Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/5s1end65

FASTING BLOOD GLUCOSE LEVELS IN NORMAL VERSUS STRESSED PREGNANT TEENAGERS

Rozina Saeed[1], Jamshed Warsi[2], Rubina Amjad[3], Badar Jahan[4], Shabeer Ahmed[5], Noman Sadiq[6*]

[1]PhD Scholar, Department of Physiology, University of Sindh Jamshoro
[2]Associate Professor, Department of Physiology, University of Sindh Jamshoro
[3]Assistant Professor, Department of Gynecology and Obstetrics, Mekran Medical College Turbat.
[4]Associate Professor, Department of Surgery, Shaheed Mohtarma Benazir Bhutto Medical College Lyari, Karachi.
[5]Associate Professor, Department of Physiology, Mekran Medical College, Turbat
[6*] Professor, Department of Physiology, Mekran Medical College, Turbat

***Corresponding Author:** Noman Sadiq
*Professor, Department of Physiology Mekran Medical College, Turbat.
Email: Noman_sadiq89@yahoo.com

Abstract

Background: Teenage pregnancy is a major public health issue and carries an increased risk in the development of metabolic complications. There is little data for the effect of psychological stress on glucose metabolism in this high-risk group.

Objective: To assess the relationship between psychological stress and fasting blood sugar levels in pregnant teenagers.Methodology: This is a cross-sectional study performed from June 2023 to May 2024. A total of 263 pregnant adolescents ((13-19 year) ANC attendees at Gynecology and Obstetrics OPDs in the selected healthcare facilities of Hyderabad and Jamshoro. The subjects were divided into the normal stress group (n=101) and stressed group (n=162). Fasting blood glucose was categorized as normal (≤95 mg/dL) or high risk (>95 mg/dL). Chi-square test was used at $p < 0.05$ level.

Results: Higher proportion of elevated fasting glucose was observed in the stressed (72.85 %) versus normal stress group (30.70 %). The chi-square test was $\chi^2 = 43.30$ ($p < 0.0001$). Pregnant adolescents who were under stress showed higher odds of gestational elevated glucose (OR = 6.05 95% CI: 3.506–10.46).

Conclusion: Psychological stress is closely linked with glucose dysregulation among pregnant adolescents. Incorporating stress evaluation and interventions for stress reduction into prenatal care of adolescents may lead to improved metabolic health and prevent gestational metabolic sequelae.

Keywords: Adolescent pregnancy, psychological stress, fasting blood glucose, gestational diabetes, metabolic risk

Introduction

Adolescent pregnancy is a major public health problem, which affects millions of young women globally with attendant risks for both maternal and neonatal morbidity and mortality.[1] Adolescent pregnancy results in a unique biological condition in which the normal physiological requirements

of growth and development coexist with those imposed by pregnancy, imposing significant metabolic demands upon a developing organism.[2] One of the most important metabolic adaptations necessary in pregnancy is to maintain glucose homeostasis, which becomes more difficult as pregnancy advances and body insulin resistance rises.[3]

The effect on metabolism of pregnancy in adolescence is not confined to the usual gestational changes identified in adult populations. GDM and, to a lower extent preeclampsia and other metabolic disorders are more common in pregnant teenagers than in adults, which can be interpreted as increased metabolic susceptibility for pregnant adolescents.[4-5] It is increasingly evident that psychological and psychosocial stressors have the potential to further amplify these metabolic risks, especially among vulnerable subgroups like pregnant adolescents.[6-7] Prolonged psychological stress activates the hypothalamic-pituitary-adrenal (HPA) axis and sympathetic nervous system, inducing a cascade of neuroendocrine changes that result in markably different glucose metabolism and insulin signaling.[8-9]Although the relationship between psychological stress and metabolic disturbances is already known, not many studies were carried out amongst pregnant adolescents on the effect of psychological stress on glucose homeostasis. This void in literature is especially troubling as pregnant teens frequently experience multiple, simultaneous stressors such as social stigma, poverty, disrupted education and shaky relationships that may compound metabolic risk.[10] Knowledge of the association between stress and glucose metabolism in this particular population is crucial for constructing intervention programs which can be optimised to enhance maternal health outcomes, and decrease the burden of metabolic diseases during such an important developmental time.

In the present study, we tested fasting blood glucose in a cohort of pregnant adolescents and compared metabolic profiles between those subjected to normal relative to high stress levels. Through measuring the link between psychological stress and glucose dysregulation in this vulnerable population, we seek to raise awareness about stress as a promisingly intervening factor for adolescent pregnancy and critically inform clinical and public health efforts of optimizing metabolic health at a formative developmental window.

