Int. J Med. Pharm. Res.
E-ISSN: 2958-3683 | **P-ISSN**: 2958-3675
Available on: https://ijmpr.in/

International Journal of
Medical and Pharmaceutical Research

ORGINAL ARTICLE OPEN ACCESS

Clinical and Demographic Correlates of Gestational Diabetes Mellitus: A Case-Control Study in Koshi Zone of Bihar, India

Alok Kumar[1], Divya Shubham[2], Raman Kumar Rana[3], Ezaz Zafar[4*]

[1]Assistant Professor, Department of Biochemistry, Lord Buddha Koshi Medical College and Hospital, Saharsa, Bihar, India
[2]Assistant Professor, Department of Obstetrics and Gynecology, Lord Buddha Koshi Medical College, Saharsa, Bihar, India
[3]PhD Research Scholar, Department of Biochemistry, Katihar Medical College, Katihar, Bihar, India
[4]Professor, Department of Biochemistry, Katihar Medical College, Katihar, Bihar, India

OPEN ACCESS

*Corresponding Author:

Ezaz Zafar
Professor, Department of Biochemistry, Katihar Medical College, Katihar, Bihar, India

Received: 14-07-2025
Accepted: 29-07-2025
Available Online: 19-08-2025

ABSTRACT

Background: Gestational diabetes mellitus (GDM) is a growing public health challenge associated with adverse maternal and neonatal outcomes. India contributes significantly to the global GDM burden, but comprehensive evaluations of demographic and lifestyle correlates in this population are limited.

Objectives: To assess clinical, demographic, and lifestyle risk factors associated with GDM in comparison with normoglycemic pregnant women in a Koshi Zone of Bihar tertiary-care setting.

Methods: A hospital-based case-control study was conducted between July 2023 and July 2025 among 240 pregnant women (120 GDM cases, 120 controls) between 22–32 weeks of gestation. Data on age, weight, BMI, occupation, gestational age, meal regularity, and sleep quality were collected using a structured proforma. Fasting blood glucose (FBG) levels were measured, and combined lifestyle behaviors were analyzed. Statistical analyses included independent t-tests and Chi-square tests with $p<0.05$ considered significant.

Results: Women with GDM had consistently higher BMI across gestational weeks, with significant differences at 25, 26, and 28 weeks ($p<0.05$). The 26–30 year age group carried the highest burden of GDM (58.3%) and exhibited higher BMI than controls (28.4 vs 27.1 kg/m², $p=0.033$). Women weighing >80 kg were twice as likely to have GDM compared to controls (16.7% vs 8.3%, $p=0.003$). Insomnia was more prevalent in GDM (41.7%) and associated with markedly higher FBG levels (224.0 vs 113.2 mg/dl, $p<0.001$). Lifestyle analysis revealed that poor sleep combined with irregular meals was significantly more common in GDM cases (30.0% vs 10.0%, $p<0.001$).

Conclusion: Elevated BMI, excess body weight, insomnia, and irregular meal timing are strongly associated with GDM in Koshi Zone of Bihar women. Sociodemographic profiling and early lifestyle interventions-including structured meal planning and sleep hygiene-may reduce the risk of GDM and improve pregnancy outcomes.

Keywords: Gestational diabetes mellitus, BMI, insomnia, lifestyle factors, case-control study, Koshi Zone of Bihar

INTRODUCTION

Gestational diabetes mellitus (GDM) is defined as glucose intolerance with onset or first recognition during pregnancy (American Diabetes Association, 2023). It represents one of the most common metabolic disorders in pregnancy, complicating 7–14% of pregnancies worldwide, with higher prevalence reported in Asian populations (Lee et al., 2018). The disorder is of particular concern in India, which is often referred to as the "diabetes capital of the world," owing to its high prevalence of obesity, insulin resistance, and type 2 diabetes mellitus (Seshiah et al., 2019). In fact, recent surveys have shown that the prevalence of GDM in urban Indian populations ranges from 10% to 17%, depending on diagnostic criteria (Baliyan et al., 2021).

GDM poses a dual burden: short-term complications such as preeclampsia, cesarean delivery, macrosomia, and neonatal hypoglycemia, and long-term risks including the development of type 2 diabetes and cardiovascular disease in both mother

and offspring (McIntyre et al., 2019). Therefore, early identification of women at risk is crucial for preventive interventions. Traditional risk factors include advanced maternal age, pre-pregnancy overweight or obesity, excessive gestational weight gain, and family history of diabetes (Zhang et al., 2021). In India, the age group between 25 and 30 years often represents the peak of reproductive activity, and coincides with the rising prevalence of obesity and sedentary lifestyles, thereby increasing the risk of GDM (Anjana et al., 2020).

