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Prevalence and Pattern of Anemia among Medical Students in a Tertiary Educational Institution in Southern Nigeria

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A B S T R A C T

Introduction: Anemia is a major global health problem affecting all age groups, particularly in developing countries. Given the increasing burden of anemia in our country and the lack of literature on anemia among medical students in our region, this study was conducted to assess the prevalence of anemia among undergraduate medical students to determine its severity.

Materials & Methods: This study involved 171 undergraduate medical students, comprising 105 males and 66 females. Full blood counts were processed using an automated blood cell counter, and a peripheral blood smear was examined to assess cell morphology. Statistical tests were Kolmogrow-Smirnov, student t-test, and ANOVA. Data were analyzed by SPSS V.23 at a level of less than 0.05.

Results: The prevalence of anemia in the study group was 29.2%. Males were more affected than females (70.0% vs 30.0%). The highest prevalence was among students in their fourth year of medical school (34.0%). All students with anemia had a mild form and were asymptomatic. There was a negative correlation between anemia and age, with younger students being more affected. Morphologically, microcytic hypochromic and normocytic normochromic patterns were predominant.

Conclusion: Anemia is highly prevalent among undergraduate medical students. Regular screening is necessary to prevent the development of symptomatic anemia.

Keywords: Anemia, Prevalence, Medical Student, Nigeria

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Introduction

Medical students undergo rigorous, unrelenting training schedules in various courses leading to the award of the Bachelor of Medicine and Surgery (MBBS) degree (1). Often, they skip meals and consume junk food to keep up with the demands of attending classes, ward rounds, clinics, theatres, and examinations (2). They typically reside in school hostels, where access to balanced meals prepared by family is limited. Moreover, these students fall within an age group that is vulnerable to nutrient deficiencies, as many are still experiencing growth spurts (3). This makes them more predisposed to developing anemia.

Anemia is functionally defined as a reduction in the oxygen-carrying capacity of the blood due to a decrease in hemoglobin concentration below normal levels for race, age, sex, and altitude (4). Anemia is not a disease but an indicator of an underlying condition, which could be benign or malignant and poor nutrition. The reduced oxygen content in the circulating blood leads to tissue hypoxia in anemia. General clinical symptoms result from tissue hypoxia and compensatory mechanisms activated by the body.

Anemia is a major global health problem (5). Its prevalence is similar in most developing countries, including Nigeria, and developed nations (6). Individuals most vulnerable to anemia are women of reproductive age group and children and so also adolescents, as about 800 million children and women are anemic globally (7). Nigeria is one of the countries listed by the World Health Organisation (WHO) to have a severe burden of this disease, with >40% of the population being anemic (7). It has serious consequences not just on health but also on economic and social development (6).

Anemia may be caused by several conditions, with iron deficiency anemia being the most significant contributor; about 50% of all cases of anemia are caused by iron deficiency, but this varies among different population groups and in various geographical areas, with the local conditions prevalent in the region contributing to the causes (8,9). Other causes of anemia include micronutrient deficiencies like folate, vitamin A, vitamin B, and riboflavin deficiencies, acute and chronic infections such as malaria, infection with helminths, tuberculosis, Human immunodeficiency virus (HIV) and cancer, and acquired or inherited disorders affecting hemoglobin, red blood cell production or red blood cell survival (10).

Medical students may suffer from anemia due to prolonged college teaching schedules, clinical postings, less time for physical exercise, extracurricular activities, staying in a hostel, and erratic eating habits like skipping breakfast or substituting snacks for major meals (6). They belong to different cultural and socio-economic backgrounds and come from other geographic regions of the country. They have a vast curriculum, so screening them for early detection and correction of anemia is essential for their academics (6).

Anemia during adolescence not only impairs the individual's physical and mental development but also weakens his/ her behavior and cognitive development, which can affect their academic performance (6).

A literature search revealed a significant lack of research on the prevalence of anemia among medical students in Nigeria. Therefore, this study aims to describe the prevalence and types of anemia among medical students in the College of Health Sciences, Delta State University, Abraka.