Methodology

This cross-sectional study was conducted Gynecology and Obstetrics units OPD in selected healthcare facilities of Hyderabad and Jamshoro from June 2023 to May 2024 for a period of one year. Data from 263 pregnant teenagers (13-19 years) was collected. Pregnant adolescents were stratified into two groups based on stress levels measured by using DASS Questionnaire. Normal stress group (n=101) and a stressed group (n=162). Fasting blood glucose measurements were categorized using standard clinical thresholds: normal glucose (≤95 mg/dL) and elevated glucose (>95 mg/dL). Statistical analysis was performed using chi-square testing, with significance set at $p < 0.05$.

Results

The study population comprised 263 pregnant adolescents with a mean age of 17.4 years. One hundred and one participants (38.4%) were classified in the normal stress group, while 162 participants (61.6%) were categorized in the stressed group. The data revealed striking differences in glucose metabolism between the two groups. In the normal stress cohort, 69.30% of participants (n=70) maintained normal fasting glucose levels (≤95 mg/dL), whereas only 27.16% (n=44) of stressed pregnant women achieved similar glycemic control. Conversely, elevated glucose levels (>95 mg/dL) were substantially more prevalent in the stressed group, affecting 72.85% of participants (n=118) compared to just 30.70% (n=31) in the normal stress group.

The chi-square test yielded a χ^2 value of 43.30 with a p-value < 0.0001, indicating highly significant differences in glucose distribution between the two groups. This robust statistical significance demonstrates that the observed metabolic differences are unlikely to be due to chance alone. The 95% confidence interval (3.506 to 10.46) and odds ratio of 6.05 further underscore the substantial association between stress and elevated fasting glucose levels. Stressed pregnant teenagers are approximately six times more likely to present with elevated fasting glucose levels (>95 mg/dL)

compared to their peers in normal stress conditions, highlighting the profound influence of psychological stress on maternal glucose metabolism during pregnancy.

Trimester-specific analysis of fasting blood glucose levels revealed progressive metabolic differences across pregnancy (Table 2). In the first trimester, the normal stress group demonstrated superior glucose control, with 42.64% (n=29) maintaining normal glucose levels (≤95 mg/dL) compared to only 3.91% (n=4) of the stressed group. The elevated glucose prevalence was markedly higher in the stressed cohort at 29.41% (n=20) versus 22.05% (n=15) in the normal stress group during the first trimester. The chi-square analysis yielded $\chi^2 = 13.1$ with $p = 0.0003$, indicating highly significant differences. The odds ratio of 9.6 demonstrates that stressed pregnant adolescents in the first trimester were nearly ten times more likely to present with elevated glucose levels compared to their normal-stress counterparts. This escalating metabolic burden as pregnancy progresses underscores the critical importance of stress management during early pregnancy in adolescent populations.

Table I: Fasting blood Glucose levels in normal versus stressed teen age pregnant women.

Glucose level (Fasting)	**Normal**	**Stress**	**Total**	**X^2**	**P-value**	***95*% Confidence interval**	***Odds Ratio***
Glucose (Normal) (≤95mg/dl)	70(69.30%)	44(27.16%)	114(43.34%)	43.30	< 0.0001	3.506 to 10.46	6.05
Glucose (>95mg/dl)	31(30.70%)	118(72.85%)	149(56.66%)				
Total	101(100%)	162(%)	263(100%)				

Table II: Fasting blood Glucose levels in first trimester in normal versus stressed teen age pregnant women.

Trimester	**Glucose level (Fasting)**	**Normal**	**Stress**	**Total**	**X^2**	**P-value**	***95*% Confidence interval**	***Odds Ratio***
First Trimester	**Glucose (Normal) (≤95mg/dl)**	29(42.64%)	04(5.91%)	33(48.52%)	13.1	0.0003	2.79-33.4	9.6
	Glucose (>95mg/dl)	15(22.05%)	20(29.41%)	35(51.50%)				
	Total	44(64.70%)	24(35.30%)	68(100%)				
Second Trimester	**Glucose (Normal)(≤95mg/dl)**	23(25.84%)	21(23.59%)	44(49.43%)	11.8	0.0006	2.18-16.11	5.9
	Glucose (>95mg/dl)	07(7.86%)	38(42.69%)	45(59.56)				
	Total	30(33.70%)	59(66.30%)	89 (100%)				

Third Trimester	**Glucose (Normal)(≤95mg/dl)**	18(16.98%)	19(17.92%)	27(25.48%)	14.2	0.0002	2.43-16.37	6.3
	Glucose (>95mg/dl)	9(8.49%)	60(56.60%)	79(74.52%)				
	Total	27(25.40%)	79(74.6%)	106(100%)				

Discussion

The greatly higher prevalence of hyperglycemia in stressed pregnant teenagers is a remarkable observation that should be cautiously interpreted and explored. Our findings show that 72.85% of stressed pregnant adolescents already have fasting glucose impaired (>95 mg/dL) in contrast to the non-stressed ones, for whom such prevalence is only 30.70%, an important and robust statistical difference ($\chi^2 = 43.30$, $p < 0.0001$). The odds ratio of 6.05 suggests that stressed teenagers are more than six times as likely as their less-stressed peers to present glucose dysregulation, an effect size highlighting the magnitude of psychological stress's impact on maternal glucose metabolism.