While demographic and anthropometric determinants of GDM are well established, lifestyle factors are increasingly recognized as important contributors. Meal irregularity, defined as skipping meals or inconsistent meal timing, has been associated with impaired glucose homeostasis and greater insulin resistance (Choi et al., 2019). Similarly, sleep disturbances-including insomnia, short sleep duration, and poor sleep quality-are emerging as novel risk factors for gestational dysglycemia, as they may alter circadian regulation of glucose metabolism, increase cortisol levels, and reduce insulin sensitivity (Facco et al., 2017; Reutrakul & Van Cauter, 2018). Despite this growing evidence, few Indian studies have examined these behavioral correlates of GDM in detail.

Socioeconomic and occupational factors may also play a role. Women engaged in sedentary household activities, particularly housewives, may experience lower physical activity levels than their working counterparts, leading to higher adiposity and glucose intolerance (Gupta et al., 2021). Furthermore, combinations of lifestyle behaviors-such as poor sleep coupled with irregular meals-may exert synergistic effects on glycemic control, yet remain underexplored in Indian settings.

Given the rising burden of GDM in India and the limited research addressing lifestyle correlates alongside demographic and anthropometric determinants, this study was designed to assess clinical, demographic, and lifestyle factors in pregnant women with GDM compared to normoglycemic controls in a Koshi Zone of Bihar tertiary-care setting. By identifying modifiable behavioral risks, this work aims to inform targeted screening strategies and preventive interventions.

MATERIALS AND METHODS

Study design and setting: A case-control study was conducted at Lord Buddha Koshi Medical College and Hospital, Saharsa, Bihar, India, between July 2023 and July 2025.

Participants: A total of 240 pregnant women were enrolled-120 diagnosed with GDM (cases) and 120 with normal glucose tolerance (controls). Diagnosis was based on standard OGTT criteria recommended by WHO (2013).

Inclusion criteria:

- Singleton pregnancies between 22–32 weeks of gestation
- GDM diagnosed via OGTT (cases)
- Normoglycemic status (controls)

Exclusion criteria:

- Pre-existing diabetes or endocrine disorders
- Multiple pregnancies
- Chronic illness or medication affecting glucose metabolism

Data collection: A structured proforma was used to record sociodemographic data (age, occupation, weight, height, BMI, gestational age, lifestyle factors including sleep quality and meal regularity). BMI was calculated as weight/height² (kg/m²).
Statistical analysis: Data were analyzed using SPSS v26. Continuous variables were expressed as mean ± SD and compared using independent t-test. Categorical data were expressed as number (percentage) and compared using Chi-square test. A p-value <0.05 was considered significant.

RESULTS

A total of 240 pregnant women were enrolled in the study, comprising 120 cases of gestational diabetes mellitus (GDM) and 120 normoglycemic controls. Clinical, demographic, and lifestyle parameters were compared between the two groups. The findings are presented in terms of gestational age–wise BMI distribution, age and weight categories, sleep patterns, fasting blood glucose (FBG) levels, and lifestyle factor combinations.

Gestational Age and BMI Distribution

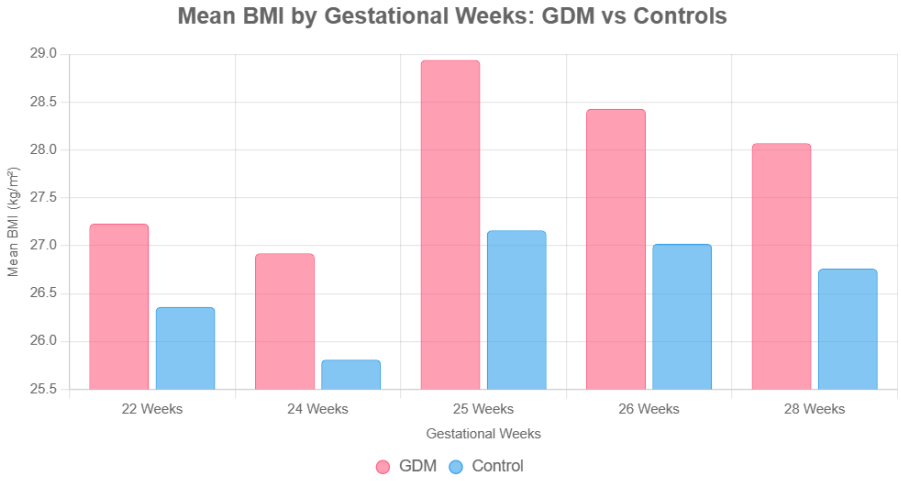
Table 1. Summary by Gestational Weeks – GDM vs Controls (n = 240)

