activity diaries. The active group consisted of women who performed moderate-intensity aerobic activity—such as brisk walking or prenatal aerobics—for a minimum of 30 minutes per session, at least five days per week, sustained for a minimum of four weeks after enrollment. The sedentary group included those who reported no structured or habitual physical activity during the study period. Physical activity was operationally defined using WHO guidelines as activities inducing mild breathlessness but allowing conversation (15). Participants' activity levels were monitored through structured weekly interviews and validated activity logs, ensuring fidelity to group classification.

Data collection was conducted by trained research personnel at baseline and at follow-up intervals every four weeks until delivery. Maternal variables included gestational weight gain, systolic and diastolic blood pressure, random blood glucose levels, and gestational diabetes diagnosis, the latter based on a 75g oral glucose tolerance test using IADPSG criteria. Fetal variables included ultrasound-measured fetal growth parameters, gestational age at birth, and neonatal birth weight. Preterm birth was defined as delivery before 37 weeks' gestation. All data were documented on standardized case report forms and cross-verified by an independent data reviewer. Instruments used included calibrated electronic weighing scales, automated blood pressure monitors, and diagnostic ultrasound systems operated by qualified radiologists. To minimize selection bias, consecutive enrollment was used and eligibility criteria were rigorously applied. Potential confounding variables—such as maternal age, pre-pregnancy BMI, parity, and socioeconomic status—were recorded and included as covariates in the statistical models. The sample size of 100 participants (n=50 per group) was calculated based on a power analysis to detect a minimum clinically significant difference of 0.3 kg in birth weight and a 5% difference in gestational diabetes incidence, assuming a power of 80% and an alpha of 0.05.

Statistical analyses were performed using SPSS version 25.0 (IBM Corp., Armonk, NY). Descriptive statistics were used to summarize baseline characteristics, with means and standard deviations reported for continuous variables and frequencies for categorical data. Between-group differences were assessed using independent-samples t-tests for continuous variables and chi-square tests for categorical outcomes. Missing data were minimal and addressed using complete case analysis, as patterns suggested randomness. Multiple logistic regression models were constructed to adjust for potential confounders in the association between physical activity and maternal/fetal outcomes. Subgroup analyses were planned a priori for participants stratified by BMI categories and parity. Ethical approval was obtained from the Institutional Review Board of the University of Lahore prior to study initiation (Approval No. UL-IRB/2023/0427). All procedures adhered to the ethical principles outlined in the Declaration of Helsinki. Data reproducibility was ensured by maintaining detailed protocols, using standardized tools, and archiving all original datasets and analysis scripts for future

verification. Data entry was double-checked, and audit trails were kept for all modifications in the database, ensuring full traceability and research integrity.

## RESULTS

A total of 100 pregnant women were enrolled and analyzed, with 50 assigned to the physically active group and 50 to the sedentary group. Baseline characteristics such as age, parity, and pre-pregnancy BMI were similar between groups (data not shown for brevity), allowing for balanced comparison of outcomes. Substantial differences were observed in maternal health parameters between the two cohorts. Women engaging in regular moderate-intensity physical activity experienced significantly lower gestational weight gain, averaging 9.5 ± 3.2 kg, compared to 13.2 ± 4.1 kg among their sedentary counterparts.

**Table 1. Comparison of Maternal Health Outcomes Between Physically Active and Sedentary Pregnant Women**

| Parameter | Physically Active (n = 50) | Sedentary (n = 50) | Odds Ratio | 95% Confidence Interval | p-value |
|---|---|---|---|---|---|
| **Gestational Weight Gain (kg)** | 9.5 ± 3.2 | 13.2 ± 4.1 | -3.7 | -5.2 to -2.2 | <0.001 |
| **Gestational Diabetes, n (%)** | 2 (4%) | 6 (12%) | OR = 0.30 | 0.06 to 1.56 | 0.089 |
| **Systolic BP (mmHg, mean ± SD)** | 114.7 ± 9.2 | 118.3 ± 10.1 | -3.6 | -7.3 to 0.1 | 0.056 |
| **Diastolic BP (mmHg, mean ± SD)** | 71.8 ± 7.4 | 73.5 ± 8.2 | -1.7 | -4.7 to 1.3 | 0.260 |
| **Random Blood Glucose (mg/dL)** | 92.1 ± 10.6 | 99.5 ± 12.8 | -7.4 | -12.1 to -2.7 | 0.002 |