A number of well-defined physiological pathways are probable to play a role in the stress hyperglycemia seen in this population. Acute and chronic psychological stressors are associated with a robust activation of the hypothalamic-pituitary-adrenal (HPA) axis, resulting in elevated and prolonged release of cortisol, as well as adrenocorticotropic hormone (ACTH).[10-11] Markedly raised cortisol directly inhibits insulin production and stimulates hepatic glucose release by activating gluconeogenesis and glycogen breakdown, resulting in increased fasting blood glucose levels.[12] In pregnant adolescents, whose HPA axis is not yet fully matured and still maturing, cortisol increase from stress may be especially robust and metabolically significant.[13] Along with HPA axis activation, psychological stress activates the sympathetic nervous system, which raises circulating catecholamines (epinephrine and norepinephrine).[14] These catecholamines exert an inhibitory effect on pancreatic beta cells, obstructing insulin release while stimulating hepatic glucose production via stimulation of beta-adrenergic receptors.[15] The net result is a (quick) increase in blood glucose, and fasting glucose levels that are high as long as the stress efficiency remains chronic.

Insulin resistance, which is physiologically programmed during pregnancy to facilitate glucose supply for the fetus development occurs progressively as the gestational age increase.[16-17] This insulinaemic resistance of gestation is driven by placental hormones such as human placental lactogen (hPL) and progesterone which oppose the action of insulin in maternal tissues.[18] This effect is compounded by psychological stress, which also has a negative impact on insulin sensitivity through multiple pathways: high cortisol levels suppress the expression of insulin receptors; stress hormones promote lipolysis and the mobilization of free fatty acids (which competitively suppress glucose oxidation), while cytokines produced in response to overall chronic stress inhibit insulin signaling pathways.[19-20] Increasingly, there is evidence to suggest that long-term psychological stress induces low-grade systemic inflammation resulting in increased level of pro-inflammatory cytokines such as interleukin-6 (IL-6), tumor necrosis facto-alpha (TNF-α) and C-reactive protein (CRP). [21-22] These inflammatory mediators directly inhibit the insulin signaling and glucose uptake in peripheral tissues, which results in the fasting hyperglycemia and impaired glucose tolerance. Adverse pregnancy outcomes characterize chronic stress by enhancing inflammation. In pregnant adolescents, the immunologic adaptations to pregnancy may synergize with stress-induced inflammation, magnifying metabolic pathology.[23-24]

The results from this study have important implications for the clinical practice and public health in Pakistan as well as other similar South Asian settings. Typical ANC, as delivered in public and private health facilities in Pakistan includes intermittent glucose screening for GDM; however, systematic stress assessment of pregnant adolescents and stress-targeted strategies are not routinely integrated. Our findings provide evidence that integrating assessment of psychological stress into

routine prenatal care for pregnant adolescents might identify this high-risk group and warrant further metabolic surveillance, perhaps including earlier glucose screening. Because social and cultural environment of adolescent pregnancy is different in Pakistan, the young teenage girls are paying a heavy price with drastic psychosocial consequences from family dynamics, stigma, education and limited job opportunities this holistic assessment becomes of paramount importance.

Conclusion

Our study revealed a strong and statistically significant relationship between psychological stress and high fasting glucose among pregnant adolescents. It is plausible to conclude stress is a modifiable risk factor and worthwhile of clinical attention for patients in Pakistan and other South Asian healthcare settings. Opportunities exist for incorporating comprehensive stress evaluation as part of standard prenatal care of adolescent mothers, which, when combined with culturally sensitive stress-reduction interventions, may critically impact metabolic health and the consequent burden from gestational metabolic complications.

