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Effects on Cardiovascular Parameters in Sleep-Deprived and Caffeine-Consuming Students among the Faculty of Basic Medical Sciences, Bayero University, Kano, Nigeria

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Abstract: Academic and social demands have made sleep deprivation and caffeine consumption very common amongst university students. Both have been linked to cardiovascular changes, but the combined effect of both factors has not been fully studied. This study investigated the effects on Cardiovascular Parameters in Sleep-Deprived and Caffeine-Consuming Students among the Faculty of Basic Medical Sciences, Bayero University, Kano, Nigeria particularly Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Mean Arterial Pressure (MAP), and pulse rate (PR) among students of the Faculty of Basic Medical Sciences, Bayero University Kano. This was a cross-sectional study of 112 students, categorized into four groups of 28 participants each: Sleep Deprived (SD), Caffeine + Normal Sleep (C+N), Sleep Deprived + Caffeine (SD+C), and Control. Cardiovascular parameters were recorded using standard procedures, and data were analyzed using one-way ANOVA and independent t-test. There was a significant difference in DBP, MAP, and PR between the study groups ($p<0.05$), while no significant difference was found in SBP. The highest DBP and MAP values were observed in the C+N group, indicating a vasoconstriction effect of caffeine. The SD group exhibited the highest pulse rate, while the SD+C group recorded the lowest, suggesting autonomic adaptation. Pulse rate in females in the SD+C group was significantly higher than in males ($p=0.008$). Sleep deprivation and caffeine intake markedly affect cardiovascular parameters of university students, especially DBP, MAP, and pulse rate. These findings highlight the possible cardiovascular risks of unhealthy sleep habits and excessive caffeine intake.

Keywords: *Sleep Deprivation; Caffeine Consumption; Blood Pressure; Pulse Rate; Cardiovascular Health; University Students.*

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I. INTRODUCTION

Academic and social demands have made sleep deprivation and caffeine consumption very common amongst students (Nagai et al., 2010). Both have been linked to cardiovascular changes, but the combined effect of both factors has not been fully studied (Crooks et al., 2019). Physiological homeostasis and cardiovascular stability require sleep. The period of sleep considered healthy for most people ranges between 7–9 hours per night (Grandner, 2016). If this sleep threshold is not met, it is possible to experience impaired cognitive function, a weakened immune system, and increased stress (Grandner, 2016). However, university students often face sleep deprivation as a result of academic duties, social life, and lifestyle habits.

Students use caffeine-containing products such as energy drinks, coffee, or tea to deal with fatigue and to increase alertness (Nagai et al., 2010). Caffeine is a stimulant that acts mainly by blocking adenosine receptors, thereby enhancing sympathetic nervous system activity (Kharaba et al., 2022). Although moderate caffeine intake can improve alertness, excessive consumption has been linked to cardiovascular stress, hypertension, and tachycardia. Caffeine also alters circadian rhythm, resulting in reduced sleep efficiency (Bonanni, 2023).

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The effects of sleep deprivation and caffeine consumption on cardiovascular function have been studied separately, with both factors shown to have significant effects. However, few studies have examined the combined effects of the two (Kharaba et al., 2022). These interactions are relevant because they highlight the importance of cardiovascular parameters such as blood pressure and pulse rate as measures of cardiovascular health. This study therefore aimed to determine the effects of sleep deprivation and caffeine consumption on cardiovascular parameters among students of the Faculty of Basic Medical Sciences, Bayero University Kano.

II. MATERIALS AND METHODS

➤ *Study Design and Population*

This was a cross-sectional study conducted among students of the Faculty of Basic Medical Sciences, Bayero University Kano, Nigeria. A total of 112 participants were recruited using simple random sampling. Participants were categorized into four groups based on self-reported sleep duration and caffeine consumption patterns:

- Sleep Deprived (SD): students with restricted sleep (less than 6 hours/night) for 24 hours.
- Caffeine + Normal Sleep (C+N): students who obtain above 7 hours of sleep per night and consume caffeine regularly.
- Sleep Deprived + Caffeine (SD+C): students with restricted sleep (less than 6 hours/night) who also consume caffeine.
- Control: students with above 7 hours of sleep per night, no caffeine intake, and no sleep deprivation.