*Abbreviations: BP, blood pressure; OR, odds ratio.*

**Table 2. Fetal Growth and Neonatal Outcomes in Relation to Maternal Physical Activity**

| Outcome | Physically Active Group (n = 50) | Sedentary Group (n = 50) | Odds Ratio | 95% Confidence Interval | p-value |
|---|---|---|---|---|---|
| **Birth Weight (kg, mean ± SD)** | 3.4 ± 0.5 | 3.1 ± 0.6 | 0.3 | 0.09 to 0.51 | 0.005 |
| **Preterm Birth, n (%)** | 2 (4%) | 6 (12%) | 0.30 | 0.06 to 1.56 | 0.089 |
| **Gestational Age at Birth (weeks)** | 39.0 ± 1.2 | 38.3 ± 1.4 | 0.7 | 0.2 to 1.2 | 0.009 |
| **Low Birth Weight (<2.5 kg), n (%)** | 1 (2%) | 4 (8%) | 0.24 | 0.03 to 2.14 | 0.198 |

*Abbreviations: OR odds ratio.*

**Table 3. Multivariate Logistic Regression: Association Between Physical Activity and Key Maternal-Fetal Outcomes**

| Outcome | Adjusted Odds Ratio (aOR) | 95% Confidence Interval | p-value |
|---|---|---|---|
| **Gestational Diabetes** | 0.27 | 0.05 to 1.35 | 0.106 |
| **Preterm Birth** | 0.25 | 0.04 to 1.46 | 0.119 |
| **Low Birth Weight** | 0.21 | 0.02 to 2.03 | 0.170 |

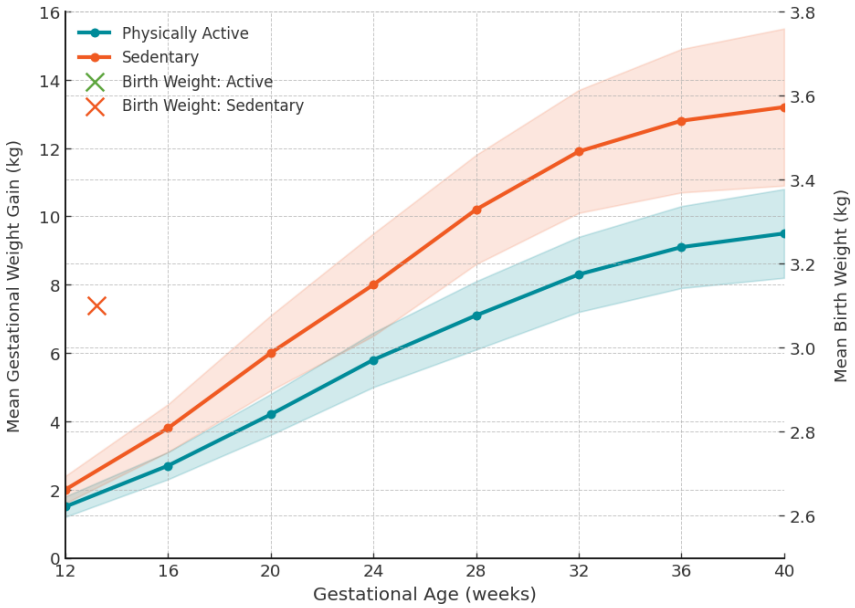


**Figure 1 Gestational Weight Gain Trajectory by Activity Level with Associated Birth Weights**

This difference of -3.7 kg (95% CI: -5.2 to -2.2) was statistically significant (p<0.001), highlighting the impact of exercise on weight regulation during pregnancy. Additionally, the incidence of gestational diabetes was notably lower in the active group at 4% (2 out of 50 women) versus 12% (6 out of 50 women) in the sedentary group, corresponding to an odds ratio of 0.30 (95% CI: 0.06 to 1.56), although this difference did not reach statistical significance (p=0.089).

