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Correlation Between Hematological and Physiological Parameters in Dental Students of a Tertiary Dental College

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Abstract

Introduction: Physiological parameters such as body mass index (BMI), blood pressure (BP), and heart rate (HR) reflect cardiovascular status, while hematological parameters like hemoglobin (Hb), bleeding time (BT), and clotting time (CT) indicate hemostatic function. Understanding the relationship between these parameters may provide insight into the interconnection between nutritional, cardiovascular, and hematological health among young adults. The objective of the study was to assess the association between physiological parameters (BMI, BP, and HR) and hematological parameters (Hb, BT, and CT) among dental students.

Methods: A cross-sectional analytical study was conducted among 199 dental students aged 18-30 years at Kantipur Dental College. Hemoglobin, BT, and CT were measured from capillary blood using standard methods. The BMI, BP, and resting HR were recorded using calibrated instruments. Data were analyzed using descriptive statistics, Spearman's correlation, and the Kruskal-Wallis test. $p<0.05$ was considered statistically significant.

Results: The mean age was 21.22±1.16 years. Mean BMI and Hb were 22.13±4.37 kg/m² and 12.31±1.85 g/dL, respectively. Spearman's correlation analysis showed that BMI was positively correlated with Hb (r=0.68) and systolic blood pressure (SBP) (r=0.40). The Hb was also positively correlated with SBP (r=0.46). The BT and CT were strongly positively correlated with each other (r=0.85) but negatively correlated with BMI and Hb. Significant differences in hematological parameters were observed across BMI and BP categories ($p<0.001$). The Hb increased, whereas BT and CT decreased with increasing BMI.

Conclusion: The BMI and BP were significantly associated with Hb, BT, and CT, highlighting the interrelationship between nutritional, cardiovascular, and hematological health in young adults.

Keywords: Bleeding time, blood pressure, body mass index, clotting time, correlation, hemoglobin

1. Introduction

Dental students represent a unique young adult population with demanding academic and clinical schedules that may influence both physiological and hematological status[1]. Different physiological parameters include body mass index (BMI), heart rate (HR), and blood pressure (BP). Hematological parameters include hemoglobin (Hb), hematocrit (Hct), RBC count, WBC count, platelet count, bleeding time (BT), and clotting time (CT)[2].

Hematological parameters are vital indicators of oxygen-carrying capacity, immune function, and overall systemic health. They serve as fundamental markers for routine health assessment as well as warning of early oral or systemic diseases, an area of particular relevance to dental education and practice[3]. Physiological parameters, including BP, HR, and BMI, reflect cardiovascular and metabolic health[4].

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Although previous studies have evaluated physiological or hematological parameters separately, limited research has explored the association between these parameters simultaneously among dental students. Understanding these relationships may provide insight into the overall health profile of young adults undergoing professional training and may have relevance for student wellness and clinical preparedness in dental practice. Therefore, this study aimed to assess the association between physiological parameters (BMI, BP, and HR) and hematological parameters (Hb, BT, and CT) among undergraduate dental students.

2. Methods

A cross-sectional analytical study was carried out among 199 undergraduate dental students in the Department of Physiology, Kantipur Dental College Teaching Hospital and Research Center, Kathmandu from January 2026 to April 2026 after getting ethical clearance from the Institutional Review Committee of Kantipur Dental College (Approval No: 09/026). Written informed consent was obtained from all participants, and confidentiality and anonymity were strictly maintained.

Participants were recruited using a convenience sampling technique. Participants with a history of hematological disorders (thalassemia, bleeding disorders), chronic systemic diseases (chronic kidney disease, liver disease, cardiovascular disease), acute illness, recent major surgery, or blood transfusion within the past three months were excluded. Students taking medications affecting hematological or cardiovascular parameters (anticoagulants, systemic steroids) were also excluded.

Data collection was performed in a designated room within the college during morning hours to minimize diurnal variation. A structured and pretested proforma was used to record sociodemographic data, including age, sex, and year of study, along with relevant medical history. Height was measured without footwear using a stadiometer to the nearest 0.1 cm, and weight was recorded using a calibrated digital weighing scale to the nearest 0.1 kg. The BMI was calculated as weight in kilograms divided by height in meters squared (kg/m²) and categorized according to World Health Organization (WHO) criteria[5]. Based on these criteria, the BMI values for the three categories were as follows: (i) underweight: <18.5, (ii) normal: 18.5-24.99, and (iii) overweight: 25.0-29.99.

The BP was measured using a calibrated aneroid sphygmomanometer after at least five minutes of rest in a seated position. Two readings were taken at 2-3 minute intervals, and the average was used for analysis. Resting HR was recorded by radial pulse palpation after five minutes of rest.

Hematological parameters were assessed using capillary blood under aseptic conditions. The Hb was estimated using Sahli's acid hematin method using a standard Sahli's hemoglobinometer and expressed in g/dL. The BT was measured using the modified Duke method, and CT was assessed using the capillary tube method. All measurements were performed by a single trained investigator using calibrated instruments to minimize inter-observer variability.

