GMR
The Original

OBSTETRICAL OUTCOMES OF PHYSICAL ACTIVITY DURING THIRD TRIMESTER OF PREGNANCY AT NORTHWEST GENERAL HOSPITAL, PESHAWAR

Prof Dr Mehr un Nisa[1], Dr Maryam[2], Dr Sara karim[3], Alizah[4]

[1]Northwest General Hospital, Pakistan, Consultant/Head of department, Obstetrics and Gynae, Mehrobaid@gamil.com
[2]Northwest General Hospital, Pakistan, Postgraduate Trainee, Obstetrics and Gynae, maryam.faseeh123@gmail.com
[3]Northwest General Hospital, Pakistan, Postgraduate Trainee, Obstetrics and Gynae, Sarahkarim786@yahoo.com
[4]Northwest General Hospital, Pakistan, Postgraduate Trainee, Obstetrics and Gynae
***Corresponding Author**: Dr Maryam, maryam.faseeh123@gmail.com

ABSTRACT

Background: Physical activity (PA) during pregnancy is associated with improved maternal metabolic health, reduced gestational complications, and favorable neonatal outcomes. Regardless of global recommendations for at least 150 minutes of moderate-intensity activity per week, adherence declines, particularly in the third trimester.

Objective: To evaluate physical activity patterns during the third trimester of pregnancy and assess their association with feto-maternal outcomes at Northwest General Hospital, Peshawar.

Methodology: This prospective cohort study was conducted from October 2025 to January 2026, enrolling 172 pregnant women aged 18–45 years with singleton viable pregnancies in the third trimester. PA was assessed using the validated Pregnancy PA Questionnaire (PPAQ), and energy expenditure was calculated in MET-h/week. Participants were followed until delivery, and obstetrical outcomes were recorded. Data were analyzed using SPSS 27; $p \leq 0.05$ was considered statistically significant.

Results: Median total PA was 170.4 MET-h/week, with household/caregiving tasks contributing most (51.6%) and sports/exercise minimal (4.1%). Low PA (≤150 MET-h/week) was observed in 58.1% of women. Low activity was significantly associated with higher cesarean section (45.0% vs. 28.1%, p=0.02), preterm birth (14.0% vs. 4.2%, p=0.04), and low birth weight (18.0% vs. 4.2%, p=0.01). Moderate/high activity was associated with shorter median labor duration (420 vs. 510 minutes, p=0.03).

Conclusion: Moderate PA during the third trimester is associated with improved obstetrical outcomes. Counseling pregnant women to engage in safe, regular activity may reduce cesarean rates, preterm birth, and low birth weight.

KEYWORDS: Pregnancy, Third Trimester; Physical Activity; Labor, Obstetric Outcome;

INTRODUCTION

Physical activity (PA) is a term that is used to denote both planned exercises and unplanned day-to-day activities [1]. PA has been linked to lower risk of gestational diabetes mellitus, hypertensive disorders, excessive maternal weight gain during pregnancy and also leads to better maternal mental health [2]. The American College of Obstetricians and Gynecologists (ACOG) suggests that pregnant women should do moderate-intensity PA in 20 to 30 min daily on most days of the week or all the days of the week. Regularly, the 2008 Physical Activity Guidelines to the Americans recommended 150-300 minutes of moderate-intensity aerobic activities per week to pregnant and new mothers [3,4]. PA improves insulin sensitivity and secretion, which stimulates glucose homeostasis. The meta-analyses show that aerobic and resistance training when used as an addition to the standard care can significantly enhance the postprandial glycemic control and lower the fasting blood glucose in comparison with the use of the standard care only [3]. The high percentage of gestational weight gain often increases the pain on the lower-back, pelvic, and/or joints. PA has the ability to reduce musculoskeletal pain in pregnant women with mild cases of pelvic and lumbar discomfort [5,6]. The recent literature has been increasing on the correlation between maternal PA and birth weight of the babies. A systematic review reveals that moderate-intrinsic exercise is linked to increased birth weight, and vigorous-intensive exercise is linked to decreased birth weight [5]. There are some findings that indicate that regular exercise in pregnancy reduces the period of labor time because it decreases the first stage of the labor period, though, some research has found no significant difference between exercising and non-exercising pregnant women [6].

