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Workplace Stress and The Impacts on Blood Sugar Levels in Individuals with Diabetes

Abstract:

The study investigated the effects of stress on glucose, cholesterol, and mean arterial pressure (MAP) in individuals with diabetes. Thirteen volunteers from the POLAC community participated, with six meeting the inclusion criteria. Participants underwent testing over three phases: before exams (pre-stress), during exams (stress), and after exams (post-stress), each lasting two weeks. Glucose and blood pressure were measured on alternate days, while cholesterol and weight were measured weekly. All the measured parameters were taken in the morning after an overnight fast of at least ten hours. Results showed glucose levels generally peaked during stress, with some variations. Total cholesterol also peaked during or after stress for half the participants, and MAP peaked during stress in one-third of participants. Significant changes (P<0.05) were observed mainly in glucose levels, indicating that stress heavily impacts glucose regulation, and cholesterol levels can remain elevated even after stress subsides. The findings highlight the considerable impact of stress on health parameters in individuals with diabetes. The study interprets this finding as challenging to maintain stable glucose levels in diabetic individuals under stress, emphasizing strict compliance

Key Words: stress; diabetic individuals; glucose; total cholesterol and mean arterial pressure

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Introduction:

Stress is a nonspecific response of the body that causes biochemical reactions within the body, leading to feelings of anxiety, depression, and tension [1]. It activates the body's fight-or-flight response in different situations, shaped by internal and external factors. As a natural physical and psychological response to life events, stress affects everyone at various times. Workplace stress is a global problem for years. In the workplace, it has gained particular importance due to its effects on health [2] (Table 1, Fig. 1, 2 and 3) and job performance. The notion of stress has been a longstanding topic of debate in scientific discourse, with scholars frequently defining it as a disruption to homeostasis [3-4]. Earlier interpretations described stress as the body's reaction to harmful stimuli.

In today's fast-paced world, stress is a negative experience. However, it can be neutral, harmful, or beneficial (stimulating, inspiring and enjoyable). The positive effects of stress help maintain cellular and species homeostasis, promoting ongoing survival [5]. Excessive stress triggers various health issues (Table 1), with substantial evidence indicating its impact on individual well-being [6]. Stress can further aggravate preexisting health conditions, such as diabetes, which involves disruptions in glucose (Fig 1), cholesterol (Figure. 3), and other metabolic processes.

Diabetes is a persistent metabolic problem characterized by elevated blood glucose levels (Fig. 1, see E and Hii), insulin resistance, and relative insulin inadequacy (Fig. 1, see F), in some cases, diabetes could cause abnormal elevation in cholesterol concentration which could precipitate to clogging of artery (Fig. 3 see A, D and F). Stress can equally trigger cholesterol elevation especially low-density lipoprotein (Fig. 3 see B and E). When homeostatic is disrupted, stress-induced biochemical changes occur. Homeostasis remains a central concept in understanding stress.

Stress hormones (cortisol and others) may trigger more liver glucose production (Fig. 3 see E) and increased blood pressure (Figure 3 number G and Fig. 2) making the body more responsive to stress, which can degenerate into insulin resistance (Fig 1 see F), high blood pressure (Fig. 2), diabetes (Fig. 1), and organ damage. Blood pressure, glucose level, and cholesterol are valid clues in assessing stress signals as they are negatively impacted in chronic stress. Since high blood pressure harms the organs and mean arterial pressure is an indication of pressure for organ perfusion and oxygen delivery, determining it provides an additional research advantage. The researchers consider these parameters values to study diabetes in individual burden with workplace stress in the Police Academy.

Stress Impacts	Description of the Phenomenon
Headache	Triggers and intensified tension leading to headache
Increased Depression	Chronic stress can wear down emotionally and lead to depression
Heart Burn	Increased production of stomach acid, leading to heart burn
Rapid Breathing	Breathing Muscles tensed up, causing short of breath
Heart attack and sudden Cardiac death	Increased heart rate and high blood pressure over time damage arteries, leading to heart attach
Weakened immune system	Long-term stress weakens immunity, leading to vulnerability to diseases
Insomnia	Stress makes it difficult to fall and stay asleep, leading to insomnia
High *glucose in blood, obesity and type 2 diabetes	Stress causes liver to release extra glucose into the bloodstream and over time triggers type diabetes development
Pounding Heart	Stress hormones make the heart pump faster
Fertility problem	Stress interferes with the reproductive system in male and female making it difficult to conceive.
Skin problems	Acne, rashes, eczema, bags under the eye, wrinkles, dry skin, hair and gray hair, all develop on the skin
High *blood pressure	Stress hormones tighten blood vessels, leading to high blood pressure
Stomach-Ache	It affects the body's digestive system, leading to stomach-ache, nausea, and ulcer
Missed period	Fluctuations in Hormones can throw off the mensural cycle
Tensed muscle	Stress makes muscle tense up and chronic stress can lead to tension-related headaches and back pains
low Sex Drive, chronic	Stress and fatigue that often comes with it can take a toll on the libido
High *Cholesterol	May interfere with lipid clearance. Stimulation the release of cortisol and adrenaline which stimulate the release The more anger and hostility that stress produces in the body, the higher (and worse) the LDL and Triglyceride. Stress increases cholesterol levels and in particular the bad (LDL)cholesterol

Table 1: ***Various serious risk of prolonged stress impacts on health.***

Asterisk indicate the parameter that were used in deciding stress impact on diabetes individuals Adopted with modification from Parker et al. [7] and Ketchesin et al. [8].