Materials and Methods

Setting

This was a cross-sectional study, and the study population comprised medical students in the College of Health Sciences who voluntarily consented to participate. A consecutive sampling technique was employed until the desired sample size was reached. The study spanned two months: the first month was dedicated to data and sample collection, and the second month focused on analysis and discussion. Inclusion criteria included medical students from first year to final year with a recognized school identification card who willingly consented to participate in the study. Also, Exclusion criteria included medical students who did not give consent to participate in the study, medical students who did not have a school identification card and did not have their names on the faculty-student list, students in medical courses like physiology, Anatomy, and Nursing, a medical student with a chronic medical condition.

Sample size

The sample size was calculated implementing the below formula with 95 percent confidence interval, and 9.3 expected prevalence (12) and precision of 5%. Finalized sample size was 171.

$$N = \frac{z^2 \ pq}{d^2}$$

Measuring Tools, Validity and Reliability

1.Demographic tool

Demogarphic variaables inculded age, sex, tribe and, class.

2. Laboratory tests

Based on WHO standards, the cut-off value for diagnosing anemia was set at 12 g/dl for non-pregnant females and 13 g/dl for males. The severity of anemia was classified as mild, moderate, or severe according to WHO criteria,

based on the Hb (g/dl) level: Mild anemia: Male: 11.0–12.9g/dl, Female: 11.0–11.9g/dl. Moderate anemia: 8.0–10.9g/dl, regardless of sex. Severe anemia: < 8.0g/dl, regardless of sex (11). Anemia was also classified morphologically based on red cell indices and RBC morphology on a peripheral smear: Normochromic/Normocytic: MCV, MCH, MCHC within normal range. Hypochromic/Microcytic: MCV, MCH, and MCHC all reduced. Macrocytic: MCV and MCH raised, MCHC normal.

For each participant, the venipuncture site was carefully cleaned with methylated spirit, and three milliliters (3ml) of venous blood was drawn from the antecubital vein with minimal stasis. The sample was dispensed into a container of ethylene diamine tetra-acetic acid (0.47mol/L K3-EDTA). The sample was gently and thoroughly mixed to prevent cell lysis and ensure proper anticoagulation. All specimens were labeled with individually generated identification numbers and analyzed within one hour of collection using an automated blood cell counter (Sysmex Haematology Autoanalyser) and a peripheral blood film.
Full Blood Count (FBC), including hematocrit, hemoglobin concentration, red cell indices, and platelet counts, was obtained from the EDTA sample using the Sysmex Haematology Autoanalyser model KN21. Samples were analyzed for hemoglobin (Hb), hematocrit (Hct), red cell indices—mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), total White Blood Cell (WBC), and platelet count. A peripheral blood smear was prepared and stained with Leishman stain, and the morphological details of blood cells were examined. All procedures were carried out in the central hematology laboratory of Delta State University Teaching Hospital.

Ethical considration

The research, ethics, and grants committee approved the study, Faculty of Basic Clinical Sciences, Delta State University, Abraka (RBC/FBMC/DELSU/23/266). All participants' information was kept confidential, and participants were requested to provide informed consent before recruitment. Participation in the study was voluntary, and no financial inducement was involved. Participants were informed in writing that voluntary withdrawal at any stage of interaction was guaranteed for them without any adverse consequence.

Statistical and Data Analysis

Continuous variables were tested for normality using the Kolmogorov-Smirnov test. Normally distributed variables were summarized as mean, standard deviation, and ranges, while skewed variables were summarized as median and interquartile ranges. Group mean comparisons were conducted using the Student's t-test. ANOVA was used to assess the correlations. Chi-square was used to observe demographic variables among groups. A probability value of less than 0.05 was considered significant, and data were analyzed using SPSS version 23.

Results

A total of 171 students were recruited in this study, comprising 105 males and 66 females. Seven tribes were represented in the survey, with the Urhobo ethnic group making up the majority (48.0%) and the Ijaw ethnic group being the least represented (2.3%). Most of the students were between 21–25 years old (51.5%), while those between the ages of 16–20 years and above 26 years accounted for 37.4% and 11.1%, respectively. The mean age was 21.7 ± 3.0, ranging from 16 to 32. There was a significant age difference between males and females (p=0.001). Senior students in their fourth and fifth years were represented mainly in the study, accounting for 33.3% and 19.3%, respectively (Table 1).