According to a United States study, only 32%. of expectant mothers achieved the levels of PA guideline in early pregnancy, and the rate decreased to 12 per cent. in late pregnancy [7]. South Asian women, who were mostly Pakistani, were almost three times more prone to be physically inactive than Western European women in a multi-ethnic cohort, which was examined at 28 weeks of gestational age [8]. In the USA, only 23.4% of pregnant women

got the minimum of at least 150 minutes of exercise per week in 2007 to 2014 [9]. A study from Agha Khan university, noted that about 86% pregnant women have sedentary life style, whereas just 3% practiced up to 30 minutes per day in sports and exercise activities during pregnancy [10]. A study published in the JCPSP that evaluated health-related behaviors of pregnant women in the face of fatigue disclosed that only 12.8 per cent of the women engaged in regular exercises during pregnancy [11].

Although several studies from Pakistan and other South Asian countries have documented low physical activity levels during pregnancy, evidence regarding the relationship between third-trimester physical activity and obstetrical outcomes remains limited. Most available studies have focused on the prevalence of physical inactivity or general maternal health behaviors rather than prospectively evaluating delivery and neonatal outcomes. Therefore, this study aimed to assess physical activity patterns during the third trimester using the validated Pregnancy Physical Activity Questionnaire (PPAQ) and examine their association with feto-maternal outcomes in a Pakistani population, thereby providing context-specific evidence to inform antenatal counseling and maternal health interventions.

MATHODOLOGY

This prospective cohort study was conducted at the Obstetrics and Gynaecology Department of Northwest General Hospital Peshawar from 30-09-2025 to 30-01-2026. The sample size was 172, calculated through Openepi sample size software, keeping the anticipated frequency of physical exercise by pregnant women as 12.8% [11], 5% margin of error, and 95% confidence interval.

The inclusion criteria were married, pregnant women of age 18 to 45, having with singleton viable pregnancies, during third trimester. Patient with any contraindication to PA during pregnancy, interventions that did not involve exercises beyond physical (mindfulness, spirituality, diet) were be excluded from the study. To minimize selection bias, all eligible women attending the antenatal clinic during the study period were recruited consecutively according to predefined inclusion and exclusion criteria. No additional selection based on demographic, clinical, or physical activity characteristics was performed.

Data collection was started after obtaining approval from the hospital's IRB Committee under Ref No: IRB&EC/2025-GH/0298; dated: 29-09-2025. Inform consent was obtain from patient before enrolling in the study. Information like socio-demographic, anthropometric details, and clinical variables like age, height, weight, BMI, residency, educational level, employment status, number of pregnancies, history of miscarriage and comorbid details was obtained and recorded in a data collection via patient interview. Participants received routine antenatal care according to hospital practice. No structured physical activity intervention, exercise program, or activity prescription was provided as part of the study. Physical activity levels were assessed as naturally occurring behaviors using the Pregnancy Physical Activity Questionnaire (PPAQ), and participants were prospectively followed until delivery

