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Lifestyle Habits and Obesity Risk Among Adolescent Medical Students: Screening and Prevention Challenges

[1] Jasmina Pleho
[2] Dženan Pleho
[3] Anes Jogunčić
[4] Kenan Pleho
[2] Edna Supur
[1] Altijana Dizdarević
[5] Ruvejda Dizdarević
[2] Lutvo Sporišević

[1] Medical High School Sarajevo, Sarajevo, Bosnia and Herzegovina
[2] Primary Health Care Center of Canton Sarajevo, Sarajevo, Bosnia and Herzegovina
[3] Public Health Institute of Canton Sarajevo
[4] Wiener Rotes Kreuz, Wien, Austria
[5] Medical student at the Sarajevo Medical School - SSST, Sarajevo, Bosnia and Herzegovina

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Author for correspondence:
Dženan Pleho
Primary Health Care Center of Canton Sarajevo, Sarajevo, Bosnia and Herzegovina
E-mail: dzenanpleho@hotmail.com

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Abstract

Introduction. Obesity is a significant public health issue and a prevalent preventable nutritional disorder. It can result from hereditary factors, prenatal conditions, environmental influences, metabolism, and lifestyle choices. This condition leads to an accumulation of adipose tissue and increased body mass.

Aim. This study aimed to identify participants' lifestyle habits, determine their nutritional status, and assess potential predictors of obesity.

Methods. The cross-sectional study included 354 students from the Sarajevo High School of Medicine, of whom 236 (approximately 70%) were female. Participants were aged 14 to 18 years, with a mean age of 16.32 ± 1.74 years. The study involved collecting anthropometric data from physical education class records and administering a structured questionnaire (socio-demographic characteristics and assessment of life habits) designed for this study.

Results. It was found that approximately one quarter of the subjects were overweight/obese. Unhealthy eating habits were prevalent, with around 50% of respondents consuming fruits and vegetables every day, 80% consuming sugar-sweetened beverages, snacks and fast food. The Pearson correlation test and linear regression determined that inappropriate eating habits, lack of physical activity and pronounced sedentary habits significantly affect the occurrence of excessive body mass/obesity in the subjects.

Conclusion. Research shows many adolescents have unhealthy habits and obesity, which pose serious health risks. Early screening and prevention are crucial to reduce these risks and promote long-term health.

Introduction

Adolescence is the period between childhood and adulthood characterized by significant physical, cognitive, hormonal, emotional, and social development. It typically spans ages 10 to 19; however, Kingorn A. et al. (1) categorize adolescence into early (10–14 years), middle (15–19 years), and late adolescence (20–24 years), highlighting that this phase is subject to various epidemiological, social, and environmental influences distinct from those of childhood and adulthood. Early adolescence is considered one of the healthiest life stages but also a critical time when risky behaviors (e.g., smoking, alcohol and substance abuse, unprotected sexual activity) are often adopted and can persist into adulthood, impacting long-term health (2). Adolescence is a period marked by a higher prevalence of obesity, with estimates suggesting approximately 80% of obese adolescents will remain so into adulthood (3). Obesity constitutes a major public health challenge, ranking as the fifth leading cause of death globally and the principal cause of chronic noncommunicable diseases in adulthood (4). According to the World Health Organization (WHO), around 39 million children under five were overweight or obese in 2020, and over 18% of children and adolescents aged 5–19 were overweight or obese in 2016 (5). Between 1975 and 2016, the prevalence of overweight or obesity in the 5–19 age group increased approximately 4.5 times. In the United States, obesity rates have more than doubled in children and tripled in adolescents over the past three decades, with 2015-2016 data indicating an obesity prevalence of around 18% in children aged 6–11 and approximately 20% in adolescents aged 12–19 (6). Obesity is a multifactorial condition resulting from the interplay of genetic factors, prenatal influences, metabolism, environmental conditions, socioeconomic status, and other variables. Prolonged energy imbalance leads to excess energy storage in the body, culminating in obesity (7, 8). Lifestyle changes over the past four decades, particularly unhealthy dietary patterns characterized by excessive consumption of processed foods, fast food, sweets, snacks, and insufficient intake of fruits, vegetables, legumes, whole grains, nuts, and seafood, have significantly contributed to the rising prevalence of obesity among children and adolescents worldwide. Other contributing factors include skipping meals (notably breakfast), consuming large portions of unhealthy food outside the family home, limited family meals, high sugary drink consumption, inadequate physical activity, and prolonged sedentary behavior (8-11). Obesity is a chronic non-communicable disease that negatively impacts almost every organ system, necessitating early detection to prevent or mitigate associated conditions. Common comorbidities in adolescents with obesity include high blood pressure, dyslipidemia, asthma, obstructive sleep apnea, metabolic syndrome, type 2 diabetes, polycystic ovary syndrome, non-alcoholic fatty liver disease, pseudotumor cerebri, musculoskeletal disorders, social isolation, low self-esteem, anxiety, eating disorders, and adolescent depression (7-11). Obesity is linked to accelerated coronary atherosclerosis in adolescents and young adults, leading to premature cardiovascular disease (12). Adolescents with obesity exhibit carotid intima-media thickening and arterial stiffness, signifying early vascular damage (13). The notable prevalence of obesity, its persistence from adolescence to adulthood, and its association with comorbidities underscore the importance of obesity screening, balanced nutrition, regular physical activity, and reduced sedentary behavior. In treating obesity in adolescents (12–17 years), lifestyle modifications should be complemented by medical interventions, such as Liraglutide, a glucagon-like peptide (GLP)-1 analog, and bariatric surgery in appropriate cases (14).