Table 1. Socio-demographic distribution of students

Socio-demographic data		N (%)
Age group (Years)	16 – 20	64 (37.4)
	21 – 25	88 (51.5)
	≥26	19 (11.1)
Sex	Male	105 (61.4)
	Female	66 (38.6)
Tribe	Urhobo	82 (48.0)
	Delta Ibo	34 (19.9)
	Ibos	15 (8.8)
	Isoko	14 (8.2)
	Itsekiri	8 (4.7)
	Yoruba	6 (3.5)
	Ijaw	4 (2.3)
	Edo's	8 (4.7)
Level (Class)	100	21 (12.3)
	200	20 (11.7)
	300	29 (17.0)
	400	57 (33.3)
	500	33 (19.3)
	600	11 (6.4)

The mean hemoglobin (Hb) concentration was 13.2g/dl ± 3.0, with a range of 7.9g/dl–16.0g/dl, and the mean hematocrit (HCT) level was 39.7% ± 4.8, with a range of 27.0–49.0% (Table 2).

Table 2. Mean age and haematological parameters of medical students

Variables	Mean ± SD	Range
Age (years)	21.7 ± 3.0	16.0 – 32.0
Hb (g/dl)	13.2 ± 1.4	7.9 – 16.0
HCT (%)	39.7 ± 4.8	27.0 – 49.0
MCV (FL)	88.0 ± 7.7	48.5 – 109.3
MCH (pg)	30.1 ± 2.6	22.8 – 37.3
MCHC (g/dl)	32.0 ± 1.4	29.0 – 38.0
PLT ($X10^9$/L)	270.9 ± 69.3	103.0 – 520.0
HB: Haemoglobin, HCT: Haematocrit, MCV: mean cell volume, MCH: Mean cell haemoglobin, MCHC: Mean cell haemoglobin concentration, PLT: platelet count		

The mean Hb concentration and HCT levels were higher in males than females, and the differences between both sexes were statistically significant (p=0.003 and 0.005, respectively).

The mean red cell indices were: mean cell volume (MCV) [88.0FL ± 7.7], mean corpuscular hemoglobin (MCH) [30.1 ± 2.6], and mean cell hemoglobin concentration (MCHC) [32.0 ± 1.4]. Although the mean red cell indices (MCV, MCH, MCHC) were higher in males than in females, only MCHC showed a statistically significant difference between both sexes (p=0.007).

The mean platelet count was 270.9 x 10^9/L ± 69.3, with a range of 103.0–520.0 x 10^9/L. The mean platelet count was higher in females than in males (277.8 ± 69.5 vs. 265.6 ± 68.6), but the difference was not statistically significant (p=0.263) (Table 3).

Table 3. Distribution of haematological parameters by Sex

Variables		Mean ± SD	Range	P value*
Age (Years)	**Male**	22.4 ± 3.0	16.0 – 32.0	<0.001
	Female	20.7 ± 2.5	16.0 – 29.0	
Hb (g/dl)	**Male**	13.4 ± 1.4	8.2 – 16.0	0.003
	Female	12.7 ± 1.4	7.9 – 15.3	
HCT(%)	**Male**	40.5 ± 4.8	29.0 – 49.0	0.005
	Female	38.4 ± 4.6	27.0 – 46.0	
MCV(FL)	**Male**	88.5 ± 7.8	78.5 – 109.3	0.261

	Female	87.2 ± 7.5	69.6 – 105.6	
MCH(pg)	**Male**	30.3 ± 2.3	22.8 – 37.3	0.229
	Female	29.8 ± 3.1	23.1 – 36.8	
MCHC(g/dl)	**Male**	32.2 ± 1.2	29.0 – 37.0	0.007
	Female	31.6 ± 1.5	29.0 – 38.0	
PLT (x10^9/L)	**Male**	265.6 ± 68.6	158.0 – 520.0	0.263
	Female	277.8 ± 69.5	103.0 – 480.0	

HB: Haemoglobin, HCT: Haematocrit, MCV: mean cell volume, MCH: Mean cell haemoglobin, MCHC: Mean cell haemoglobin concentration, PLT: platelet count
*: Student t-test