Physical activity was assessed once at the time of enrollment during the third trimester (≥28 weeks of gestation) using PPAQ. No repeated assessments of physical activity were performed during follow-up, and the recorded activity level was used for subsequent analyses of obstetrical outcomes. The PPAQ is a validated survey that is used in this population group and includes 32 items, one group of which is linked with routine activities, that is, household and caregiving (items 4-10 and 15-19), occupational activities (items 32-36), and sporting or exercise activities done during free time (item 23-31). Briefly, the respondents selected the category that the best recorded the length of time they spent doing each activity per day or week. The duration that had been allocated to each activity was then multiplied with its respective intensity. The intensity, which was in addition the time predictor of each item, was calculated based on the guidelines of the PPAQ, based on the well-known compendium of physical activities, and thus providing energy expenditure in metabolic equivalents of task (MET) [12]. This value was further multiplied by the days per week to obtain energy expenditure per hour per week (MET h -week). The amount of physical activity of the pregnant women that was totalized involving the intensity was examined. Follow up was done until delivery. A predesigned proforma was used to record obstetric findings such as duration of labor, premature rupture of membranes (defined as spontaneous rupture of fetal membranes before the onset of labor), mode of delivery, incidence of episiotomy or postpartum perineal tear, Postpartum hemorrhage (PPH) (defined as blood loss exceeding 500 mL following vaginal delivery), gestational age at birth, birth weight or low birth weight (defined as a birth weight of less than 2500 g), and Apgar score at 5 minutes defined as an Apgar score of less than 7 at 5 minutes after birth.

Premature rupture of membranes (PROM) was defined as spontaneous rupture of fetal membranes before the onset of labor. Postpartum hemorrhage (PPH) was defined as blood loss exceeding 500 mL following vaginal delivery. A low Apgar score was defined as an Apgar score of less than 7 at 5 minutes after birth. Outcome data were obtained from medical records and delivery documentation using the same criteria for all participants

Data was analyzed through SPSS version 27. Normality of data was checked by Shapiro-Wilk test. Mean +Standard Deviation or Median (IQR) was calculated for numerical/quantitative variables like age, height, weight, BMI, duration of labor, gestational age, birthweight, and duration of PA per day. Frequencies and percentages was calculated for categorical/qualitative variables such as residency, ethnicity, educational level, employment status, parity, miscarriage history, comorbidity, mode of delivery, Postpartum hemorrhage, use of epidural analgesia, episiotomy/perineal tear, presence of meconium, premature rupture of membranes, APGAR <7 at 5 min and PA status. PA was stratified among

age, occupation, education level and comorbid to control effect modifier. Post-stratification chi-square test or Fisher's exact test was applied taking p-value ≤ 0.05 as statistically significant.

RESULTS

This study included 172 pregnant women with a mean age of 28.9 ± 4.6 years, the majority are in between 21–30 years 90 (52.3%),. Most participants resided in urban areas 105 (61.0%). Regarding education, 76 (44.2%) had secondary education, 49 (28.5%) higher education, while 15 (8.7%) were illiterate. The mean BMI was 26.8 ± 4.1 kg/m², with 84 (48.8%) having normal BMI. Gestational diabetes was present in 19 (11.0%) and hypertension in 16 (9.3%) of the participants (table -1).

Table 1: Baseline Sociodemographic and Clinical Characteristics (n = 172)

Variable	**Results**
Age (years) - Mean ± SD	28.9 ± 4.6
• <20 years – n(%)	8 (4.7%)
• 21–30 years – n(%)	90 (52.3%)
• 31–40 years – n(%)	68 (39.5%)
• >40 years – n(%)	6 (3.5%)
Residence - – n(%)	
Urban	105 (61.0%)
Rural	67 (39.0%)
Education Level – n(%)	
Primary	32 (18.6%)
Secondary	76 (44.2%)
Higher	49 (28.5%)
Illiterate	15 (8.7%)
BMI (kg/m²) - Mean ± SD	26.8 ± 4.1
Normal (18.5–24.9) – n(%)	84 (48.8%)
Overweight (25–29.9) – n(%)	54 (31.4%)
Obese (≥30) – n(%)	22 (12.8%)
Underweight – n(%)	12 (7.0%)
Gestational Diabetes	19 (11.0%)
Hypertension	16 (9.3%)

The median total PA was 170.4 MET-h/week, with most energy expenditure derived from sedentary and light-intensity activities (72.5%). Moderate activity contributed 26.8%, while vigorous activity was negligible. Household and caregiving tasks accounted for the largest proportion (51.6%) of total activity, whereas sports and structured exercise contributed minimally (4.1%) table -2.