Each group consisted of 28 participants, amounting to 112 participants in total. Students who consented to participate and met the study criteria were included. Individuals with diagnosed cardiovascular diseases, sleep disorders, or those taking medications affecting cardiovascular function were excluded.

➤ *Data Collection*

Online platforms and social media groups were used to announce the study and its objectives, clearly stating the inclusion and exclusion criteria. A structured questionnaire was used to obtain demographic information, sleep patterns, health status, and caffeine consumption habits. Cardiovascular parameters measured included Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Mean Arterial Pressure (MAP), and Pulse Rate (PR). A standard digital sphygmomanometer was used to measure both systolic and diastolic blood pressure; the instrument automatically inflates the cuff, measures the pressure, and provides a digital reading.

- Procedure: The cuff was wrapped securely around the left upper arm, about 1 inch above the elbow, with the participant seated comfortably and the arm relaxed, palm facing upward. The device was activated to automatically inflate and gradually deflate the cuff, detecting and displaying the systolic and diastolic pressures.
- Timing: Measurements were taken after the participant had rested for at least 5 minutes in a quiet, comfortable environment, to ensure a baseline physiological state and minimize the influence of stress or physical activity.
- Pulse Rate Measurement: Pulse rate was measured manually by palpation of the radial artery on the lateral side of the wrist. Using the index and middle finger, beats were counted for 30 seconds using a digital timer and multiplied by two to obtain beats per minute (bpm). MAP was calculated using the formula:

$$MAP = DBP + \tfrac{1}{3}(SBP - DBP)$$

➤ *Statistical Analysis*

Data were analyzed using Statistical Package for Social Sciences (SPSS) version 25. Descriptive statistics were expressed as mean ± standard deviation. One-way Analysis of Variance (ANOVA) with Tukey post hoc analysis was used to compare cardiovascular parameters across groups, while independent t-test was used to compare male and female participants within the SD+C group. Statistical significance was set at $p < 0.05$.

➤ *Ethical Approval*

Ethical approval for the study was obtained from Ministry of Health Kano State, Nigeria. Consent from the participant was also be obtained.

III. RESULTS

➤ *Comparison of Cardiovascular Parameters of the Respondents*

A one-way ANOVA followed by Tukey's post-hoc multiple comparison test was used to compare systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and pulse rate across the four study groups. A significant p-value ($p<0.05$) indicates a statistically significant difference between at least two groups.

Table 1 Comparison of Cardiovascular Parameters of the Respondents

Parameter	Control (n=28)	C+N (n=28)	SD (n=28)	SD+C (n=28)	F-value	p-value
SBP (mmHg)	115.89 ± 13.63	122.71 ± 3.41	122.32 ± 14.23	120.68 ± 11.25	2.845	0.041
DBP (mmHg)	71.61 ± 8.35[b]	81.00 ± 2.84[a,c]	74.46 ± 9.96[d]	68.82 ± 9.13[b]	11.723	0.000**
MAP (mmHg)	86.22 ± 8.49	94.77 ± 2.77[a,d]	90.26 ± 10.68	85.93 ± 9.17	7.623	0.000**
Pulse Rate (bpm)	82.00 ± 13.44	72.50 ± 10.08[a, c]	85.14 ± 12.28	70.54 ± 13.66[a, c]	10.371	0.000**

Values are expressed as Mean ± SD. a,b,c,d indicate statistically significant results at p<0.05 level of Tukey multiple comparison: a = significant vs Control; b = significant vs C+N; c = significant vs SD; d = significant vs SD+C. ** = p<0.001. SD, Sleep Deprived; C+N, Caffeine + Normal Sleep; SD+C, Sleep Deprived + Caffeine; SBP, Systolic Blood Pressure; DBP, Diastolic Blood Pressure; MAP, Mean Arterial Pressure; bpm, beats per minute.

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- *Comparison of Cardiovascular Parameters between Males and Females in the SD+C Group*

Mean ± standard deviation of cardiovascular parameters by gender among participants in the SD+C group were compared using an independent-samples t-test. There was no significant difference between males and females in systolic blood pressure, diastolic blood pressure, or mean arterial pressure ($p>0.05$). However, a significant difference was observed in pulse rate ($p=0.008$), with females recording a significantly higher pulse rate (75.93 bpm) than males (65.14 bpm).