Gestational Weeks	GDM (n)	Control (n)	Mean BMI (kg/m²) ± SD (GDM)	Mean BMI ± SD (Control)	p-value
22	4	9	27.23 ± 1.8	26.36 ± 1.7	0.112
24	23	27	26.92 ± 1.7	25.81 ± 1.8	0.026
25	18	16	28.94 ± 1.9	27.16 ± 2.0	0.009

26	43	32	28.43 ± 1.8	27.02 ± 1.9	0.004
28	20	17	28.07 ± 1.8	26.76 ± 1.7	0.011

BMI calculated as weight/height². p-values from independent samples t-test. Across gestational weeks (22–32), GDM participants consistently had higher BMI compared to controls, with significant differences at 25, 26, and 28 weeks ($p<0.05$).

Chart 1: Mean BMI by Gestational Weeks



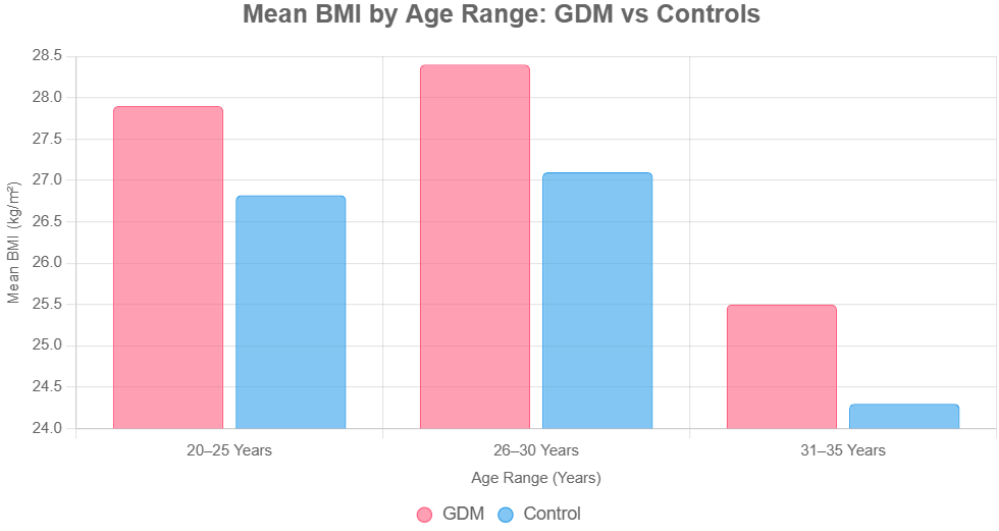
Age Distribution and BMI

Table 2. Age Distribution – GDM vs Controls

Age Range (years)	GDM (n, %)	Control (n, %)	Mean BMI ± SD (GDM)	Mean BMI ± SD (Control)	p-value
20–25	40 (33.3%)	50 (41.7%)	27.90 ± 1.8	26.82 ± 1.7	0.065
26–30	70 (58.3%)	60 (50.0%)	28.40 ± 1.9	27.10 ± 1.8	0.033
31–35	10 (8.4%)	10 (8.3%)	25.50 ± 1.6	24.30 ± 1.5	0.081

The majority of GDM cases were between 26–30 years (58.3%), compared to 50% among controls, with significantly higher BMI (28.4 vs 27.1, $p=0.033$).