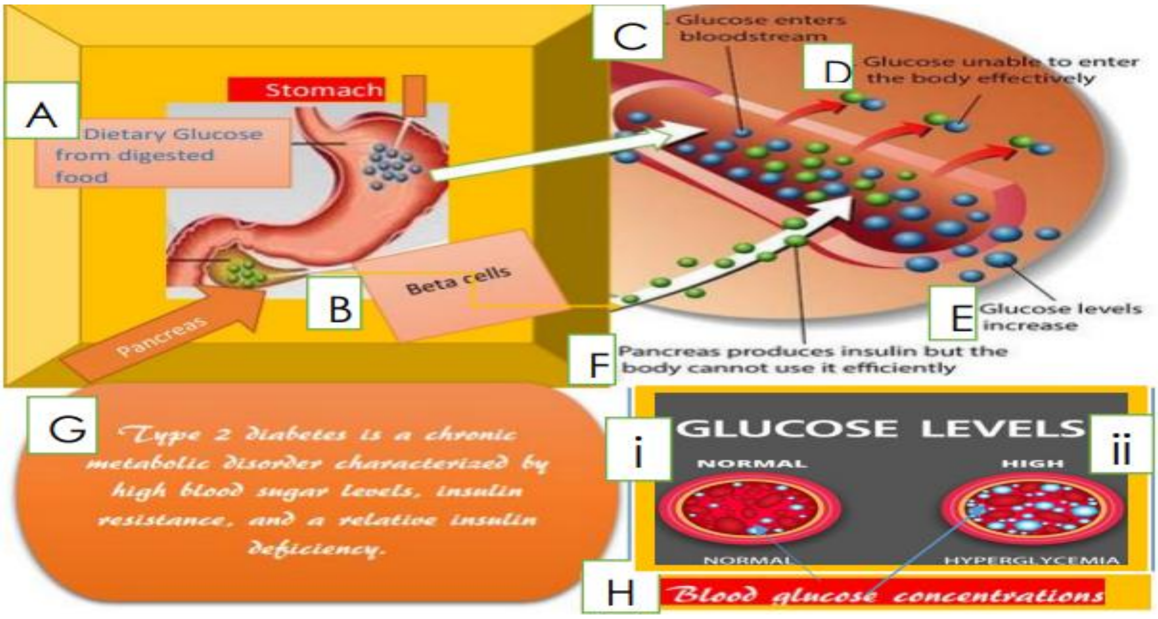


Figure 1: ***Type 2 Diabetes developmental mechanisms and manifestations adopted with modification from Parker et al. [7], Pataki and Szőllősi, [7] Chen et al., [10] and Midha et al. [11].***

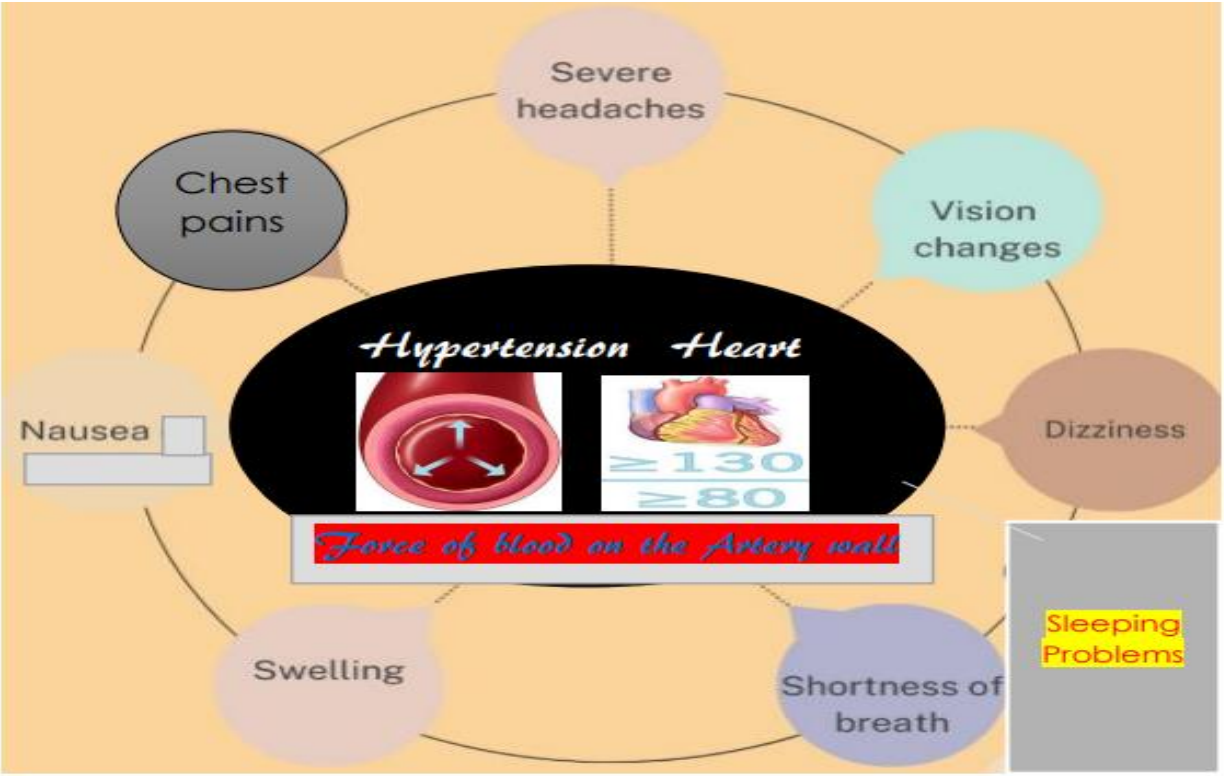


Figure 2: *Symptoms of stress triggered high blood pressure. Adopted with modification from Burch et al. [12], Viera, [13] and Mancia et al. [14].*