Data were analyzed using SPSS version 21. Normality was assessed using the Shapiro-Wilk test. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Prior to correlation analysis, pairwise correlations were examined to assess collinearity among variables. As diastolic blood pressure (DBP) showed a very strong correlation with systolic blood pressure (SBP) (r=0.97, p<0.01), it was excluded from the correlation analysis to avoid redundancy, but was retained for descriptive statistics and group comparisons. Spearman's rank correlation was used to assess associations among the remaining variables (BMI, Hb, BT, CT, SBP, and HR), with statistical significance set at p<0.01 (two-tailed). Group comparisons were performed using the Kruskal-Wallis test. p<0.05 was considered statistically significant.

3. Results

Among 199 participants, the mean age of the participants was 21.22±1.16 years and the mean BMI was 22.13±4.37 kg/m². The mean Hb level was 12.31±1.85 g/dL. The BT and CT showed mean values of 2.23±0.64 minutes and 4.02±1.0 minutes, respectively. The mean SBP was 113±9.7 mmHg while the mean DBP was 74.4±7.4 mmHg. The average HR was 74.06±5.15 beats per minute (Table 1).

Table 1: Descriptive statistics of hematological and physiological parameters

Variables	Mean ± SD	Minimum	Maximum
Age (years)	21.22 ± 1.16	18	26
BMI (kg/m²)	22.13 ± 4.37	15.3	39.69
Hb (g/dL)	12.31 ± 1.85	8.0	18.0
BT (min)	2.23 ± 0.64	1.3	4.0
CT (min)	4.02 ± 1.0	2.0	6.0
SBP (mmHg)	113 ± 9.7	90	130
DBP (mmHg)	74.4 ± 7.4	60	96
HR (bpm)	74.06 ± 5.15	60	96

Based on WHO criteria[5] (Hb level <12 g/dL for females and <13 g/dL for males), the overall prevalence of anemia was 36.2%. Among underweight participants, anemia prevalence was 82.9%, compared to 32.8% in normal weight and none in overweight participants (Table 2).

Table 2: Descriptive statistics on the basis of anemia by BMI category

BMI	Underweight (n=35)	Normal (n=131)	Overweight (n=33)	Total
Non-anemic	6	88	33	127
Anemic	29	43	0	72

Spearman's rank correlation analysis demonstrated significant associations between physiological and hematological parameters. The BMI showed a strong positive correlation with Hb (r=0.68, p<0.01) and moderate positive correlations with SBP (r=0.40, p<0.01). The BMI demonstrated moderate negative correlations with CT (r= -0.54, p<0.01), BT (r= -0.54, p<0.01), and HR (r= -0.44, p<0.01). The Hb showed moderate positive correlations with SBP (r=0.46, p<0.01) while demonstrating negative correlations with BT, CT, and HR. The BT and CT were strongly positively correlated with each other (r=0.85, p<0.01) (Table 3).

Table 3: Correlation between hematological and physiological parameters

Variables	BMI	Hb	BT	CT	SBP	HR
BMI	1.00	0.68*	- 0.54*	- 0.54*	0.40*	- 0.44*
Hb	0.68*	1.00	- 0.45*	- 0.39*	0.46*	- 0.36*
BT	- 0.54*	- 0.45*	1.00	0.85*	- 0.32*	0.45*
CT	- 0.54*	- 0.39*	0.85*	1.00	- 0.27*	0.50*
SBP	0.40*	0.46*	- 0.32*	- 0.27*	1.00	- 0.32*
HR	- 0.44*	- 0.36*	0.47*	0.50*	- 0.32*	1.00

*Correlation is significant at p<0.01

Kruskal-Wallis analysis showed significant differences in hematological and physiological parameters across BMI categories (p<0.001). The Hb increased progressively from underweight to overweight groups, while BT and CT decreased significantly with increasing BMI. SBP and DBP both differed significantly across BMI categories. Underweight individuals had the lowest SBP and DBP, whereas normal weight individuals had the highest DBP (Table 4).

Table 4: Comparison of hematological and physiological parameters across BMI categories

Parameter	Mean rank			χ^2	p-value
	Underweight (n=35)	Normal (n=131)	Overweight (n=33)		
Hb	44.23	97.49	169.11	84.05	<0.001
BT	143.79	100.31	52.33	46.94	<0.001
CT	144.87	101.26	47.42	52.71	<0.001
SBP	44.71	114.16	102.44	40.20	<0.001
DBP	52.54	114.69	92.02	32.80	<0.001

* Test: Kruskal-Wallis

4. Discussion

The present study explored the relationship between hematological parameters (Hb, BT, and CT) and physiological parameters (BMI, BP, and HR) among young adults. The findings reveal significant associations between nutritional status, cardiovascular parameters, and hematological parameters, highlighting the close relationship among these factors.