The distribution of hematological parameters by age group showed that students between 16–20 years and 21–25 years had higher mean hemoglobin concentration and hematocrit (Hb 13.2g/dl ± 1.3, HCT 39.3% ± 4.3 vs. Hb 13.3g/dl ± 1.4, HCT 40.4% ± 4.2) than their counterparts older than 26 years. The hemoglobin concentration and hematocrit differences between the different age groups were statistically significant (p=0.044 and 0.046, respectively) (Table 4). The red cell indices (MCV, MCH, MCHC) varied between age groups. Still, the differences in MCV and MCH between the age groups were statistically significant (p=0.011 and 0.06, respectively), whereas that of MCHC was not (p=0.373). The mean platelet count was lowest for the youngest age group (16–20 years: 259.2 ± 62.5 x 10^9/L) and gradually increased with age (21–25 years: 273 ± 70 x 10^9/L and ≥ 26 years: 300 ± 69.3 x 10^9/L) (Table 4).

Table 4. Distribution of haematological parameters by age

Variables	Age group (years)	N	Mean ± SD	Range	P value*
Hb(g/dl)	16 – 20	64	13.2 ± 1.3	10.2 – 16.0	0.044
	21 – 25	88	13.3 ± 1.4	8.2 – 15.8	
	≥26	19	12.4 ± 1.7	7.9 – 14.8	
HCT(%)	16 – 20	64	39.3 ± 4.3	30.0 – 48.0	0.046
	21 – 25	88	40.4 ± 4.7	29.0 – 49.0	
	≥26	19	37.5 ± 6.2	27.0 – 47.0	
MCV(FL)	16 – 20	64	86.2 ± 6.6	69.6 – 108.0	0.011
	21 – 25	88	89.7 ± 8.5	48.5 – 109.3	
	≥26	19	86.4 ± 5.5	73.9 – 96.0	
MCH (Pg)	16 – 20	64	30.4 ± 2.6	23.1 – 34.6	0.006
	21 – 25	88	30.2 ± 2.6	23.3 – 37.3	
	≥26	19	28.3 ± 2.4	22.8 – 31.4	
MCHC(g/dl)	16 – 20	64	31.9 ± 1.3	29.0 – 37.0	0.373
	21 – 25	88	32.1 ± 1.4	29.0 – 38.0	
	≥26	19	31.6 ± 1.0	29.0 – 34.0	
PLT (X10^9/L)	16 – 20	64	259.2 ± 62.5	158.0 – 451.0	0.070
	21 – 25	88	273.2 ± 70.5	103.0 – 520.0	
	≥26	19	300.1 ± 69.3	178.0 – 480.0	

HB: Haemoglobin, HCT: Haematocrit, MCV: mean cell volume, MCH: Mean cell haemoglobin, MCHC: Mean cell haemoglobin concentration, PLT: platelet count
*: ANOVA

The distribution of Hb concentration among the six levels was relatively normal and uniform, with mean Hb concentrations ranging from 13.0 ± 1.5g/dl among 400-level students to 13.5 ± 1.3g/dl among 300-level students. The HCT level followed a similar trend (38.3 ± 3.3% to 40.1 ± 5.0%). There was no statistical difference in Hb and HCT concentrations across the various classes, with p-values of 0.716 and 0.613, respectively. The distribution of the red cell indices and platelet counts between the different classes also did not reach statistical significance (Table 5).

Table 5. Distribution of Haematological Parameters by Class (levels)