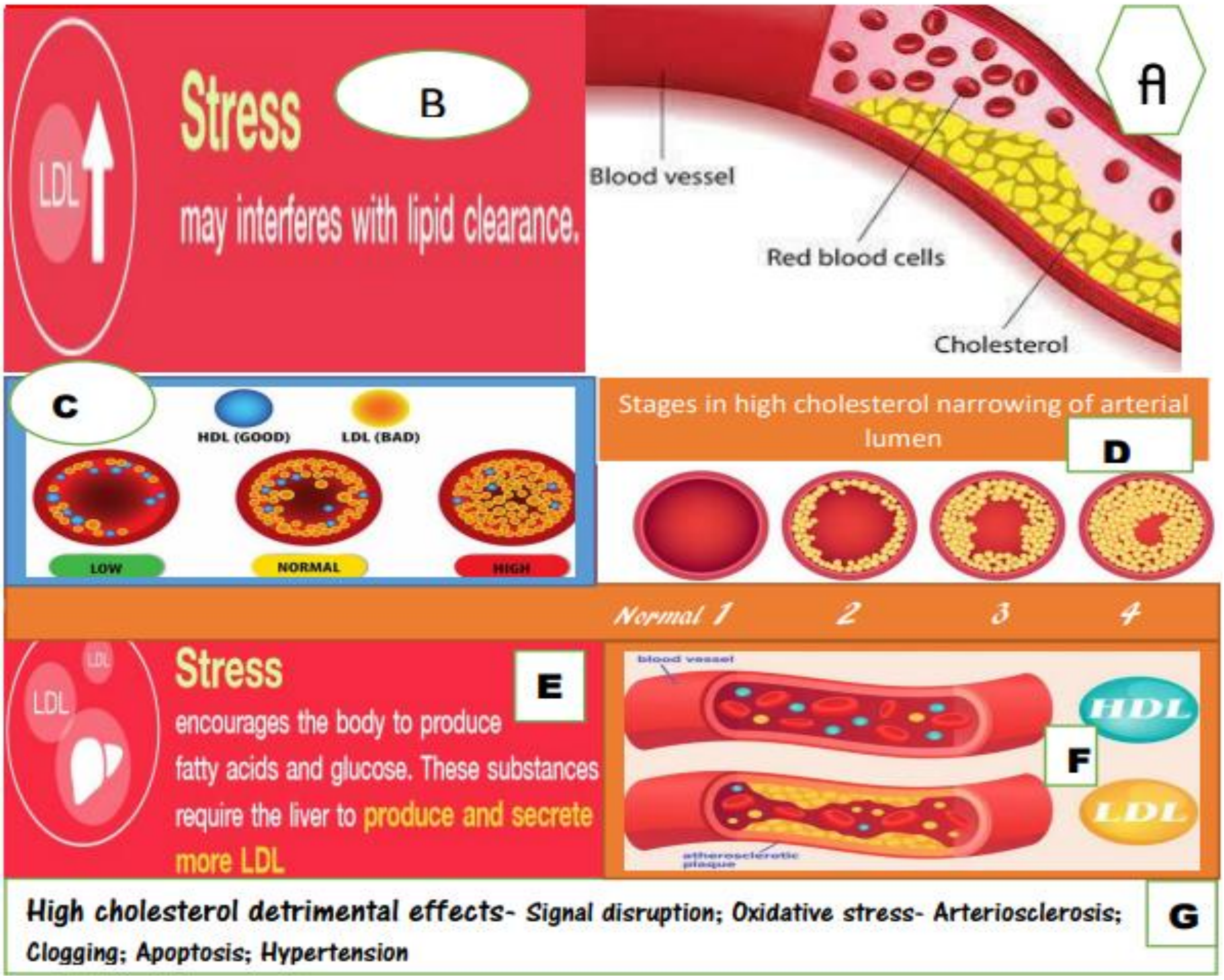


Figure 3: *Stress impacts on Cholesterol. Adopted with modifications from Assadi [15] and Memon et al. [15].*

Materials and Methods:

Materials- the Accu Isaw CE0197 and Ultra 2 strips and equipment – Accu Isaw, Ulta 2, portable electronic balance, and stethoscope were from the accredited distributor at Chris care.

Volunteers' recruitment and awareness

The POLAC community received individualized discussions about diabetes to clarify the research aim and scope before enrolling participants. These conversations covered how stress impacts diabetes. Volunteers who agreed to participate underwent fasting glucose screening in the morning after fasting for 10 to 12 hours. A plasma fasting glucose concentration of 150±20 mg/dL on two separate occasions, along with self-reported early signs and symptoms of diabetes, was the criterion for inclusion in the study. Thirteen participants were screened (Fig. 4), with six meeting up the research criteria (fasting hyperglycemia). For confidentiality, the names of selected participants were in alphabetical codes (A, B, C, D, E, and F). The results served as a preliminary screening and were unrecorded.