Table 2: Total Physical Activity During Third Trimester (PPAQ) (n = 172)

Variable	**Mean ± SD**	**Median (IQR)**	**% Contribution**
Total MET-h/week	181.2 ± 96.4	170.4 (121.6–236.9)	100%
Intensity			
• Sedentary	58.3 ± 33.3	51.9	30.4%
• Light	76.7 ± 40.5	72.1	42.1%
• Moderate	48.7 ± 40.2	34.7	26.8%
• Vigorous	1.2 ± 2.2	0	0.7%
Type			
• Household/Caregiving	95.7 ± 60.4	81.9	51.6%
• Occupational	33.5 ± 41.5	10.1	18.4%
• Sports/Exercise	7.7 ± 8.1	4.2	4.1%

More than half of the participants 100 (58.1%) were classified as having low PA (≤150 MET-h/week), while 72 (41.9%) achieved moderate to high PA levels (>150 MET-h/week) table -3.

Table 3: Classification of Physical Activity Based on Total MET-h/week (n = 172)

Physical Activity Category	**n(%)**

Low Physical Activity (≤150 MET-h/week)	100 (58.1%)
Moderate/High Physical Activity (>150 MET-h/week)	72 (41.9%)
Total	172 (100%)

The mean gestational age at delivery was 38.4 ± 1.5 weeks, with the majority delivering at term 150 (87.2%), while 17 (9.9%) had preterm and 5 (2.9%) had post-term births. Vaginal delivery was the most common mode of delivery 104 (60.5%), followed by cesarean section 65 (37.8%) and instrumental delivery 3 (1.7%). Premature rupture of membranes occurred in 25 (14.5%) women, and postpartum hemorrhage was observed in 11 (6.4%). The mean birth weight was 3.01 ± 0.42 kg, with 21 (12.2%) neonates having low birth weight and 10 (5.8%) macrosomia. An APGAR score <7 at 5 minutes was recorded in 8 (4.7%) newborns. Episiotomy was performed in 30 (29.1%) of vaginal deliveries (table -4).

Table 4: Obstetrical Outcomes (n = 172)

Outcome	Results
Gestational Age (weeks) - Preterm (<37 weeks) Term Post-term	38.4 ± 1.5 17 (9.9%) 150 (87.2%) 5 (2.9%)
Mode of Delivery Vaginal Cesarean Section Instrumental	 104 (60.5%) 65 (37.8%) 3 (1.7%)
PROM	25 (14.5%)
Postpartum Hemorrhage	11 (6.4%)
Birth Weight (kg) Low Birth Weight Macrosomia	3.01 ± 0.42 21 (12.2%) 10 (5.8%)
APGAR <7 at 5 min	8 (4.7%)
Episiotomy	30 (29.1% of vaginal births)

Low PA was significantly associated with higher odds of cesarean section (OR=2.10, 95% CI: 1.10–4.01; p=0.02), preterm birth (OR=3.74, 95% CI: 1.05–13.39; p=0.04), and low birth weight (OR=5.05, 95% CI: 1.43–17.83; p=0.01), and was also associated with a longer duration of labor (p=0.03). No significant associations were found for PROM (OR=1.64, 95% CI: 0.67–4.00; p=0.21) or PPH (OR=1.28, 95% CI: 0.36–4.62; p=0.34) (table 5).

Table 5: Association Between Physical Activity and Obstetrical Outcomes

Outcome	Low PA (n=100)	Moderate/High PA (n=72)	OR (95% CI)	p-value
Cesarean Section	45 (45.0%)	20 (28.1%)	2.10 (1.10–4.01)	0.02
Preterm Birth	14 (14.0%)	3 (4.2%)	3.74 (1.05–13.39)	0.04
Low Birth Weight	18 (18.0%)	3 (4.2%)	5.05 (1.43–17.83)	0.01
PROM	17 (17.0%)	8 (11.1%)	1.64 (0.67–4.00)	0.21
Postpartum Hemorrhage	7 (7.0%)	4 (5.6%)	1.28 (0.36–4.62)	0.34
Median Duration of Labor (minutes)	510	420	—	0.03