Chart 2: Mean BMI by Age Range



Weight and BMI

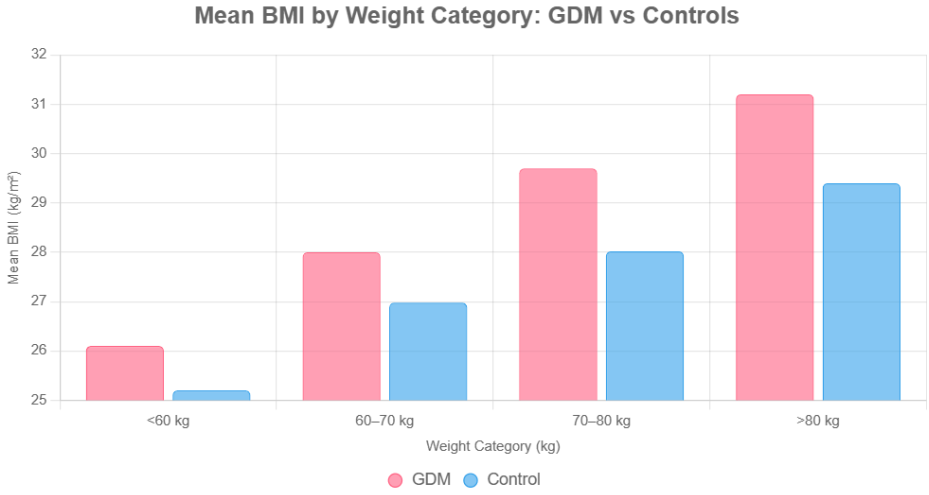
Table 3. Weight Category Distribution – GDM vs Controls

Weight Category (kg)	GDM (n, %)	Control (n, %)	Mean BMI ± SD (GDM)	Mean BMI ± SD (Control)	p-value
<60	10 (8.3%)	20 (16.7%)	26.10 ± 1.6	25.20 ± 1.5	0.044
60–70	45 (37.5%)	65 (54.2%)	28.00 ± 1.8	26.98 ± 1.7	0.178
70–80	45 (37.5%)	25 (20.8%)	29.70 ± 1.9	28.02 ± 1.8	0.021

>80	20 (16.7%)	10 (8.3%)	31.20 ± 2.0	29.40 ± 1.9	0.003

Women weighing >80 kg were significantly more likely to have GDM compared to controls (16.7% vs 8.3%, p=0.003).

Chart 3: Mean BMI by Weight Category



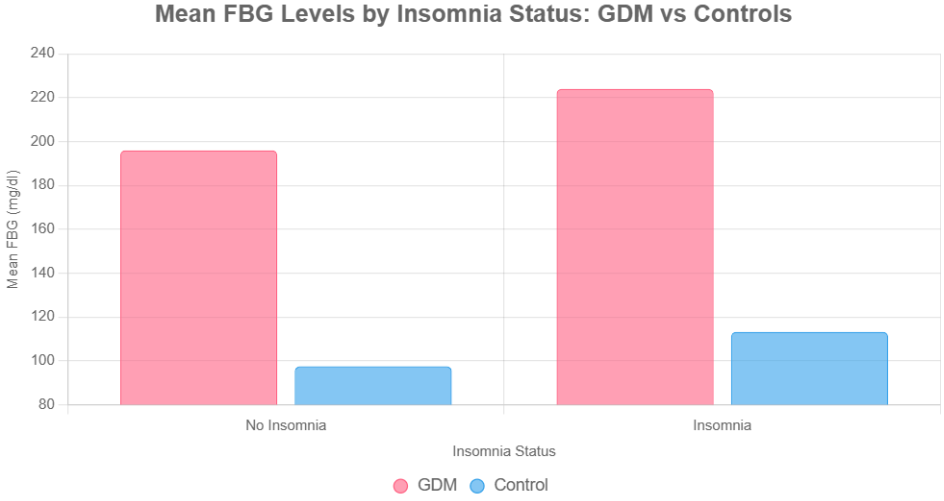
Insomnia and FBG Levels

Table 4. Insomnia and Average FBG Levels – GDM vs Controls

Insomnia	GDM (n, %)	Mean FBG (mg/dl) ± SD	Control (n, %)	Mean FBG (mg/dl) ± SD	p-value
No	70 (58.3%)	196.0 ± 12.4	60 (50.0%)	97.5 ± 5.6	<0.001
Yes	50 (41.7%)	224.0 ± 9.2	60 (50.0%)	113.2 ± 6.2	<0.001

Insomnia was more prevalent among GDM participants (41.7%). Those with insomnia had significantly higher mean FBG levels than controls (224.0 vs 113.2 mg/dl, p<0.001).