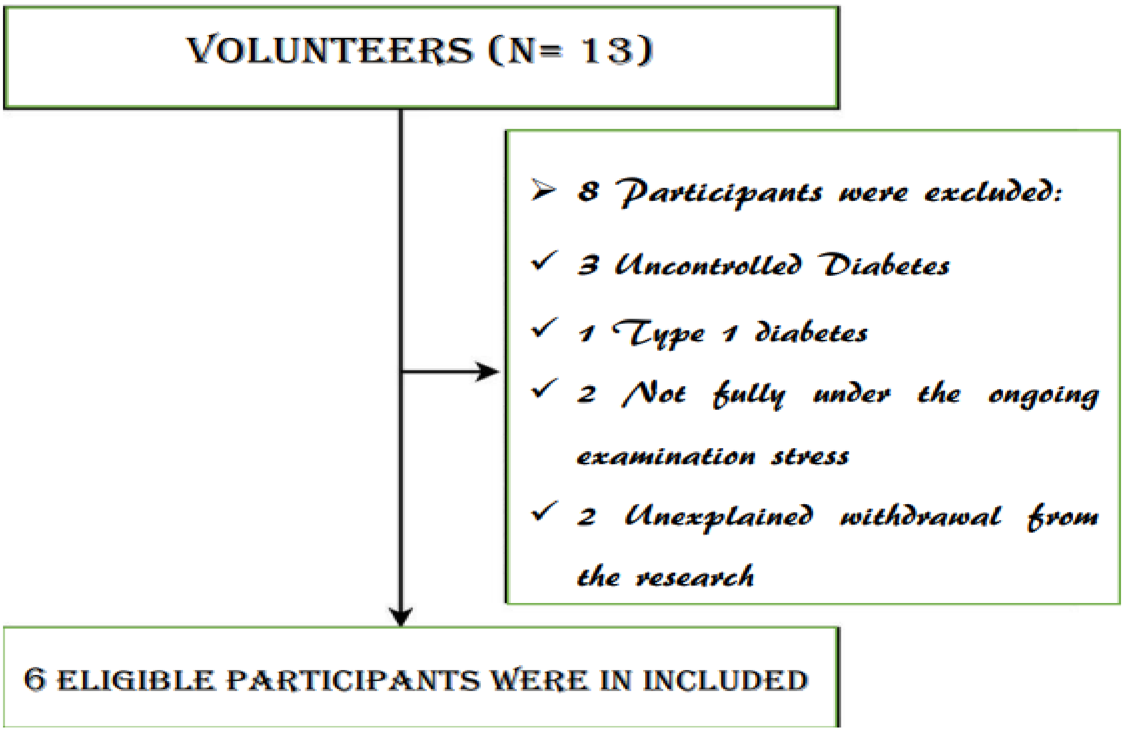


Figure 4: *Flowchart of selection process of the study*

Stress construction

Stress cannot be measured objectively through tests; best understood by the individual experiencing it, making it a personal construct [17]. Among academics, examinations are significant stressors [18] and [3]. Both mental and physical stress are commonly associated with the workplace [19]. Academic examinations are frequently used in stress research due to their predictable, standardized, real-life nature as stress-inducing events [20]. To support this study, the researcher employed a questionnaire

A questionnaire comprising eight key stress factors in POLAC was randomly distributed to participants to identify the optimal period for evaluating stress levels. The factors included Workload and Deadlines, Job Insecurity and Career Progression, Work-Life Balance, Interpersonal and Institutional Challenges, High Expectations and Performance Pressure, Bureaucratic and Administrative Burden, Emotional and Mental Strain, and Technological and Infrastructure Challenges. They were asked to mention the period (from registration time to teaching and examination time), that has the major features of the aforementioned keywords. The examination period significantly overlapped these stress factors and was selected as the designated period for evaluating work-related stress. The exam stress journey is multifaceted, requiring tailored strategies for different phases: this is the reason for tailored individual assessment for the two weeks period.

Research design

The six qualified participants from the preliminary screening were employed for phases 1 (pre- stress), 2 (stress), and 3 (post-stress). The pre-stress, stress and post-stress describe the before, during, and after examinations. In each phase was fourteen days. Glucose concentrations and blood pressure measurements were on alternate days of 2 for fourteen days (seven times measurements). The Total cholesterol and weight measurements were measured weekly (twice in fourteen days). The glucose and total cholesterol concentration measurements were via finger-prick in an overnight fasted state (10.40±0.32 hours). All measurements were between 8–9 AM. Drinking of water was allowed upon request. Blood pressure and weight were measured with pressure cut off using a Stethoscope and portable electronic scale weight device. All the measurements were from qualified health personnel. The Mean Arterial Pressure (MAP) was calculated from blood pressure readings [21] and translated formula below.

$$MAP = [(2 \text{ x diastolic}) + \text{systolic}] / 3$$

Where DBP = diastolic pressure and SBP = systolic pressure.

Results:

The results of this study are in Fig. 5 to 10 and Table 2. The Figures illustrate the mean values of glucose, total cholesterol, weight, and mean arterial pressure (MAP) across three phases: pre-stress (before stress), stress (during stress), and post-stress (after stress). Table 2 displays the percentage changes in these parameters from the pre-stress phase to the stress and post-stress phases.

For Participant A (Fig. 5), the mean glucose concentrations during and after the stress phase showed a statistically significant difference compared to the pre-stress phase ($p<0.05$). The percentage changes in glucose were the highest (24.55% during stress; 13.27% after stress), while the lowest were in MAP (1.16% and 0.29%).

Participant B (Fig. 6) showed significant changes in weight during and after stress ($p<0.05$). The highest percentage changes were in total cholesterol (14.65% during stress; 13.13% after stress), and the lowest was in MAP during stress (2.44%) and glucose after stress (0.9%).

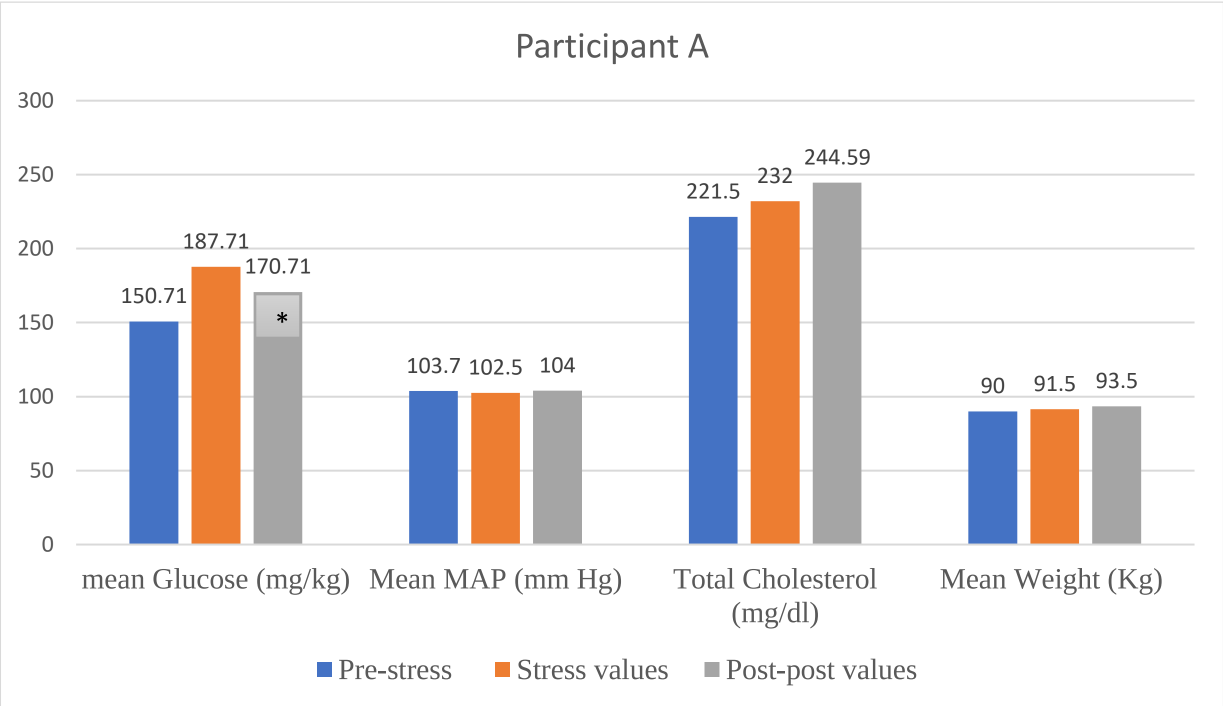
For Participant C (Fig. 7), there were no statistically significant changes in any parameters between the stress/post-stress phases and the pre-stress phase ($p>0.05$). The highest percentage changes were observed in glucose (12.68%) and MAP (12.48%) during stress, while the lowest was in total cholesterol (3.78%) after stress.

