

Occupational Stress, Serum Cortisol Concentration, and the Risk of Type 2 Diabetes Mellitus in Paramedical Workers

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Abstract:

Background: Occupational stress is increasingly recognized as a contributor to metabolic disturbances, including impaired glucose regulation. Serum cortisol serves as an important physiological marker linking psychological stress with metabolic outcomes.

Objective: To determine whether occupational stress is associated with an increased risk of Type 2 Diabetes Mellitus (T2DM) among paramedical workers, using serum cortisol as a biomarker of stress response.

Methods: A cohort of 250 non-diabetic paramedical workers was evaluated. Psychological stress was assessed using the Perceived Stress Scale (PSS-10) and General Health Questionnaire (GHQ-12). Serum cortisol levels were measured by Architect chemiluminescent immunoassay. Fasting blood glucose (FBG) and post-prandial blood glucose (PPBG) were estimated from plasma using the glucose oxidase method on an automated chemistry analyser. Workers were grouped based on years of work experience (0–10, 11–20, and 21–30 years). Statistical analysis included Pearson correlation to assess associations among cortisol, stress scores, and glucose indices.

Results: Age showed a weak but significant positive correlation with fasting blood sugar ($r = 0.152$, $p < 0.05$), while no significant association was found with cortisol or PPBS. Cortisol was significantly correlated with PPBS ($r = 0.183$, $p < 0.01$), suggesting that stress-related hormonal changes may influence post-prandial glycemic response more than fasting glucose. A strong correlation between FBS and PPBS ($r = 0.718$, $p < 0.01$) indicates consistent glycemic tendency across fasting and post-meal states. Group-wise comparison showed highest cortisol in 0–10 years, lowest cortisol and stress score in 11–20 years, and higher stress score in 21–30 years, supporting the role of stress in modulating post-meal blood glucose levels.

Conclusion: Occupational stress may promote increased cortisol secretion and disturbance in glucose regulation, thereby potentially increasing the risk of T2DM among paramedical workers.

Keywords: Type 2 Diabetes Mellitus; Occupational stress; Serum cortisol; Perceived stress; Fasting blood glucose; post-prandial blood glucose.

INTRODUCTION

Diabetes mellitus is a metabolic disorder marked by chronic disturbance of glucose regulation, most commonly resulting from defective insulin secretion, reduced insulin sensitivity, or both, ultimately leading to persistent hyperglycaemia in addition to abnormalities in insulin dynamics, stress-related hormonal changes may also influence glucose metabolism¹. Among these, cortisol plays a central role. During psychological stress, cortisol secretion rises and may increase blood glucose mainly by stimulating gluconeogenesis; when cortisol remains elevated for prolonged periods, it may contribute to the development of Type 2 Diabetes Mellitus (T2DM). However, earlier findings on the relationship between occupational stress and T2DM have been variable and at times contradictory.²

Cortisol is a glucocorticoid hormone produced by the zona fasciculata of the adrenal cortex. It is released as part of the physiological stress response and contributes to increased circulating glucose availability, while also exerting regulatory effects on immune and inflammatory pathways.³ Although short-term cortisol elevation is considered beneficial for adaptation, sustained exposure can adversely affect both metabolic and immune functions, thereby increasing vulnerability to chronic metabolic diseases. Continuous occupational and psychosocial stress may maintain cortisol at higher-than-normal levels, potentially promoting persistent hyperglycaemia.⁴

Moreover, when stress is long-standing and not counterbalanced by protective lifestyle behaviours such as adequate physical activity and healthy dietary patterns, cortisol elevation may persist and gradually contribute to insulin resistance. Over time, the pancreatic β -cells may fail to compensate for increasing insulin demand, leading to progressive metabolic deterioration and higher risk of T2DM.⁵ One of the most significant clinical outcomes associated with chronically raised cortisol is impaired glucose control, as cortisol interferes with insulin signalling, reduces insulin effectiveness, and favours prolonged elevation of blood glucose.⁶

Although T2DM is multifactorial and heterogeneous in nature, psychological stress has been recognised as an important factor influencing its onset, severity, and long-term outcomes. Stress is often linked with obesity, hypertension, physical inactivity, dyslipidaemia, and poor glycaemic regulation. Additionally, the diagnosis and long-term management of T2DM can itself become a chronic stressor, as it demands sustained lifestyle changes and continuous monitoring.⁷

In this context, the present study explores the association between occupational stress and serum cortisol levels among paramedical workers, and further evaluates the relationship between cortisol concentration and blood glucose indices.

METHODS

Study Design

A cohort study design was adopted to evaluate the association between occupational stress and risk factors suggestive of Type 2 Diabetes Mellitus (T2DM) among paramedical workers. Serum cortisol was assessed as a biological marker reflecting physiological stress response.