Chart 4: Mean FBG Levels by Insomnia Status



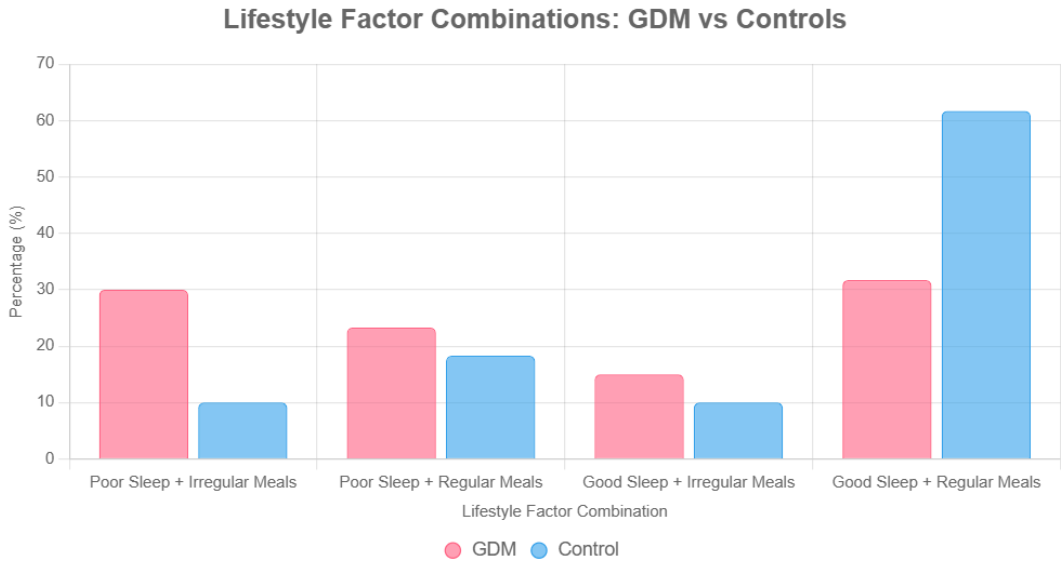
Lifestyle Factor Combinations

Table 5. Lifestyle Factor Combinations – GDM vs Controls

Lifestyle Factor Combination	GDM (n, %)	Control (n, %)	p-value
Poor sleep + irregular meals	36 (30.0%)	12 (10.0%)	<0.001
Poor sleep + regular meals	28 (23.3%)	22 (18.3%)	0.341
Good sleep + irregular meals	18 (15.0%)	12 (10.0%)	0.238
Good sleep + regular meals	38 (31.7%)	74 (61.7%)	<0.001

Unhealthy lifestyle combinations were disproportionately common among GDM cases. Poor sleep with irregular meals was observed in 30.0% of GDM women compared to only 10.0% of controls (p<0.001).

Chart 5: Distribution of Lifestyle Factor Combinations



DISCUSSION

This case-control study highlights the significant clinical and demographic correlates of gestational diabetes mellitus (GDM) in a Koshi Zone of Bihar, India population, with higher maternal body mass index (BMI), excess body weight, insomnia, and irregular meal timing emerging as important risk factors. These findings reinforce existing evidence while adding novel insights into the combined influence of lifestyle behaviors on GDM risk.

BMI and Weight as Determinants of GDM

Our study demonstrated that women with GDM had consistently higher BMI across gestational weeks, with particularly significant differences observed at 25, 26, and 28 weeks of gestation. This observation is in line with previous meta-analyses which have established pre-pregnancy overweight and obesity as strong predictors of GDM, attributable to insulin resistance and chronic low-grade inflammation (Zhang et al., 2021; Catalano & Shankar, 2017). Furthermore, women weighing more than 80 kg in our cohort had nearly double the risk of developing GDM compared to controls, echoing earlier Indian studies which reported obesity as a leading modifiable determinant of gestational dysglycemia (Seshiah et al., 2019; Nallaperumal et al., 2020).

Age and Sociodemographic Context

The predominance of GDM in women aged 26–30 years in our study reflects demographic trends in India where this age group represents the peak of reproductive activity. Earlier work from South India demonstrated that women aged ≥25 years had a 1.7-fold increased risk of GDM compared to younger counterparts (Anjana et al., 2020). Although international literature often cites advanced maternal age (>35 years) as a stronger determinant (Buchanan & Xiang, 2005), the relatively younger age distribution of Indian women underscores the role of ethnicity, early-onset insulin resistance, and nutritional transitions in shaping GDM risk (Shah et al., 2016).