Participant D (Fig. 8) showed a significant difference in glucose levels during stress compared to pre-stress ($p<0.05$). The highest percentage changes were in total cholesterol (31.60% during stress; 34.63% after stress) and the lowest in weight (2.73% during stress; 0% after stress).

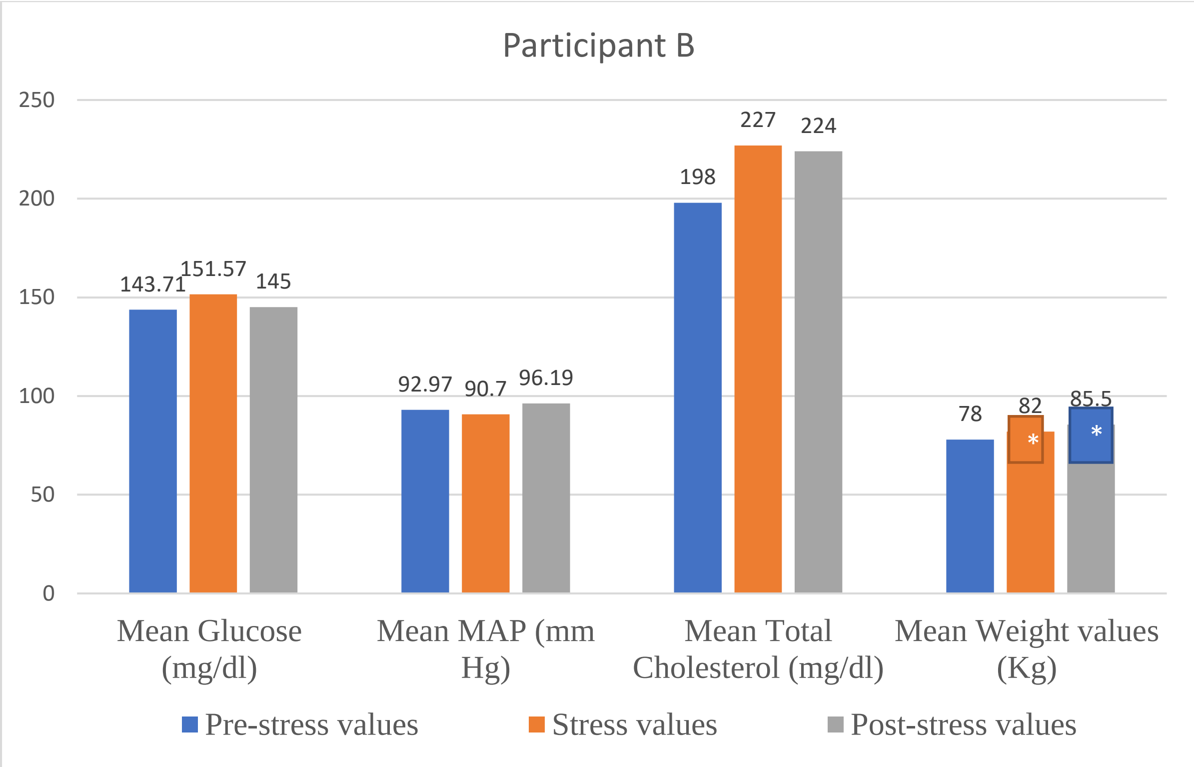
For Participant E (Fig. 9), significant differences were in glucose and total cholesterol concentrations after stress compared to before stress ($p<0.05$). The highest percentage of changes occurred in total cholesterol (24.75% during stress; 29.71% after stress), and the smallest in glucose (3.37%) and MAP (3.90%) during stress, and in weight (0.63%) after stress.

Participant F (Fig 10) showed a significant change in MAP during stress ($p < 0.05$). The highest percentage changes were in glucose (18.32% during stress; 21.57% after stress), while the lowest were in weight (3.38% during stress; 0.68% after stress).

Interestingly, Participant F did not observe a peak in mean glucose concentration during stress (Fig. 10). However, a peak in MAP during stress was in one-third of the participants (Fig. 8 and 9). In contrast, total cholesterol concentration peaks during stress were observed in half the participants (Fig. 6, 7, and 10), as were in mean weight (Fig. 8, 9, and 10).