Obesity among adolescents is a global concern. The inclusion of various age groups, sample sizes, measurement accuracy, and criteria for assessing nutritional status (WHO 2007 criteria, CDC 2000 criteria, and Cole International Obesity Task Force criteria) all influence obesity distribution. Many countries utilize national reference values to determine obesity; in the absence of such values, WHO Growth reference data for ages 5–19 were employed.

Aim

This study aimed to identify participants' lifestyle habits, determine their nutritional status, and assess potential predictors of obesity.

Methods

Respondents

A cross-sectional study involved 354 students from the Sarajevo Medical High School, Bosnia and Herzegovina, aged 14-18 years, conducted from February 12 to June 10, 2019. The students attended high school from the first to the fourth year. First-grade students were under 15 years old, second-grade students were mostly 15 and 16 years old, third-grade students were 16 and 17 years old, while fourth-year students were 17 and 18 years old. Only healthy students were included in the study. The school's management approved the research (approval number: 02-1-120/19, dated January 29, 2019). Participants provided informed consent in accordance with the ethical principles of the Helsinki Declaration and its 2002 and 2004 amendments.

Instruments

The study involved administering a questionnaire and collecting anthropometric data. A structured questionnaire with 19 questions gathered demographic details, information on acute/chronic illnesses, and lifestyle habits. The dietary habits section was based on "Quantitative models of foods and meals" by Senta A. et al. (15). Body weight and height were obtained from physical education class records.

Classification of variables

The questionnaire evaluated lifestyle habits, including meal frequency, regular breakfast consumption, food intake, physical activity, and sedentary behaviors. Adolescents were instructed on how to complete a questionnaire concerning the distribution of lifestyle habits. Multiple responses were offered, classified as follows: Regular dietary habits included five meals a day, daily breakfast, and daily consumption of fruits, vegetables, low-fat dairy, and whole grains. The frequency of food intake was measured on an ordinal scale with the following categories: Never, Rarely, Once per week, 2 to 3 times per week, and Every day. Limited consumption of fast food, sweets, snacks, and sugar-sweetened beverages was also considered. Adequate physical activity was defined as exercising for an hour or more, five times a week or more. Sedentary behavior included watching TV, using computers, or playing video games for over two hours, five or more times a week. Body mass index (BMI) is used to assess nutritional status by dividing body weight in kilograms by height in meters squared (kg/m^2). Participants' BMI values were compared with WHO 2007 Growth reference standards for ages 5-19. According to WHO criteria, participants were classified as thin (BMI < +1SD and > -2SD) or overweight (> +2SD) (16).

Statistics

The data obtained from the research were analyzed using IBM SPSS v27.1 (SPSS Inc, Chicago, IL, USA), version 27.0. The data were presented in the form of frequencies and relative representation within the sample (%). Analysis between the examined groups was performed using the Chi-square test. The normality of distribution for linear variables, including age and body mass index (BMI), was assessed using the Kolmogorov-Smirnov test. BMI exhibited a non-parametric distribution. Dietary habits, specifically the frequency of consumption of certain foods and the number of daily meals, were evaluated using an ordinal scale. Frequency was measured on a five-level ordinal scale, ranging from "never" to "every day." Based on WHO recommendations, the presence of healthy eating habits was assessed. Breakfast skipping was examined using a binary response format (Yes/No). Participants provided information regarding their physical activity over the past seven days, as well as sedentary behaviors (e.g., watching television, playing video games). These responses were subsequently classified as either present or absent. Number of meals had a range from 1 to 5 or more meals. The association of BMI values with dietary habits, number of meals, and regular consumption of certain foods was tested using Spearman's correlation. The accepted level of significance was set at $p<0.05$.