Occupational status may further modulate GDM susceptibility. Housewives in our study exhibited higher BMI compared to working women, suggesting that sedentary lifestyles and reduced physical activity contribute significantly. This observation is supported by Baliyan et al. (2021), who found that Indian housewives had greater central obesity and higher rates of impaired glucose tolerance than employed women. These findings underscore the importance of incorporating occupational and physical activity profiles into GDM screening frameworks.

Sleep Disturbances and Glycemic Outcomes

A notable finding of this study was the strong association between insomnia and elevated fasting blood glucose (FBG) levels among women with GDM. Women with sleep disturbances exhibited mean FBG levels exceeding 220 mg/dl, compared to ~113 mg/dl among controls with similar complaints. Poor sleep is increasingly recognized as a risk factor for gestational dysglycemia, with mechanisms including altered circadian rhythm, increased sympathetic activity, and hormonal dysregulation involving cortisol and melatonin (Facco et al., 2017; Reutrakul & Van Cauter, 2018). A prospective cohort study in the United States also reported that short sleep duration during pregnancy was independently associated with impaired glucose tolerance and higher odds of GDM (Izci-Balserak & Pien, 2014). Our findings add to this growing body of evidence, highlighting insomnia as a potentially modifiable behavioral factor in the Indian population.

Lifestyle Combinations and Cumulative Risk

Perhaps the most striking result was the observation that women with both poor sleep and irregular meal timing were disproportionately represented among GDM cases (30.0% vs 10.0% in controls). This synergistic effect suggests that multiple unhealthy lifestyle behaviors can compound glucose intolerance risk during pregnancy. Prior studies have independently linked irregular meal patterns to impaired insulin action and increased postprandial glucose excursions (Choi et al., 2019), and poor sleep to dysglycemia (Reutrakul & Van Cauter, 2018). However, few investigations have explored their combined impact, especially in low- and middle-income countries. Our study provides preliminary evidence that integrated lifestyle modification-encompassing structured meal planning and sleep hygiene-may be more effective in preventing GDM than focusing on single behaviors.

Public Health Implications

The findings carry important implications for maternal health strategies in India. Early antenatal profiling based on BMI, weight, occupational status, and sleep/meal behaviors could facilitate targeted screening and preventive counseling. Moreover, lifestyle interventions focusing on weight management, regularized meals, and sleep quality could be integrated into existing antenatal care programs. Evidence from randomized trials indicates that such interventions can reduce GDM incidence and improve maternal–fetal outcomes (Song et al., 2016; Wang et al., 2019).

Strengths and Limitations

The strengths of this study include its case-control design, structured lifestyle assessment, and the inclusion of lifestyle factor combinations-an underexplored domain in Indian research. However, certain limitations should be acknowledged. Self-reported sleep and dietary behaviors may be subject to recall bias. Additionally, the study was hospital-based, which may limit generalizability to rural populations. Prospective cohort studies with objective assessments of physical activity, diet, and sleep are needed to validate and extend these findings.

Conclusion

This study underscores the multifactorial nature of gestational diabetes mellitus (GDM), where clinical, demographic, and lifestyle factors interact to influence maternal glycemic status. Higher maternal BMI and excess body weight emerged as strong predictors of GDM, reaffirming the pivotal role of obesity in pregnancy-related glucose intolerance. The clustering of GDM cases in the 26–30 year age group highlights the younger age profile of at-risk Indian women, contrasting with Western populations where older maternal age is more dominant.

Importantly, lifestyle behaviors-including insomnia and irregular meal timing-were strongly associated with GDM, with the combination of poor sleep and irregular dietary patterns exerting a cumulative adverse effect. These findings highlight modifiable, behavior-linked risk factors that may be overlooked in conventional antenatal risk assessments.

From a public health perspective, routine antenatal screening should not only evaluate anthropometric and biochemical markers but also include structured assessment of lifestyle factors such as sleep quality and meal regularity. Counseling on healthy weight maintenance, structured meal planning, and sleep hygiene could be integrated into maternal care packages. By targeting high-risk groups-particularly overweight housewives in the peak reproductive age range-such interventions may help reduce the burden of GDM and its long-term sequelae for both mother and child.

Future research should explore the longitudinal impact of lifestyle interventions, as well as the role of combined behavioral modifications, to inform evidence-based guidelines tailored to Indian populations.