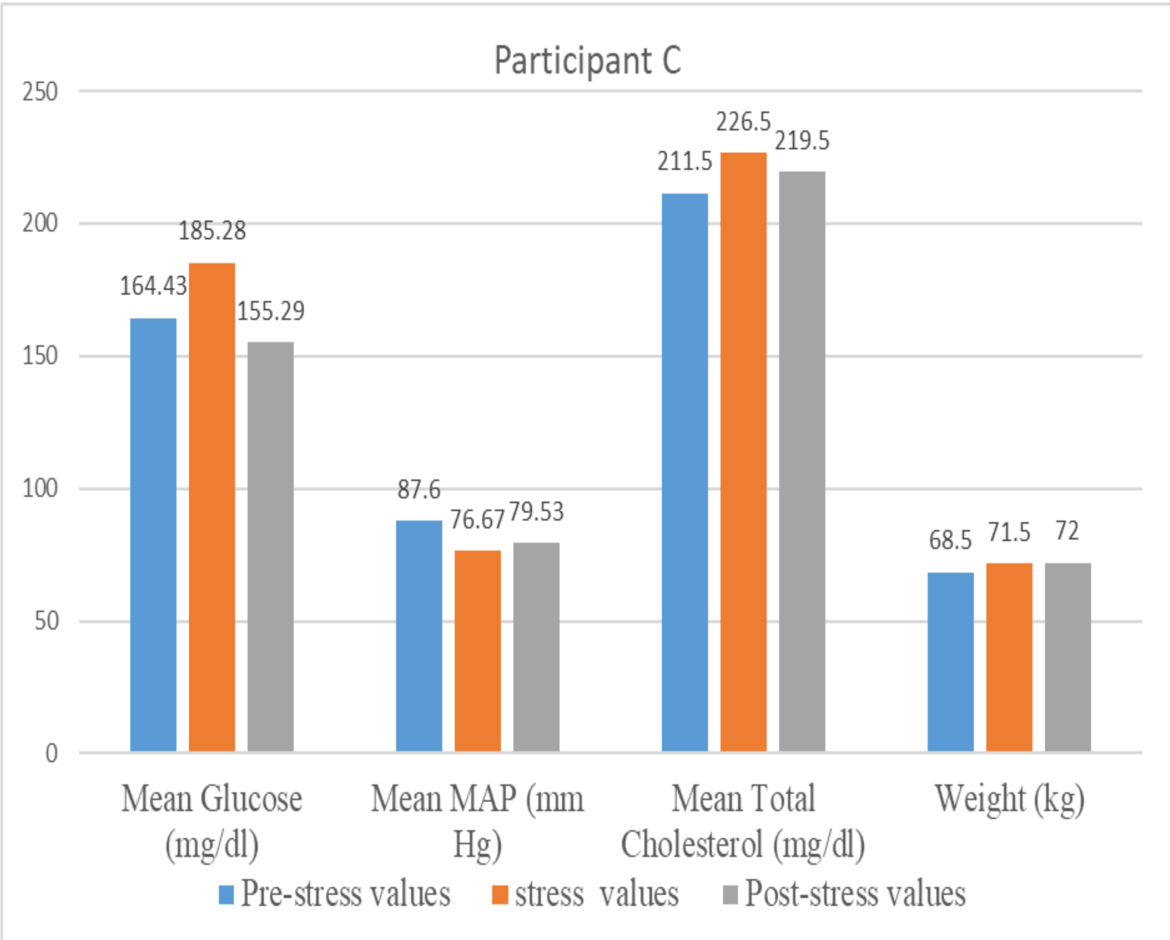


Figures 5: ***Participant A values Bar bearing * is significantly different with Pre-stress value***