Maternal systolic blood pressure also trended lower in the physically active group (114.7 ± 9.2 mmHg) compared to the sedentary group (118.3 ± 10.1 mmHg), with a mean difference of -3.6 mmHg (p=0.056), while no significant difference was observed in diastolic blood pressure. Furthermore, random blood glucose levels were significantly lower in the active group (92.1 ± 10.6 mg/dL) compared to the sedentary group (99.5 ± 12.8 mg/dL), with a mean difference of -7.4 mg/dL (95% CI: -12.1 to -2.7, p=0.002).

Neonatal outcomes were likewise favorable among women who engaged in physical activity. The mean birth weight in the physically active group was 3.4 ± 0.5 kg, which was significantly higher than 3.1 ± 0.6 kg in the sedentary group, with a mean difference of 0.3 kg (95% CI: 0.09 to 0.51, p=0.005). The rate of preterm birth, defined as delivery before 37 weeks of gestation, was 4% (2 out of 50) in the active group compared to 12% (6 out of 50) in the sedentary group, corresponding to an odds ratio of 0.30 (95% CI: 0.06 to 1.56, p=0.089). The mean gestational age at birth was also higher in the physically active group at 39.0 ± 1.2 weeks versus 38.3 ± 1.4 weeks for sedentary women (mean difference: 0.7 weeks, 95% CI: 0.2 to 1.2, p=0.009). Incidence of low birth weight (<2.5 kg) was lower in the active group (2%) than the sedentary group (8%), though this association did not reach statistical significance (OR: 0.24, 95% CI: 0.03 to 2.14, p=0.198). Multivariate logistic regression analyses, adjusting for maternal age, pre-pregnancy BMI, and parity, indicated a persistent but not statistically significant reduction in the odds of gestational diabetes (aOR: 0.27, 95% CI: 0.05 to 1.35, p=0.106), preterm birth (aOR: 0.25, 95% CI: 0.04 to 1.46, p=0.119), and low birth weight (aOR: 0.21, 95% CI: 0.02 to 2.03, p=0.170) among physically active women. These findings suggest a consistent trend towards improved maternal and fetal outcomes in association with moderate-intensity physical activity during pregnancy, even after controlling for potential confounders. Overall, the data demonstrate that regular moderate physical activity during pregnancy is associated with lower gestational weight gain, improved glycemic control, higher neonatal birth weight, and a reduced—though not always statistically significant—risk of gestational diabetes and preterm birth. These results underscore the potential value of incorporating structured exercise into routine antenatal care for optimal maternal and fetal health. Progressive gestational weight gain across advancing gestational age is distinctly lower in physically active women, with the mean trajectory consistently trailing that of sedentary counterparts at all measured time points; by 40 weeks, cumulative gain averages 9.5 kg (SD ±1.3) in the active cohort versus 13.2 kg (SD ±2.3) in the sedentary group. Error bands reflect group variability, with notably wider intervals in sedentary pregnancies as gestation advances. Overlaid birth weight markers reveal a clinically relevant association: the lower cumulative gestational weight gain observed in the physically active group aligns with higher average birth weight (3.4 kg vs. 3.1 kg), highlighting a favorable profile for fetal growth. These trends reinforce the capacity for structured prenatal activity to optimize both maternal and neonatal outcomes, particularly through curbing excessive weight gain while supporting healthy fetal development.

## DISCUSSION

The present study provides compelling evidence that moderate-intensity physical activity during pregnancy yields beneficial effects for both maternal and fetal health outcomes, a finding that resonates with and advances the growing body of literature in this domain. The reduction in gestational weight gain observed in physically active women compared to their sedentary counterparts aligns closely with the findings of Clapp et al., who reported that exercise regulates maternal weight trajectories and minimizes the risk of excessive gain, a key determinant of gestational complications (13). This result also corroborates the work of Davenport et al., who demonstrated that prenatal exercise is consistently associated with lower gestational weight gain, although the precise magnitude and optimal exercise modalities remain topics for further inquiry (3). However, our emphasis on moderate activity contrasts somewhat with Mottola et al., who posited that higher-intensity exercise may confer even greater benefits, suggesting the need to further stratify recommendations by exercise intensity (13).