Results

The final analysis included 354 adolescents aged 14–18 years (average age 16.32±1.74 years), Out of the total sample, 236 (66.7%) were female respondents, while 118 (33.3%) were male respondents. Average age of male respondents was 16.05±1.88 years, and average age of female respondents was 16.52±1.32 years, with female respondents beeing significantly older (t=2.800; p=0.005). The distribution of students by gender did not show a statistically significant difference from the first to the fourth grade (x^2=5.743, df= 3; p=0.125). Dietary habits are presented in table 1.

The table presents dietary habits based on the frequency of food consumption, where the classification of good or poor habits was determined by the author according to specific numerical criteria for each food item. Good dietary habits for a particular food were assigned based on higher consumption frequencies, while lower frequencies indicated poorer habits. Dairy products such as low-fat milk and yogurt were classified as part of good dietary habits, whereas processed cheese was associated with poorer eating patterns. Similarly, frequent consumption of fresh vegetables, fruits, and lean meats was considered a good dietary habit, while processed meats, canned foods, and margarine were categorized as poor dietary choices. The classification aligns with WHO recommendations, emphasizing the importance of consuming certain foods regularly to maintain a healthy diet. Approximately 50% of adolescents consume fruits and vegetables daily, while about 50% regularly eat fish and 40% regularly consume whole grain bread and cereals. Approximately 80% of respondents consume fast food and snacks daily, and 80% of adolescents drink sugar-sweetened beverages daily. About 70% of respondents consume sweets daily. Figure 1 shows analysis of regular physical activity, sedentary habits, and breakfast regularity.

The analysis showed that 59.6% of respondents regularly consumed breakfast, with the highest frequency in first grade (74.03%), decreasing in later grades (χ^2=14.993, p=0.002). Regular physical activity was reported by 35.31% of respondents, peaking in second grade (49.33%) and declining in other grades, with a significant difference (χ^2=14.685, p=0.002). Sedentary habits were present in 71.75% of respondents, most notably in fourth grade, however no significant age-related difference was found (χ^2=4.428, p=0.212).

When compared with age of subjects, significant findings were observed only in regularity of breakfast (table 2).

Regular breakfast consumption was more common among younger participants, with a mean age of 16.9 ± 1.1 years, while those who did not regularly eat breakfast were significantly older, with a mean age of 17.2 ± 1.1 years (p < 0.001). No significant differences were found in relation to physical activity or sedentary habits.

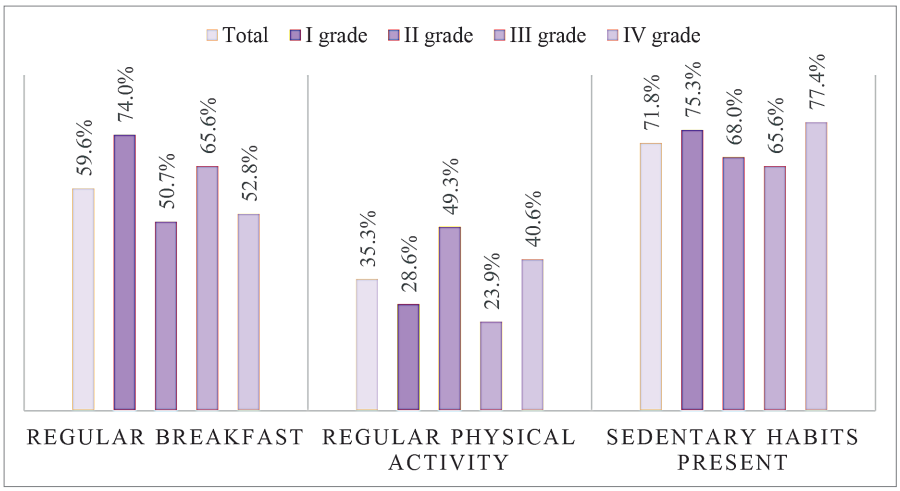

Figure 1. **Percentage of students reporting regular breakfast, regular physical activity, and sedentary habit across grades**