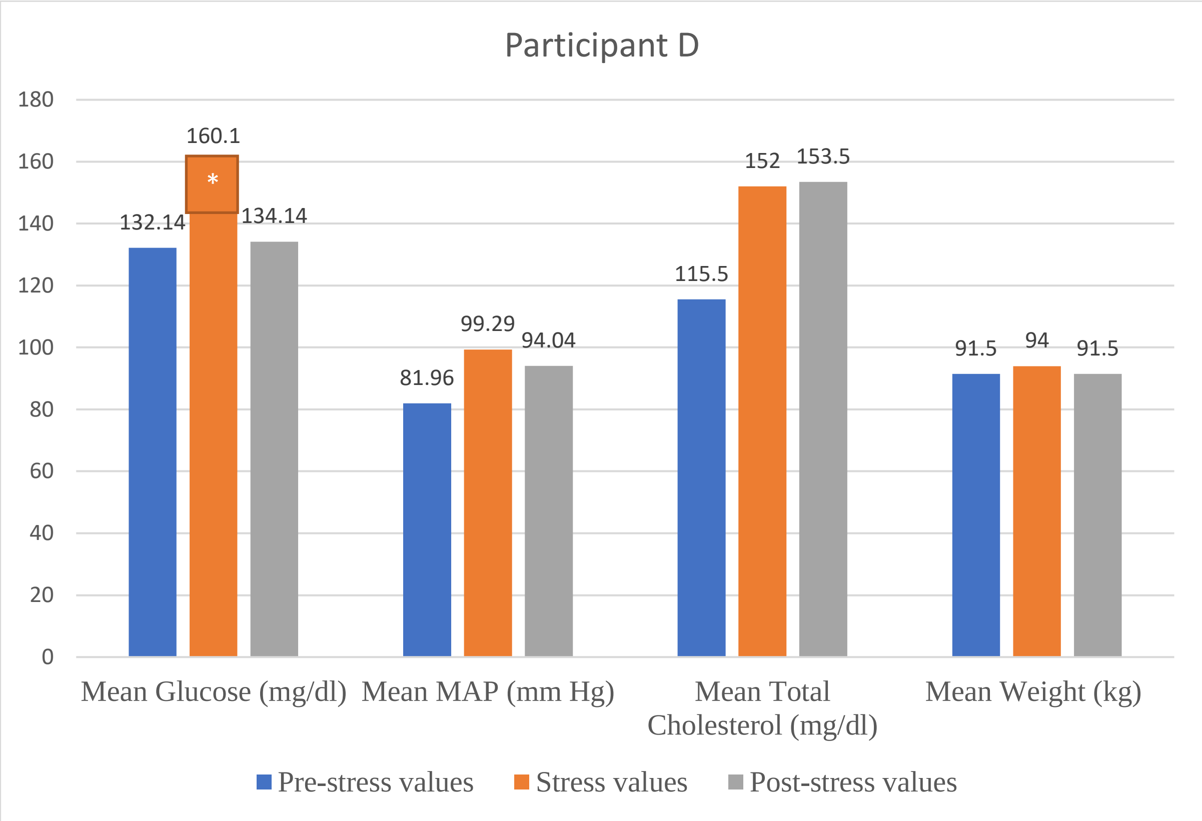


Bar bearing * is significantly different with Pre-stress value

Figure 6: *Participant B values*

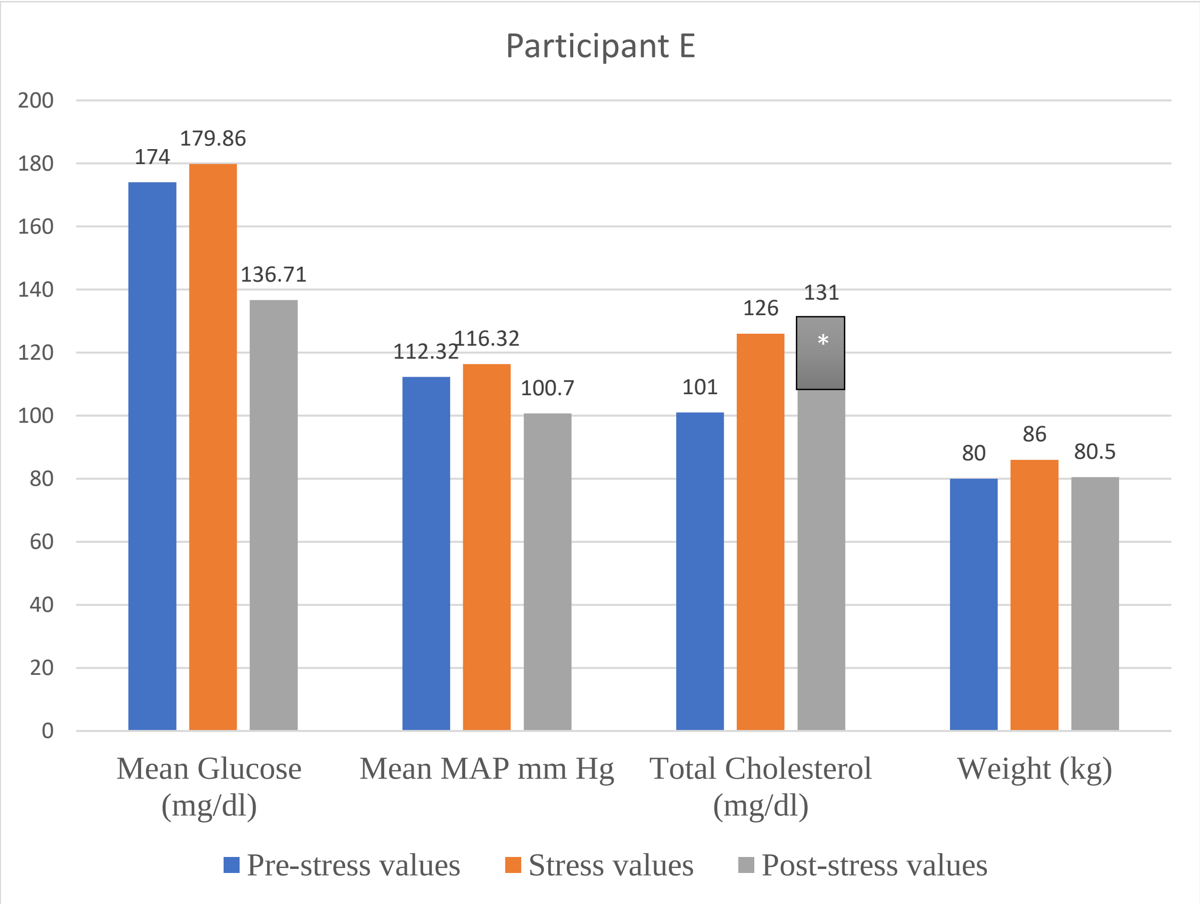


Figures 7: *Participant C values*



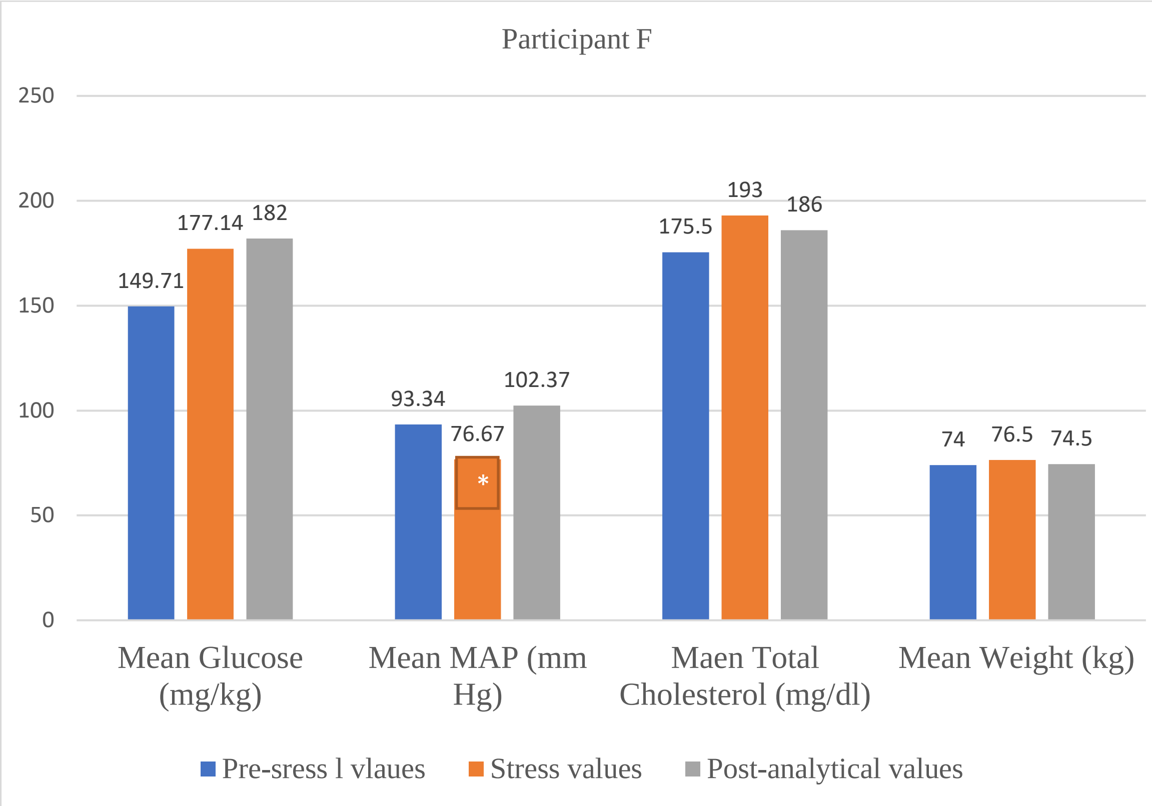
Bar bearing * is significantly different with Pre-stress value