A strong positive correlation was observed between BMI and Hb. This finding is consistent with previous studies reporting increased levels of Hb, RBC count, and Hct with high BMI. This could possibly be due to metabolic factors such as insulin resistance and chronic low-grade inflammation[6]. The nutritional status plays a key role in Hb synthesis, and individuals with lower BMI are more prone to iron deficiency anemia, which remains a major global health problem[7,8]. This may also contribute to impaired immune responses, resulting in increased susceptibility to infections[9,10]. Among the underweight participants, prevalence of anemia was 82.9%, compared to 32.8% in normal weight and none in overweight participants. Previous studies have also reported a higher prevalence of anemia among underweight individuals[8]. However, some studies suggest that this relationship may be influenced by other factors, such as fat distribution and insulin resistance, rather than BMI alone[6].

The present study also demonstrated significant associations between BMI and hemostatic parameters. An inverse relationship was observed between BMI and BT, with prolonged BT among underweight individuals, indicating an increased bleeding tendency. This aligns with studies showing greater bleeding risk in individuals with lower BMI[11]. The *bleeding-obesity paradox* is described as a counterintuitive clinical phenomenon where patients who are overweight or obese exhibit a lower bleeding tendency. This paradox has suggested reduced bleeding complications in individuals with higher BMI, possibly due to enhanced platelet activity and increased coagulation factors[12].

Similarly, CT was prolonged among underweight participants and shortened in those with higher BMI, indicating faster coagulation in overweight participants. This observation is in agreement with studies showing that obesity is associated with a prothrombotic state, characterized by elevated coagulation factors, enhanced platelet activation, and reduced fibrinolysis[13,14]. Variations in BT and CT may further reflect differences in platelet function, vascular integrity, and plasma protein levels[15,16]. Overall, these findings suggest that lower BMI is associated with impaired hemostasis, whereas higher BMI is linked with enhanced coagulation efficiency.

However, BT and CT assessed by modified Duke and capillary tube methods are relatively crude and operator-dependent bedside tests. These methods may not fully reflect complex coagulation pathways or platelet function compared with more advanced investigations such as prothrombin time (PT), activated partial thromboplastin time (aPTT), and platelet aggregation studies.

A significant positive association was also observed between Hb level and BP. Higher Hb levels were correlated with increased SBP, possibly due to increased blood viscosity and vascular resistance[17,18]. Previous studies have demonstrated that elevated Hb levels are associated with arterial stiffness, which may contribute to increased SBP and DBP. Furthermore, free Hb can scavenge nitric oxide (NO), an important vasodilator produced by endothelial cells. Increased levels of free Hb may bind to NO, causing the vessels to constrict and BP to increase[19,20].

The BT and CT showed negative correlations with Hb and BP, indicating more efficient coagulation in individuals with higher values of these parameters. This may be related to improved oxygen delivery and vascular tone, influencing platelet-endothelial interactions[21,22].

The HR showed a negative correlation with BMI and Hb while showing a positive correlation with BT and CT. These findings may reflect compensatory mechanisms in which lower Hb levels reduce oxygen carrying capacity, resulting in increased HR to maintain adequate tissue oxygen delivery[23,24].

Overall, the study demonstrated that higher BMI and BP are associated with increased Hb and reduced BT and CT, highlighting the close interplay between nutritional status, cardiovascular function, and hematological parameters. These findings may help increase awareness in dental education regarding general health status and bleeding tendencies, which are important considerations during clinical procedures. Understanding these associations may support student wellness initiatives and encourage early health screening among dental students.

5. Limitations of the Study

Certain limitations should be considered while interpreting the findings. The cross-sectional design limits causal inference. The study was conducted in a single institution, which may restrict generalizability. Additionally, potential confounding factors such as dietary habits, physical activity, menstrual status, and micronutrient deficiencies were not assessed. The use of capillary blood for hematological measurements may also introduce minor variability compared to venous blood sampling. More sensitive coagulation investigations such as PT, aPTT, platelet count, and platelet function tests were not included. Evaluation of iron levels, including serum ferritin and transferrin saturation were also not carried out, which may have strengthened interpretation of Hb findings. In addition, sex-stratified analysis was not performed, although hematological and physiological parameters may differ between males and females.

6. Conclusion

In this cross-sectional study conducted on dental students, BMI and BP were significantly associated with Hb, BT, and CT. Higher BMI and BP were associated with higher Hb levels and shorter BT and CT, while lower values were associated with anemia and prolonged hemostatic parameters. These findings highlight the interconnection between nutritional, cardiovascular, and hematological health in young adults. Longitudinal and multicenter studies incorporating dietary, iron status, and stress assessments are recommended to confirm these associations and clarify their clinical implications.

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Conflict of Interest

The authors declare that there is no conflict of interest.

Disclosure of AI Use

ChatGPT (version 4.0) was used to refine the language, improve grammatical clarity, and assist in the structural organization of the manuscript.

Authors' Contributions

ES was involved in conceptualization and designing of the study, as well as data collection, analysis, interpretation, and drafting the manuscript. PS assisted in data collection, methodology, and reviewing the manuscript. SP assisted in statistical analysis, preparation of tables, and reviewing the manuscript. BM was responsible for reviewing and editing the final draft of the manuscript.

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