Table 1. **Dietary habits**

Food Items	Every Day (A)	2-3 Times per Week (B)	Once per Week (C)	Rarely (D)	Never (E)	Good Dietary Habits (N, %)	Poor Dietary Habits (N, %)
Milk and Dairy Products							
Milk (0.5-2%)	74	79	58	66	77	153 (43.22%)	201 (56.78%)
Milk (2.8%)	76	85	70	73	53	196 (55.37%)	161 (45.48%)
Milk (3.2 or 3.5%)	78	83	64	77	52	193 (54.52%)	161 (45.48%)
Yogurt, probiotic cultures, kefir	100	76	71	65	42	176 (49.72%)	178 (50.28%)
Cheese: Fresh	69	78	65	76	66	147 (41.53%)	207 (58.47%)
Processed	63	82	83	73	53	209 (59.04%)	145 (40.96%)
Hard cheese	52	66	94	81	61	236 (66.67%)	118 (33.33%)
Fats							
Sunflower oil	141	86	48	44	35	127 (35.88%)	227 (64.12%)
Olive oil	75	73	91	56	59	148 (41.81%)	206 (58.19%)
Butter	72	107	90	52	34	179 (50.56%)	175 (49.44%)
Margarine	43	61	72	97	81	250 (70.62%)	104 (29.38%)
Meat and Meat Products							
Beef	55	78	93	67	61	226 (63.84%)	128 (36.16%)
Veal	39	66	92	85	66	197 (55.65%)	157 (44.35%)
Lamb	47	65	94	99	49	206 (58.19%)	148 (41.81%)
Chicken	90	116	70	36	42	276 (77.97%)	78 (22.03%)
Turkey	53	63	66	96	76	182 (51.41%)	172 (48.59%)
Processed meats (sausages, salami)	107	95	67	48	37	85 (24.01%)	269 (75.99%)
Eggs	105	99	68	54	28	199 (56.21%)	155 (43.79%)
Fish and Seafood							
Freshwater fish	53	52	94	96	50	199 (56.21%)	155 (43.79%)
Saltwater fish	45	66	81	91	71	192 (54.24%)	162 (45.76%)
Canned fish, pâtés	72	79	88	66	49	115 (32.49%)	239 (67.51%)
Vegetables							
Leafy greens (spinach, kale, lettuce)	62	84	82	76	49	146 (41.24%)	208 (58.76%)
Root vegetables (carrots, beets)	61	86	97	68	42	147 (41.53%)	207 (58.47%)
Onions	39	67	76	105	67	182 (51.41%)	172 (48.59%)
Tomatoes, eggplants	61	96	71	76	50	157 (44.35%)	197 (55.65%)
Legumes (beans, peas)	110	69	95	45	35	179 (50.56%)	175 (49.44%)
Fruits							
Fresh fruit	81	113	77	40	43	194 (54.8%)	160 (45.2%)
Citrus fruits	61	103	106	53	31	164 (46.33%)	190 (53.67%)
Nuts	43	82	103	87	39	125 (35.31%)	229 (64.69%)
Dried fruits	52	69	76	87	70	145 (40.96%)	209 (59.04%)
Jams, marmalades	81	68	83	75	38	151 (42.66%)	203 (57.34%)

Table 2. **Breakfast eating, regular physical activity and presence of sedentary habits regarding age of subjects**

		Age			
		Mean	SD	t	*p*
Regular breakfast	Yes	16.9	1.1	6.34	<0.001
	No	17.16	1.08		
Regular physical activity	Yes	17.04	1.1	1.7	0.089
	No	16.98	1.12		
Presence of sedentary habits	Yes	17.01	1.15	0.33	0.743
	No	16.79	1.04		

Table 3. **Correlation between unhealthy lifestyle factors and body mass index**

Variables		BMI
Number of meals per day	Rho	0.507
	p	<0.001
Consumption of fruits	Rho	-0.627
	p	<0.001
Consumption of vegetables	Rho	-0.560
	p	<0.001
Consumption of snacks	Rho	0.861
	p	<0.001
Consumption of fast food	Rho	0.779
	p	<0.001
Consumption of sweets	Rho	0.800
	p	<0.001
Consumption of sugar-sweetened beverages	Rho	0.537
	p	<0.001
Lack of physical activity	r_{pb}	0.598
	p	<0.001
Sedentary habits	r_{pb}	0.759
	p	<0.001
Irregular breakfast consumption	r_{pb}	0.752
	p	<0.001

The values represent Spearman's correlation coefficient, sig. - significance, probability

The majority of respondents reported consuming three daily meals, with prevalence rates of 42.9% among first-grade students, 41.89% among second-grade students, 46.88% among third-grade students, and 51.4% among fourth-grade students. The recommended intake of five daily meals was observed in 24.7% of first-grade students, 8.11% of second-grade students, 12.5% of third-grade students, and 8.41% of fourth-grade students. Only one or two meals per day had in total 14.4% of subjects, or regarding grades, 5.2% in first grade, 21.6% in second grade, 11.5% in third grade and 18.7% in fourth grade.