Figures 8: Participant D values



Bar bearing * is significantly different with Pre-stress value

Figures 9: *Participant E values*



Bar bearing * is significantly different with Pre-stress value

Figures10 : *Participant F values*

PT	Glucose		Total cholesterol		MAP		Weight	
	Stress	Post-stress	Stress	Post-stress	stress	Post-stress	stress	Post-stress
A	24.55	13.27	4.74	10.42	-1.16	0.29	1.67	3.89
B	5.47	0.90	14.65	13.13	-2.44	3.46	5.13	6.62
C	12.68	-5.56	7.09	3.78	-12.48	-9.21	4.38	5.11
D	21.16	1.51	31.60	34.63	21.14	14.74	2.73	0
E	3.37	-21.43	24.75	29.71	3.90	-10.35	7.5	0.63
F	18.32	21.57	9.97	5.98	-17.86	9.67	3.38	0.68

Values bearing- is lower than the pre-stress

PT= Participants, MAP= Mean Arterial Pressure and A-F= Coded names of participants

Table 2: *Mean percentage changes from pre-stress to stress and post-stress*

Discussion:

Modern workloads are stressful, negatively impacting health and exacerbating pre-existing conditions. Stress affects everyone, as it is a natural human response [17]. In this study, the researchers examined key aspects of stress-induced metabolic changes in diabetes, focusing on blood glucose and total cholesterol levels [17], as well as blood pressure measurements used to calculate mean arterial pressure (MAP) [19].

Glucose levels spiked during stress, particularly around the examination period, for all participants except Participant F (Fig. 9). This suggests that hyperglycaemia is a common and rapid consequence of stress [22], possibly due to temporary disruptions in glucose homeostasis triggered by stress hormones [22]. It is consistent with Garbarino et al. [23] and Rose et al. [24] on workplace stress. Researchers propose that hormonal-driven due to stress might cause a glucose spike. The failure of mean glucose levels to normalize post-stress in two-thirds of participants may be due to stress-induced disruptions in glucose regulation, particularly in diabetes via insulin resistance mechanisms [19]. These findings strongly reinforce the notion that job-related stress has adverse metabolic consequences.

Moreover, stress hormones reduce glucose utilization, increase glucose production, and inhibit insulin production and sensitivity [17, 25], all contributing to glucose accumulation during stress episodes. Similarly, Onyango [26] and Monroy et al. [27] reported stress-induced insulin resistance and decrease insulin production. The hyperglycaemia observed in this study

aligns with findings by Argyropoulos et al. [28], who also noted increased blood glucose during stressful periods. Additionally, elevated glucose during stress might also stem from changes in eating behaviours [29], such as more frequent eating and higher consumption of unhealthy foods [30-31], putting diabetes at greater risk for hyperglycaemia and hypercholesterolemia. Since stress responses vary individually, some participants who showed lower glucose levels after stress might be due to reduced appetite.
Pre-existing insulin resistance in diabetic participants likely worsened under stress, leading to glucose buildup and subsequent rises in total cholesterol levels. Because diabetes impairs glucose and cholesterol regulation, the continued elevation of these markers in some participants even after stress subsided (one for glucose, three for total cholesterol) suggests a lasting impact of stress. While glucose levels respond quickly to stress, total cholesterol reverts more slowly, explaining its sustained elevation in more participants.
The study also assessed MAP, which was from blood pressure readings. Significant changes in MAP were found in Participant F, although levels remained within the normal range of 60–100 mmHg [21]. However, two participants consistently had MAP values above normal across all phases, suggesting a positive association between elevated MAP and diabetes, consistent with findings by Mbanya et al. [32] and Guo et al. [33]. Since MAP represents the average blood pressure during a cardiac cycle [34], elevated MAP could contribute to arterial stiffness [35], which impairs microcirculation and insulin delivery, thereby worsening glucose metabolism and advancing diabetes [36]. It highlights the significant role of MAP in predicting diabetes progression under stress, as suggested by Wu et al. [34].
Additionally, significant post-stress weight gain observed in Participant B may be stress-induced changes in eating habits [17]. Elevated cortisol levels may drive cravings for refined, high-fat foods, and disrupted sleep may trigger emotional eating, contributing to weight gain. Similar findings link ultra-processed food consumption to increased calorie intake [37-38].

Conclusion:

In a fast-paced society, stress is a pervasive experience for many workers. Natural stressors like examinations activate the body's stress response, releasing hormones to cope with challenges. However, in individuals with diabetes, repeated stress triggers can cause the liver to discharge an abnormally high amount of glucose into the blood. Over time, this stress-induced cycle intensifies insulin resistance and further impairs the cells' response to insulin, resulting in persistently high blood sugar levels. This imbalance increases glucose, cholesterol, weight, and blood pressure. Each abnormal rise can fuel the others, compounding the health risks. These were the findings of this research. Researchers suggest that stress adds challenges to managing diabetes.

Recommendation:

The researchers emphasize the significance of Sirtuin, particularly for managing diabetes and potentially reversing insulin resistance.

Statistical analysis:

Data were as mean and percentage. One-way ANOVA conducted, using Tukey HSD and significance, was at $p<0.05$.

Ethical consideration:

The chosen participant gave verbal consent after the procedure was clearly explained and understood. Ensuring the confidentiality of their information was a top priority, and assured of this. The study was per POLAC's Guidelines for Human Subjects in Experimental Research.

Conflicts of interest:

The researchers declared that there was no conflict of interest, all cited works are dully acknowledged. There were no external funding for the research.

Authors contributions:

NWACHUKWU Chukwuedozie Francis conceived and did the initial drafting, Williams Oreoluwa Johanna and lifted Virtue Boye, did the diagrams. All authors participate in the bench work.

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