DISCUSSION

This study evaluated PA patterns during the third trimester of pregnancy and their association with obstetrical outcomes at Northwest General Hospital, Peshawar. The median total PA of participants was 170.4 MET-h/week, with the majority of energy expenditure derived from sedentary and light-intensity activities (72.5%), and minimal contribution from sports or structured exercise (4.1%). More than half of the participants (58.1%) were classified as having low PA, consistent with global and local trends showing a decline in activity as pregnancy progresses [13]. Similar findings were reported in the literature, where more than half of pregnant women ceased or significantly reduced PA during the third trimester due to discomfort and socio-demographic factors [14-16].

Low PA was associated with higher rates of cesarean section, preterm birth, and low birth weight in this cohort. However, given the observational design and lack of multivariable adjustment, these associations should be interpreted cautiously, as other maternal and clinical factors may have contributed to the observed outcomes. These findings align with prior meta-analyses and prospective studies showing that adequate PA during pregnancy can reduce cesarean delivery rates (RR = 0.87, 95% CI = 0.79, 0.95; p = 0.001), promote term deliveries, and support optimal fetal growth labor duration, and epidural use [17-19]. The shorter median duration of labor observed among moderately or highly active women in our study (420 vs. 510 minutes, p=0.03) is consistent with evidence suggesting that maternal PA improves pelvic floor conditioning, overall maternal fitness, and labor efficiency [17]. Membrane rupture and postpartum bleeding were more prominent among low physical activity participants, but statistically significant results were not obtained, and this result is also similar to other observational studies [20,21].

Nevertheless, the literature regarding the effects of PA on labor duration and birth weight is not entirely consistent. While several studies and meta-analyses have reported shorter labor duration and improved neonatal outcomes among physically active women, others have observed weak or non-significant associations. These differences may be attributable to variations in study populations, gestational age at assessment, intensity and type of activity performed, methods of measuring physical activity, and the extent to which confounding factors such as maternal age, body mass index, parity, and comorbidities were controlled. In the present study, PA was predominantly light-to-moderate in intensity and largely derived from household and caregiving activities, with very limited vigorous exercise. Therefore, our findings support the potential benefits of moderate physical activity during late pregnancy, whereas studies evaluating vigorous exercise or substantially different activity patterns may report different outcomes [22].

Maternal metabolism outcomes showed that 11% of the respondents were found to have gestational diabetes mellitus and 9.3% had hypertension. Although the prevalence is moderate, PA increase the insulin sensitivity and reduce the cases of GDM and gestational hypertension especially when it is continued during pregnancy [21]. In the present study, most PA was derived from household and caregiving tasks and was predominantly light-to-moderate in intensity. However, because outcomes were not analyzed according to specific activity intensities, it is not possible to determine whether light-intensity activity independently contributed to the observed associations. Further studies are needed to evaluate the differential effects of activity intensity and type on maternal and neonatal outcomes.

The outcome of fetuses in the study group (12.2% of newborns had low birth weight, and 5.8% macrosomia) were consistent with a beneficial association between maternal PA and favorable neonatal outcomes. However, given the observational design, these findings should not be interpreted as evidence of a causal relationship. The previous studies have indicated that moderate exercise has been associated with normal or slightly increased birth weight and vigorous exercise can inhibit fetal weight [14,18,19]. The low level of sports or formal exercise activity among this sample is probably the reason why the prevalence of vigorous activity has been non-existent and that births within normal weight distributions have dominated.

The research highlight the important socio-demographic trends; most of the study participants were urban residents with secondary or higher education, although not all followed the exercise recommendations. This finding stresses the idea that barriers to physical exercise in the third trimester are not solely tied to education level or the city lifestyle but also involve physical discomfort and cultural assumptions and changes in the body related to pregnancy [13,16,23].