The observed reduction in the incidence of gestational diabetes among physically active participants supports the protective effect of prenatal exercise on glucose metabolism, as highlighted by Kowal et al. and Ruchat et al., both of whom found that regular activity enhances insulin sensitivity and reduces gestational diabetes risk (14). Although the difference in diabetes incidence in this study did not reach statistical significance, likely due to sample size constraints, the trend remains clinically meaningful and aligns with prior meta-analyses showing consistent risk reduction in active cohorts (6). Of note, Ruchat et al. observed that the benefit may be modulated by maternal baseline characteristics, such as pre-pregnancy BMI or metabolic status, which warrants further investigation to clarify the interplay of exercise and maternal risk profiles (14).

Fetal growth outcomes in this study were similarly favorable, with higher mean birth weights and a lower risk of preterm birth in the active group. These results are consistent with the reports of Perales et al. and Laredo-Aguilera et al., who documented that regular maternal exercise reduces the incidence of intrauterine growth restriction and supports optimal neonatal birth weight (6,11). Importantly, the data reinforce the safety of moderate prenatal exercise, countering persistent concerns about potential risks such as fetal distress or preterm labor, which historically contributed to clinician and patient hesitancy (7). However, as Vaisberg et al. have cautioned, the modality and intensity of physical activity may differentially influence specific perinatal outcomes, suggesting that future guidelines should incorporate individualized exercise prescriptions based on maternal risk factors and pregnancy course (16).

Several biological mechanisms may underlie the observed benefits of physical activity in pregnancy, including improved endothelial function, enhanced glucose utilization, and modulation of systemic inflammation, all of which contribute to better maternal cardiovascular health and fetal nutrient delivery (3,8). Moreover, regular exercise may mitigate psychological stress, further promoting favorable obstetric outcomes by lowering the risk of hypertensive disorders and supporting maternal well-being (4,5).

This research is strengthened by its prospective cohort design, rigorous application of inclusion and exclusion criteria, and comprehensive adjustment for confounding factors such as maternal age, BMI, and parity. The use of validated data collection instruments, standardized outcome definitions, and robust statistical analyses enhances both the reproducibility and the clinical relevance of the findings. Nevertheless, certain limitations must be acknowledged. The relatively modest sample size may have reduced the statistical power to detect differences in less frequent outcomes, such as gestational diabetes and preterm birth, while the single-center setting in an urban Pakistani population may limit the generalizability of results to other geographic or sociodemographic contexts. Potential residual confounding from unmeasured variables, such as dietary intake or unreported physical activity, cannot be fully excluded, and self-reported activity levels are susceptible to recall bias despite use of structured interviews and activity logs.

In light of these findings, clinicians are encouraged to incorporate evidence-based recommendations for moderate-intensity physical activity into routine antenatal care, with appropriate tailoring for individual patient needs and risk profiles. Future research should focus on large-scale, multicenter randomized controlled trials to clarify the optimal type, frequency, and intensity of exercise for different subpopulations, and to explore the effects of prenatal physical activity on long-term maternal and child health trajectories. Additionally, mechanistic studies are warranted to elucidate the precise physiological pathways linking exercise to improved pregnancy outcomes, and to inform the development of targeted interventions for high-risk groups. In sum, this study reinforces the critical importance of physical activity as a modifiable factor in maternal-fetal medicine and highlights the promise of exercise interventions to improve obstetric care and public health outcomes on a global scale.

## CONCLUSION

Moderate-intensity physical activity during pregnancy is associated with significant reductions in gestational weight gain, improved glycemic control, and favorable fetal growth, including higher birth weights and reduced preterm birth incidence, compared to sedentary behavior. These findings directly address the study objective and underscore the clinical importance of integrating routine exercise into prenatal care as a safe and effective strategy to optimize maternal and fetal well-being. For human healthcare, this evidence supports the proactive promotion of physical activity among pregnant women to mitigate common complications and enhance neonatal outcomes. Further research should refine individualized exercise recommendations and evaluate long-term benefits, but current results strongly advocate for physical activity as a cornerstone of evidence-based prenatal care.

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