Study Setting

The study was conducted in Vivekanand hospital at Lucknow, Uttar Pradesh after ethical clearance

Study Population and Sampling

A total of 250 non-diabetic paramedical workers aged 25–60 years, with 2–30 years of work experience, were recruited. Participation was voluntary, and written informed consent was obtained prior to enrolment. Only workers who completed both stress assessment questionnaires (**PSS-10 and GHQ-12**) were included in the final analysis.

Eligibility Criteria

Inclusion criteria: Participants were eligible if they were active workers exposed to occupational stress, belonged to the age group 25–60 years, had 2–30 years of service, and were non-diabetic or pre-diabetic with a high physical workload.

Exclusion criteria: Workers were excluded if they were diagnosed cases of diabetes mellitus, or uncontrolled diabetes.

Statistical method:

Occupational stress was assessed using PSS-10 and GHQ-12. PSS-10 scores were categorized as low (0–13), moderate (14–26) and high (27–40). Fasting venous blood (09:00 h) was collected for FBG and serum cortisol, and post-prandial samples (2 h after breakfast) for PPBG. Glucose was estimated by the glucose oxidase method (Biolis 50i, Tokyo Boeki, Japan; Biorad QC Level 1/2) and serum cortisol by CMIA (Architect i, Abbott, USA; reference range 3.7–19.4 $\mu\text{g/dl}$).

Statistical Analysis

Data were analysed using Pearson’s correlation test (two-tailed) at a 95% confidence interval to assess relationships among serum cortisol, glucose indices, age, and perceived stress scores. Statistical significance was considered at $p < 0.05$.

Table 1. Parameters analysed for stress-associated Type 2 diabetes risk among paramedical workers (by service duration)

Parameter	0–10 years	11–20 years	21–30 years
Cortisol ($\mu\text{g/dl}$)	26.8 ± 2.0	22.4 ± 1.2	24.3 ± 3.0
Fasting blood sugar (mg/dl)	107.6 ± 2.8	109.3 ± 3.5	109.1 ± 4.0
Post-prandial blood sugar (mg/dl)	134.7 ± 1.9	135.2 ± 2.4	135.4 ± 3.4
Stress score	20.3 ± 1.1	16.4 ± 1.9	20.7 ± 2.1