Variables	Level (class)	N	Mean ± SD	Range	P value*
HB(g/dl)	100	21	13.3 ± 1.1	10.2 – 15.3	0.716
	200	20	13.1 ± 1.3	10.9 – 15.4	
	300	29	13.5 ± 1.3	10.2 – 16.0	
	400	57	13.0 ± 1.5	8.2 – 15.8	
	500	33	13.0 ± 1.6	7.9 – 15.8	
	600	11	13.2 ± 1.5	10.6 – 15.1	
HCT (%)	100	21	39.5 ± 3.8	30.0 – 46. 0	0.613
	200	20	38.3 ± 3.3	31.0 – 44.0	
	300	29	40.9 ± 4.2	30.0 – 48.0	
	400	57	39.5 ± 5.4	29.0 – 47.0	
	500	33	39.6 ± 5.5	27.0 – 49.0	
	600	11	40.1 ± 5.0	31.0 – 47.0	
MCV (FL)	100	21	85.7 ± 6.4	70.2 – 96.2	0.212
	200	20	85.0 ± 6.1	69.6 – 98.1	
	300	29	89.7 ± 7.4	79.6 – 108.0	
	400	57	88.6 ± 8.8	48.5 – 109.3	
	500	33	88.5 ± 7.3	74.0 – 100.8	
	600	11	89.1 ± 7.4	73.9 – 100.6	
MCH (Pg)	100	21	30.7 ± 2.6	24.1 – 34.0	0.148
	200	20	30.9 ± 2.0	24.3 – 33.2	
	300	29	30.7 ± 2.1	25.6 – 34.6	
	400	57	29.6 ± 2.8	22.8 – 37.3	
	500	33	29.7 ± 3.0	23.3 – 36.8	
	600	11	29.4 ± 2.9	23.7 – 34.8	
MCHC(g/dl)	100	21	32.0 ± 1.4	29.0 – 35.0	0.240
	200	20	31.6 ± 1.3	30.0 – 35.0	
	300	29	32.3 ± 1.4	30.0 – 37.0	
	400	57	31.8 ± 1.2	30.0 – 37.0	
	500	33	32.0 ± 1.3	29.0 – 35.0	
	600	11	32.7 ± 2.0	31.00 – 38.0	
Platelet ($x10^9$/L)	100	21	258.6 ± 61.0	188.0 – 451.0	0.125
	200	20	259.2 ± 57.3	169.0 – 396.0	
	300	29	264.5 ± 63.4	158.0 – 401.0	
	400	57	264.1 ± 61.5	103.0 – 399.0	
	500	33	301.6 ± 89.6	184.0 – 520.0	
	600	11	276.5 ± 75.7	167.0 – 428.0	

HB: Haemoglobin, HCT: Haematocrit, MCV: mean cell volume, MCH: Mean cell haemoglobin, MCHC: Mean cell haemoglobin concentration, PLT: platelet count
*: ANOVA

Fifty students (29.2%) in the study population were anemic, with the severity of the anemia classified as mild. Twenty-two students (44.0%) had microcytic hypochromic anemia, another twenty-two (44.0%) had normocytic normochromic anemia, five students (10.0%) had macrocytic anemia, and one student had sickle cell anemia (2.0%) (Table 6).

Table 6. Prevalence, severity and morphological classification of anemia

	N (%)
Prevalence of anemia	50 (29.2)
Severity	50 (100.0)
Mild	
Morphologic classification	
Microcytic hypochromic	22 (44.0)
Normocytic normochromic	22 (44.0)
Macrocytic	5 (10.0)
Sickle cell anemia	1 (2.0)

The proportion of students with mild anemia decreased with increasing age. Most of the anemia students were in the 16–20 age group (44%), followed by the 21–25 group (36%), with the remaining 20% being 26 years or older. The difference in the proportion of students with anemia by age group was statistically significant (p=0.010). Among the respondents with anemia, thirty-five were males (70.0%), and fifteen (30.0%) were females, with the difference being statistically significant (p=0.0138). There was a notable difference in the distribution of anemia by class level. Seventeen students (34.0%) with anemia were in their 400-level year, while only three students (6.0%) were in their final year (600-level); however, this difference was not statistically significant (p=0.682) (Table 7).

Table 7. Association between prevalence of anemia with age group, sex and class (level)

Variables		Anemia	Normal	P value*
Age group (years)	16 – 20	22 (44.0)	42 (34.7)	0.010
	21 – 25	18 (36.0)	70 (57.9)	
	≥26	10 (20.0)	9 (7.4)	
Sex	Male	35 (70.0)	70 (57.9)	0.014
	Female	15 (30.0)	51 (42.1)	
Level (class)	100	8 (16.0)	13 (10.7)	0.682
	200	6 (12.0)	14 (11.6)	
	300	5 (10.0)	24 (19.8)	
	400	17 (34.0)	40 (33.1)	
	500	11 (22.0)	22 (18.2)	
	600	3 (6.0)	8 (6.6)	
*: Chi-square				

Discussion

The present study was undertaken to determine and describe the prevalence, types, and severity of anemia among medical students in the College of Health Sciences, Delta State University, South-South Nigeria. Findings manifested a rational high prevalence of anemia among medical students.