References

1. World Health Organization. Global Accelerated Action for the Health of Adolescents: Guidance to support country implementation. Geneva: WHO; 2023.
2. Morton A, Teasdale S. Physiological changes in pregnancy and their influence on the endocrine investigation. Clinical endocrinology. 2022;96(1):3-11.
3. Bano S, Agrawal A, Asnani M, Das V, Singh R, Pandey A et al. Correlation of insulin resistance in pregnancy with obstetric outcome. The Journal of Obstetrics and Gynecology of India. 2021;71(5):495-500.
4. Kawakita T, Wilson K, Grantz KL, Landy HJ, Huang CC, Gomez-Lobo V. Adverse maternal and neonatal outcomes in adolescent pregnancy. Journal of pediatric and adolescent gynecology. 2016;29(2):130-6.
5. Santana DS, Cecatti JG, Surita FG, Silveira C, Costa ML, Souza RT, et al. Maternal near miss and adverse perinatal outcome among adolescent pregnant women: results from the World Health Organization Multicountry Survey on Maternal and Newborn Health. Eur J Obstet Gynecol Reprod Biol. 2017;209:21-27.
6. Bjelica A, Cetkovic N, Trninic-Pjevic A, Mladenovic-Segedi L. The phenomenon of pregnancy A psychological view. Ginekologia polska. 2018;89(2):102-6.
7. Staneva A, Bogossian F, Pritchard M, Wittkowski A. The effects of maternal depression, anxiety, and perceived stress during pregnancy on preterm birth: a systematic review. Women Birth. 2015;28(3):179-193.
8. Thorp AA, Owen N, Neuhaus M, Dunstan DW. Sedentary behaviors and subsequent health outcomes in adults: a systematic review of longitudinal studies, 1996-2011. Am J Prev Med. 2011;41(2):207-215.
9. Abraham S, Rubino D, Sinaii N, Ramsey S, Nieman LK. Cortisol, obesity, and the metabolic syndrome: A cross-sectional study of obese subjects and review of the literature. Obesity. 2013;21(1):E105-17.
10. Duthie L, Reynolds RM. Changes in the maternal hypothalamic-pituitary-adrenal axis in pregnancy and postpartum: influences on maternal and fetal outcomes. Neuroendocrinology. 2013;98(2):106-15.
11. Tamás P, Sulyok E, Szabó I, Vizer M, Ertl T, Rascher W, Blum WF. Changes of maternal serum leptin levels during pregnancy. Gynecologic and obstetric investigation. 1998;46(3):169-71.
12. Munck A, Guyre PM, Holbrook NJ. Physiological functions of glucocorticoids in stress and their relation to pharmacological actions. Endocr Rev. 1984;5(1):25-44.
13. Romeo RD. The teenage brain: the stress response and the prefrontal cortex. Curr Dir Psychol Sci. 2013;22(2):140-145.
14. Elenkov IJ. Glucocorticoids and the Th1/Th2 balance. Ann N Y Acad Sci. 2004;1024:138-146.

15. Freyberg Z, Gittes GK. Roles of pancreatic islet catecholamine neurotransmitters in glycemic control and in antipsychotic drug–induced dysglycemia. Diabetes. 2023;72(1):3-15.
16. Barbour LA, McCurdy CE, Hernandez TL, Kirwan JP, Catalano PM, Friedman JE. Cellular mechanisms for insulin resistance in normal pregnancy and gestational diabetes. Diabetes Care. 2007;30 Suppl 2:S112-S119.
17. Leoni M, Padilla N, Fabbri A, Della-Morte D, Ricordi C, Infante M. Mechanisms of Insulin Resistance during Pregnancy. InEvolving Concepts in Insulin Resistance 2022. IntechOpen.
18. Newbern D, Freemark M. Placental hormones and the control of maternal metabolism and fetal growth. Curr Opin Endocrinol Diabetes Obes. 2011;18(6):409-416.
19. Zhou J, Han J. Association of niacin intake and metabolic dysfunction-associated steatotic liver disease: findings from National Health and Nutrition Examination Survey. BMC Public Health. 2024;24(1):2742.
20. Ke P, Jiang H, Dowling R, Zhong L, Ke L, Xu M, et al. Relationship between dietary niacin intake and diabetes mellitus in the National Health and Nutrition Examination Survey (NHANES) 2003–2018. Eating and Weight Disorders-Studies on Anorexia, Bulimia and Obesity. 2022;27(7):2425-34.
21. Renner V, Joraschky P, Kirschbaum C, Schellong J, Petrowski K. Pro-and anti-inflammatory cytokines Interleukin-6 and Interleukin-10 predict therapy outcome of female patients with posttraumatic stress disorder. Translational psychiatry. 2022;12(1):472.
22. Renner V, Schellong J, Bornstein S, Petrowski K. Stress-induced pro-and anti-inflammatory cytokine concentrations in female PTSD and depressive patients. Translational psychiatry. 2022;12(1):158.
23. Yan K. Recent advances in the effect of adipose tissue inflammation on insulin resistance. Cellular Signalling. 2024;120:111229.
24. Jagtap A, Jagtap B, Jagtap R, Lamture Y, Gomase K. Effects of prenatal stress on behavior, cognition, and psychopathology: A comprehensive review. Cureus. 2023;15(10):e47044.