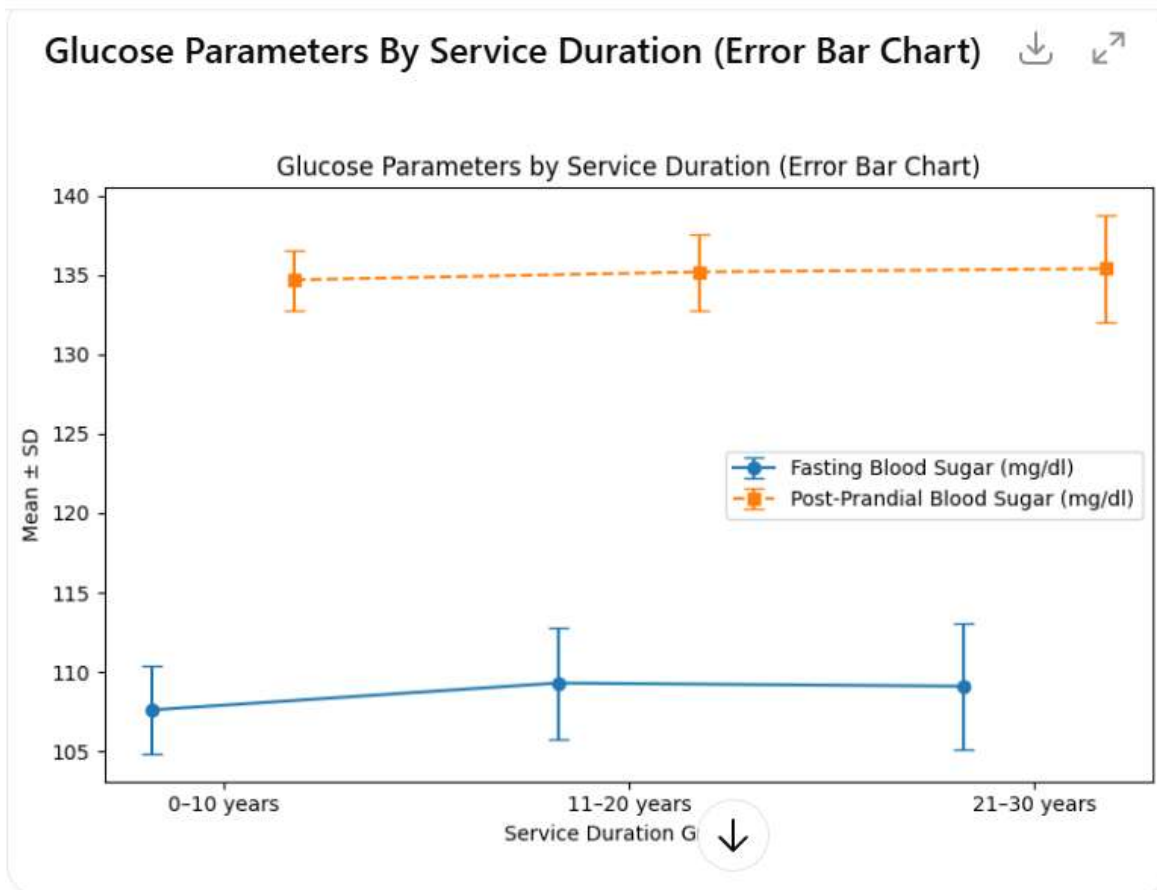


Table 2. Correlation between age, cortisol and blood glucose levels

	Age	Cortisol	FBS	PPBS
Age	1	-0.062	0.152*	0.095
Cortisol	-0.062	1	0.104	0.183**
FBS	0.152*	0.104	1	0.718**
PPBS	0.095	0.183**	0.718**	1

*Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Correlation Chart (Heatmap Style Representation)

	Age	Cortisol	FBS	PPBS
Age	✓ 1.00	▼ -0.062	□ 0.152*	□ 0.095
Cortisol	▼ -0.062	✓ 1.00	□ 0.104	□ 0.183**
FBS	□ 0.152*	□ 0.104	✓ 1.00	□ 0.718**
PPBS	□ 0.095	□ 0.183**	□ 0.718**	✓ 1.00

Legend (Correlation Strength Chart Key)

- ✓ 1.00 = Perfect correlation (self)
- ▼ Negative correlation
- □ Very weak positive (0.00 – 0.10)
- □ Weak positive (0.11 – 0.30)
- □ Strong positive (≥ 0.70)

* Correlation significant at 0.05 level (2-tailed)

** Correlation significant at 0.01 level (2-tailed)

RESULTS

Correlation analysis revealed a weak but significant positive association between age and fasting blood sugar (FBS) ($r = 0.152, p < 0.05$), whereas age was not significantly correlated with cortisol ($r = -0.062$) or post-prandial blood sugar (PPBS) ($r = 0.095$). Cortisol showed a significant positive correlation with PPBS ($r = 0.183, p < 0.01$), but not with FBS ($r = 0.104$). A strong positive correlation was observed between FBS and PPBS ($r = 0.718, p < 0.01$). Across age groups, mean cortisol levels were highest in the 0–10 years group ($26.8 \pm 2.0 \mu\text{g/dl}$), lowest in the 11–20 years group ($22.4 \pm 1.2 \mu\text{g/dl}$), and intermediate in the 21–30 years group ($24.3 \pm 3.0 \mu\text{g/dl}$). Mean FBS values were comparable across groups ($107.6 \pm 2.8, 109.3 \pm 3.5, \text{ and } 109.1 \pm 4.0 \text{ mg/dl}$, respectively), as

were PPBS values (134.7 ± 1.9 , 135.2 ± 2.4 , and 135.4 ± 3.4 mg/dl). Stress score was lowest in the 11–20 years group (16.4 ± 1.9) and higher in the 0–10 years (20.3 ± 1.1) and 21–30 years groups (20.7 ± 2.1).

DISCUSSION

The findings suggest that fasting blood sugar tends to increase slightly with age, as indicated by the weak but significant positive correlation between age and FBS. Although the correlation strength is low, it may reflect an age-related shift in baseline glucose regulation.

A significant positive relationship was observed between cortisol and post-prandial blood sugar (PPBS), indicating that higher cortisol levels (stress hormone) may contribute to elevated glucose levels after meals. This supports the concept that stress-related hormonal changes can influence post-meal glycemic response more prominently than fasting glucose.

The strong positive correlation between FBS and PPBS shows that individuals with higher fasting glucose levels also tend to have higher post-prandial glucose, suggesting an overall consistent glycemic pattern and possible early metabolic dysregulation in individuals with raised FBS.

Across age groups, children (0–10 years) showed the highest cortisol levels, while adolescents (11–20 years) had the lowest cortisol and lowest stress score, indicating comparatively better stress adaptation in this group. Adults (21–30 years) showed a higher stress score, which may explain the rise in cortisol compared to adolescents, although cortisol remained lower than in children.

Overall, the results indicate that stress (reflected by cortisol levels) has a greater influence on post-prandial glucose than fasting glucose, and age shows only a minor effect on fasting blood sugar. These findings highlight the importance of stress management in maintaining healthy glucose regulation, particularly in controlling post-meal blood sugar levels.

Conclusion

This study identified an association between occupational stress and serum cortisol levels and demonstrated significant correlations between cortisol and glucose indices. Occupational stress was associated with higher fasting and post-prandial glucose levels, suggesting stress-related endocrine changes may increase the risk of T2DM among industrial workers.

CONFLICT OF INTEREST

None

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