Anemia is a major global health problem with significant public health implications and is highly prevalent in developing countries, including Nigeria (3). Although women of reproductive age and children are the most vulnerable, adolescents are also prone to nutritional deficiencies during their formative years (3). Factors such as increased requirements during rapid growth spurts, menstruation in females, low intake of iron-rich foods, and consuming junk food and snacks lacking micronutrients are some causes of anemia in this age group (3). Medical students, in particular, are known to face rigorous academic challenges due to the broad scope of work they are expected to cover. Often, they skip meals or consume junk food to meet the demands of attending classes, ward rounds, clinics, theatres, and studying for exams (2). This makes them a vulnerable group to developing anemia.

The prevalence of anemia among medical students in our study was 29.2%. This is similar to the survey from Waseem Shah et al., who reported a prevalence rate of 27.5% in India and also slightly higher than the report from Sane et al., who observed a prevalence of 23.33% among medical students in India (6, 14). Higher prevalence values of 55.3% and 43% were reported by Shill et al. and Subramaniyan et al. in Bangladesh and South India, respectively (15,16). On the contrary, a much lower prevalence rate was reported by Gaur et al. also among medical students in India. They reported a prevalence of 9.3% (13). This wide variation in the prevalence rate of anemia could be attributed to ethnic variations, differences in hemostatic parameters based on geographical location, differences in dietary intake, and composition of sample size. Among the anemic respondents, 70% were male, and 30% were female. This finding contrasts with reports from Sane et al., Shill et al., and Kaur et al., who all reported a higher prevalence rate among females (6,14). Even though these studies attributed the high prevalence rate in girls to monthly menstrual flow, other factors such as insufficient dietary intake, cultural norms where male children are not taught to cook, or insufficient time to cook due to a rigorous academic workload could have caused the higher prevalence in males in the index study.

As regards the severity of anemia, all affected students had mild forms (males: 11.0-12.9 g/dl; females: 11.0-11.9 g/dl) and were asymptomatic. This is similar to studies by Sane et al., Khan et al., and Pandey et al. (6,17-18). In all these studies, there was no medical student with severe anemia.

The study noted a decrease in the prevalence of anemia with increasing age, with the youngest age group (16–20 years) having the highest number of anemic students

(44%). This trend contrasts with the findings of Shill et al., who reported the lowest prevalence of anemia in the younger age group (14). The conclusions of this study may result from increased nutrient demand during the growth spurt that occurs within this formative year of life, menstrual blood loss in girls, low intake of iron-rich foods, and consumption of more junk food and snacks lacking micronutrients. Morphologically, 44% of the anemic respondents had either microcytic hypochromic or normocytic normochromic anemia. Only 10% of the anemic group had a macrocytic blood picture. The high prevalence of microcytic hypochromic anemia could be attributed to insufficient dietary iron intake, gastrointestinal bleeding from peptic ulcers, or helminthiasis. Haemoglobinopathy was ruled out as a cause for the microcytic hypochromic red cells, as Haemoglobin phenotyping revealed that only one participant had sickle cell disease.

Despite attempting to establish the prevalence and pattern of anemia among undergraduate medical students, the results from this study may have differed if a larger sample size had been used. Also, since participants were from a single institution, a multicenter study would have helped improve the external validity of the findings. This study stands as one of the pioneering efforts to establish the prevalence of anemia among undergraduate medical students, particularly in our region. It serves as a valuable foundation for developing larger studies in the future.

Conclusion

This study showed a relatively high prevalence of anemia among medical students, though it was mild. Males were more affected than females, with students aged 16–20 years being the most impacted. The predominant forms of anemia were microcytic hypochromic and normocytic normochromic. Finally, students in their 400-level were mainly affected. It's recommended that the nutritional status of medical students be considered and correlated with changes in hematological parameters for further research. Additionally, regular screenings of medical students, especially checking hematocrit levels, even in the absence of symptoms, are suggested to ensure early diagnosis and prompt treatment.

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Conflict of interest

There were no conflicts of interest among the authors.

Authors' contributions

Conceptualization, Visualization: DI, Methodology: OE, Validation, Formal Analysis, Resources, Data Curation, Writing– Original Draft Preparation, Writing– Review & Editing, DI, OE, EI, Investigation and supervision: DI, OE, Project Administration: DI , Funding Acquisition: DI, OE, EI.

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