Table 2 Comparison of Cardiovascular Parameters Between Males and Females in the SD+C Group

Parameters	Males (n=14)	Females (n=14)	t	F-value	p-value
SBP (mmHg)	121.64 ± 7.48	119.71 ± 9.29	0.605	0.538	0.470 (NS)
DBP (mmHg)	67.71 ± 9.23	69.93 ± 9.25	-0.634	0.038	0.847 (NS)
MAP (mmHg)	85.51 ± 7.24	86.36 ± 8.75	-0.270	0.213	0.648 (NS)
PR (bpm)	65.14 ± 13.40	75.93 ± 6.79	-2.686	8.348	0.008 (sig)

Significant at $p < 0.05$. NS = Not Significant. SBP, Systolic Blood Pressure; DBP, Diastolic Blood Pressure; MAP, Mean Arterial Pressure; PR, Pulse Rate; bpm, Beats Per Minute.

IV. DISCUSSION

The results show that insufficient sleep, jointly with caffeine intake, significantly affects cardiovascular parameters among students. Notable changes were observed in diastolic blood pressure (DBP), mean arterial pressure (MAP), and pulse rate (PR), with statistically significant group differences ($p<0.05$). These changes may stem from altered autonomic nervous system (ANS) activity and hormonal regulation due to stress, sleep loss, and stimulant intake.

Participants in the Sleep Deprived (SD) group exhibited elevated pulse rates compared to other groups. This can be attributed to increased sympathetic nervous system activity due to the absence of restorative sleep, leading to reduced parasympathetic tone and increased cardiovascular output. However, no statistically significant differences were observed in systolic blood pressure across the groups. Subjects in the Caffeine + Normal Sleep (C+N) group had the highest DBP and MAP values, reflecting caffeine's mechanism as an adenosine receptor antagonist, which inhibits vasodilation and leads to vasoconstriction and elevated blood pressure (Kharaba et al., 2022). Despite these elevations, SBP values were not significantly different among groups, potentially due to tolerance in habitual caffeine users.

The Sleep Deprived + Caffeine (SD+C) group recorded the lowest pulse rate, a surprising but explainable outcome that may result from autonomic adaptation to chronic stimulant use under sleep deprivation. Post hoc analysis revealed that pulse rate in this group was significantly different from the others. The pulse rate and DBP values in this group were lower than those in the C+N group, suggesting that caffeine alone has a more pronounced hypertensive effect than when combined with sleep deprivation.

In the SD+C group, females exhibited significantly higher pulse rates than males, consistent with previous studies on gender differences in autonomic and hormonal regulation. Female participants generally demonstrate higher resting heart rates, likely influenced by estrogen and reduced stroke volume (Yu et al., 2022). However, there were no significant gender-based differences in SBP, DBP, or MAP.

V. CONCLUSION

The results of this study indicate that selected cardiovascular parameters were significantly affected in university students who were sleep deprived and consuming caffeine. One-way ANOVA showed significant differences between the study groups in the mean values of SBP, DBP, MAP, and pulse rate. Tukey's post-hoc analysis, however, revealed no significant difference between any two pairs of groups for SBP, meaning the overall ANOVA significance for SBP was not attributable to any single pair of groups; significant between-group differences remained for DBP, MAP, and pulse rate. The C+N group had the highest DBP and MAP values, and the SD+C group had the lowest pulse rate. Pulse rate was significantly higher in females than males within the SD+C group ($p=0.008$), though no significant differences were found in SBP, DBP, or MAP between males and females within that group. Overall, sleep deprivation and caffeine intake are linked to changes in cardiovascular parameters (DBP, MAP, PR) in university students.

RECOMMENDATIONS

Universities should promote awareness of healthy sleep habits and moderate caffeine consumption among students. Students should be informed of the potential cardiovascular effects of overconsumption of energy drinks and other caffeine-containing products. Longitudinal studies should further examine the long-term cardiovascular effects of chronic sleep deprivation and caffeine intake.

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