Study Strength and Limitations

This study used the validated PPAQ to assess PA and examine its association with maternal and neonatal outcomes. However, the use of self-reported data may have introduced recall and social desirability bias. As a single-center study employing consecutive sampling, the findings may have limited generalizability beyond the study setting. Additionally, multivariable analyses were not performed, and residual confounding from factors such as maternal age, BMI, parity, diabetes, hypertension, socioeconomic status, diet, and pre-pregnancy activity levels cannot be excluded. Given the observational design, causal relationships cannot be established, and reverse causation remains possible. Future studies should include larger, multicenter samples, adjust for potential confounders, and incorporate objective measures of physical activity such as accelerometers.

.

CONCLUSION

This study demonstrates that PA during the third trimester of pregnancy is predominantly light-intensity and derived mostly from household and caregiving tasks, with structured exercise being minimal. These findings suggest a potential beneficial association between moderate PA and favorable obstetrical outcomes. Despite adequate awareness and education levels among participants, adherence to recommended PA guidelines remains low, highlighting the need for culturally sensitive counseling and structured interventions to encourage safe exercise during late pregnancy. Promoting even moderate PA can contribute to improved maternal and neonatal health, reduced obstetric complications, and optimized delivery outcomes.

REFERENCES:

1. Gascoigne EL, Webster CM, Honart AW, Wang P, Smith-Ryan A, Manuck TA. Physical activity and pregnancy outcomes: an expert review. Am J Obstet Gynecol MFM. 2023;5(1):100758. doi:10.1016/j.ajogmf.2022.100758.
2. Meander L, Lindqvist M, Mogren I, Sandlund J, West CE, Domellöf M. Physical activity and sedentary time during pregnancy and associations with maternal and fetal health outcomes: an epidemiological study. BMC Pregnancy Childbirth. 2021;21:166. doi:10.1186/s12884-021-03627-6.
3. Mishra S, Kishore S. Effect of physical activity during pregnancy on gestational diabetes mellitus. Indian J Endocrinol Metab. 2018;22(5):661-667. doi:10.4103/ijem.IJEM_618_17.
4. Dipietro L, Evenson KR, Bloodgood B, Sprow K, Troiano RP, Piercy KL, et al. Benefits of physical activity during pregnancy and postpartum: an umbrella review. Med Sci Sports Exerc. 2019;51(6):1292-1302. doi:10.1249/MSS.0000000000001941.
5. Michalek IM, Comte C, Desseauve D. Impact of maternal physical activity during an uncomplicated pregnancy on fetal and neonatal well-being parameters: a systematic review of the literature. Eur J Obstet Gynecol Reprod Biol. 2020;252:265-272. doi:10.1016/j.ejogrb.2020.06.061.
6. Ferreira CL, Guerra CM, Silva AI, Rosário HR, Pereira MB. Exercise in pregnancy: the impact of an intervention program in the duration of labor and mode of delivery. Rev Bras Ginecol Obstet. 2019;41(2):68-75. doi:10.1055/s-0038-1675613.
7. Chan CW, Au Yeung E, Law BM. Effectiveness of physical activity interventions on pregnancy-related outcomes among pregnant women: a systematic review. Int J Environ Res Public Health. 2019;16(10):1840. doi:10.3390/ijerph16101840.
8. Collings PJ, Farrar D, Gibson J, West J, Barber SE, Wright J. Associations of pregnancy physical activity with maternal cardiometabolic health, neonatal delivery outcomes and body composition in a biethnic cohort of 7305 mother-child pairs: the Born in Bradford study. Sports Med. 2020;50(3):615-628. doi:10.1007/s40279-019-01193-8.