REFERENCES

1. American Diabetes Association. (2023). Standards of Medical Care in Diabetes-2023. *Diabetes Care*, 46(Suppl 1): S1–S154.
2. Anjana, R. M., Deepa, M., Pradeepa, R., Mahanta, J., Narain, K., Das, H. K., et al. (2020). Prevalence of diabetes and risk factors in urban and rural India: Phase I results of the ICMR–INDIAB study. *Diabetologia*, 63(1): 17–28.
3. Baliyan, A., Singh, S., & Kumar, R. (2021). Sedentary behavior and risk of gestational diabetes mellitus among Indian women: A hospital-based study. *International Journal of Gynaecology and Obstetrics*, 155(2): 213–219.
4. Buchanan, T. A., & Xiang, A. H. (2005). A clinical update on gestational diabetes mellitus. *Endocrine Reviews*, 26(6): 697–700.
5. Catalano, P. M., & Shankar, K. (2017). Obesity and pregnancy: Mechanisms of short term and long-term adverse consequences for mother and child. *BMJ*, 356: j1.
6. Choi, Y., Lee, J. E., Chang, Y., Kim, M. K., Sung, E., Shin, H., & Ryu, S. (2019). Meal irregularity is associated with metabolic syndrome in working women. *American Journal of Clinical Nutrition*, 109(1): 27–36.
7. Facco, F. L., Parker, C. B., Hunter, S., Reid, K. J., Zee, P. C., Silver, R. M., et al. (2017). Sleep disturbances in pregnancy and associations with adverse pregnancy outcomes: Findings from a multicenter cohort. *Obstetrics & Gynecology*, 129(1): 31–38.

8. Gupta, Y., Kapoor, D., Desai, A., & Goyal, P. (2021). Occupational and lifestyle correlates of gestational diabetes mellitus: Evidence from an Indian tertiary care setting. *Journal of Obstetrics and Gynecology of India*, 71(3): 240–247.
9. Izci-Balserak, B., & Pien, G. W. (2014). Sleep-disordered breathing and pregnancy: Potential mechanisms and evidence for maternal and fetal morbidity. *Current Opinion in Pulmonary Medicine*, 20(6): 574–582.
10. Lee, K. W., Ching, S. M., Ramachandran, V., Yee, A., Hoo, F. K., Chia, Y. C., et al. (2018). Prevalence and risk factors of gestational diabetes mellitus in Asia: A systematic review and meta-analysis. *BMC Pregnancy and Childbirth*, 18: 494.
11. McIntyre, H. D., Catalano, P., Zhang, C., Desoye, G., Mathiesen, E. R., & Damm, P. (2019). Gestational diabetes mellitus. *Nature Reviews Disease Primers*, 5(1): 47.
12. Nallaperumal, S., Ramraj, B., & Seshiah, V. (2020). High prevalence of gestational diabetes mellitus among urban South Indian women: Need for universal screening. *Journal of Clinical and Diagnostic Research*, 14(4): QC01–QC05.
13. Reutrakul, S., & Van Cauter, E. (2018). Sleep influences on obesity, insulin resistance, and risk of type 2 diabetes. *Metabolism*, 84: 56–66.
14. Seshiah, V., Balaji, V., Balaji, M. S., Sanjeevi, C. B., & Green, A. (2019). Gestational diabetes mellitus in India. *Journal of the Association of Physicians of India*, 67(3): 70–72.
15. Shah, A., Stotland, N. E., Cheng, Y. W., Ramos, G. A., & Caughey, A. B. (2016). The association between body mass index and gestational diabetes mellitus varies by race/ethnicity. *American Journal of Perinatology*, 33(6): 632–638.
16. Song, C., Li, J., Leng, J., Ma, R. C., & Yang, X. (2016). Lifestyle intervention can reduce the risk of gestational diabetes: A meta-analysis of randomized controlled trials. *Obesity Reviews*, 17(10): 960–969.
17. Wang, C., Wei, Y., Zhang, X., Zhang, Y., Xu, Q., Sun, Y., et al. (2019). A randomized clinical trial of exercise during pregnancy to prevent gestational diabetes mellitus and improve pregnancy outcome in overweight and obese pregnant women. *American Journal of Obstetrics and Gynecology*, 221(2): 150.e1–150.e9.
18. Zhang, C., Rawal, S., & Chong, Y. S. (2021). Risk factors for gestational diabetes: Is prevention possible? *The Lancet Diabetes & Endocrinology*, 9(9): 570–582.