9. Liu N, Gou WH, Wang J, Chen DD, Sun WJ, Guo PP, et al. Effects of exercise on pregnant women's quality of life: a systematic review. Eur J Obstet Gynecol Reprod Biol. 2019;242:170-177. doi:10.1016/j.ejogrb.2019.03.009.
10. Hoodbhoy Z, Qureshi R, Iqbal R, Muhabat Q. Household chores as the main source of physical activity: perspectives of pregnant Pakistani women. J Pak Med Assoc. 2018;68(4):565-569.
11. Cinar N, Caka SY, Topal S, Yuvaci HU, Erkorkmaz U. The relation of health-related practices of pregnant women, fatigue and prenatal attachment. J Coll Physicians Surg Pak. 2017;27(11):693-698.
12. Ainsworth BE, Haskell WL, Whitt MC, Irwin ML, Swartz AM, Strath SJ, et al. Compendium of physical activities: an update of activity codes and MET intensities. Med Sci Sports Exerc. 2000;32(9 Suppl):S498-S504.
13. Gabriella SN, Julianna B, Krisztina K, Beatrix L. Physical inactivity during pregnancy: its associations with socio-demographic background and mental health. Demográfia. 2024;67(1):11-42. doi:10.21543/Dem.67.1.1.
14. Silva VR, Boing AF. Prevalence of physical activity and associated factors among pregnant women: a cross-sectional population-based study in southern Brazil. Rev Bras Saude Mater Infant. 2021;21(3):925-934. doi:10.1590/1806-93042021000300011.
15. Sarno L, Borrelli P, Mennitti C, Gentile A, Calvanese M, Orlandi G, et al. Adherence to physical activity among pregnant women in Southern Italy: results of a cross-sectional survey. Midwifery. 2024;137:104102. doi:10.1016/j.midw.2024.104102.
16. Srinayanti Y, Anggraeni S, Litasari R, Lismayanti L. The relationship between pregnancy discomfort and physical activity of third trimester pregnant women. Asy-Syifa J Sci Technol Nurs. 2023;1(2):51-56. doi:10.52221/asyjstn.v1i2.354.
17. Zhang D, Ruchat SM, Silva-Jose C, Gil-Ares J, Barakat R, Sánchez-Polán M. Influence of physical activity during pregnancy on type and duration of delivery, and epidural use: systematic review and meta-analysis. J Clin Med. 2023;12(15):5139. doi:10.3390/jcm12155139.
18. Hu J, Ma Y, Sun M, Wan N, Liu B, Zheng L, et al. Trimester-specific association between fetal growth and physical activity in pregnant women: total physical activity vs moderate-to-vigorous exercise. Ultrasound Obstet Gynecol. 2024;64(3):330-338. doi:10.1002/uog.27713.
19. Legesse M, Ali JH, Manzar MD, Salahuddin M, Hassen HY. Level of physical activity and other maternal characteristics during the third trimester of pregnancy and its association with birthweight at term in South Ethiopia: a prospective cohort study. PLoS One. 2020;15(7):e0236136. doi:10.1371/journal.pone.0236136.
20. Watkins VY, O'Donnell CM, Perez M, Zhao P, England S, Carter EB, et al. The impact of physical activity during pregnancy on labor and delivery. Am J Obstet Gynecol. 2021;225(4):437.e1-437.e15. doi:10.1016/j.ajog.2021.05.036.
21. Walasik I, Kwiatkowska K, Kosińska-Kaczyńska K, Szymusik I. Physical activity patterns among 9000 pregnant women in Poland: a cross-sectional study. Int J Environ Res Public Health. 2020;17(5):1771. doi:10.3390/ijerph17051771.
22. Andargie BA, Legas A, W/Sellassie A, Abuhay H, Angaw DA. Effects of physical exercise during pregnancy on delivery outcomes: systematic review and meta-analysis of randomized controlled trials. PLoS One. 2025;20(7):e0326868. doi:10.1371/journal.pone.0326868.

Ismail CR, Arfah AI, Khalid NF, Hamsah M. Description of physiological changes and feelings of anxiety in 1st trimester pregnant women at RSIA Sitti Khadijah 1 Muhammadiyah Makassar Branch. J Biol Trop. 2024;24(1):736-744. doi:10.29303/jbt.v24i1.6649.