It was found BMI is significantly associated with poor dietary habits, physical inactivity and sedentary habits (Table 3). Consumption of snacks such as chips and sweets showed a very strong positive association with BMI. Higher consumption was correlated with higher values of BMI. Expressed sedentary habits, fast food consumption, irregular breakfast habits have strong influences on BMI. In addition, also lower and irregular consumption of fruits and vegetables emerged as predictors of obesity.

BMI - body mass index. Using Spearman's correlation coefficient, no significant correlation was found between age and BMI (rho=0.241; *p*=0.346). More frequent consumption of snacks, fast food, sweets, and sugar sweetened beverages was in correlation with higher values of BMI.

Discussion

Our research indicates that approximately one-third of adolescents have excess body weight or obesity. Unhealthy lifestyle habits are linked to this condition: only 6% of 15-16-year-olds and 19% of 14-15-year-olds eat five meals a day, one-third to one-half skip

breakfast, about 50% do not consume fruits and vegetables daily, around 80% frequently eat fast food, snacks, sweets, and sugar-sweetened beverages, approximately 35% regularly exercise, and approximately 70% are sedentary. Overweight/obesity rates in adolescents are in line with other studies. The CDC states that one in five U.S. children and adolescents is overweight/obese (17). In Ireland, 24% of adolescents were overweight/obese in 2020, up from 18% in 2006 (18). In Poland, 13-18-year-olds have a significant prevalence of overweight/obesity, with 15-19% of boys and 10-13% of girls affected (19). A cross-sectional study by Matana and Krajinović (2024) of 344 Croatian adolescents aged 15-18 found that 15% were overweight, with 11% overweight and 4% obese. These findings highlight obesity as a global health issue, suggesting the need for further cohort studies to identify specific factors influencing obesity prevalence.

We found that factors such as, number of meals per day, skipping breakfast, intake of sugar-sweetened beverages, snacks, and sweets, physical inactivity, and sedentary behavior, as well as lower intake of fruits and vegetables are significant indicators of excess body weight/obesity in our respondents.

About 80% of our respondents do not eat the recommended five daily meals. Toschke AM et al. show that obesity rates drop with more daily meals: the odds ratio (OR) for obesity is 0.71 with 4 meals, and 0.57 with 5 or more meals compared to 3 or fewer meals (21). The recommended five meals significantly lower the risk of obesity in 16-year-old boys and girls: OR for overweight/obesity is 0.47 for boys and 0.57 for girls; for abdominal obesity, it is 0.32 for boys and 0.54 for girls (22). Our study did not find that more frequent meals reduce obesity. This may be due to differences in methodology, such as study type, participant number, follow-up period, criteria for defining obesity and meal frequency, types and quality of meals, and potential errors in self-assessment. Demographic differences and individual variations among respondents also play a role.

Numerous studies have indicated that skipping breakfast affects nutritional status. It was found that a significant number of adolescents skip breakfast, which is a predictor of overweight/obesity. Chen S. et al. reported that in respondents aged 8-17 years, the odds ratio for overweight or obesity among those who skipped breakfast was 1.25 (23). Studies have shown that skipping breakfast increases the risk of obesity by around 40% in children and adolescents (24). Unhealthy eating habits, such as high consumption of fats, sugars, and salt, along with low intake of fiber, fruits, vegetables, legumes, whole grains, nuts, and seafood, contribute to obesity and related diseases. Approximately half of our respondents rarely eat fruits, vegetables, and whole grains, while approximately 75% excessively consume processed foods, fast food, snacks, sweets, and sugar-sweetened beverages. Consuming fatty cheese, processed foods, fast food, refined grains, snacks, biscuits, high-fat milk, and sugar-sweetened beverages also increases the risk of excess body weight.

Liberali R. et al. state that eating fatty cheese, processed foods, fast food, refined grains, snacks, biscuits, and drinking high-fat milk and non-alcoholic beverages increase the risk of excess body weight (25).

Daily consumption of fruits and vegetables is part of a healthy diet. A study with 203 obese children aged 12-18 years showed that eating more fruits and vegetables reduces obesity risk (26). However, our study did not find this link. This discrepancy might be due to different study methods, sample sizes, definitions of obesity, ways of measuring consumption, the quality and quantity of fruits and vegetables consumed, high intake of processed foods and sugars, as well as demographic differences and individual variations.

Long-term consumption of sugar-sweetened beverages leads to obesity and related diseases. Our research indicates that adolescents consume sugar-sweetened beverages in large quantities, which may contribute to obesity. The European Society for Paediatric Gastroenterology, Hepatology, and Nutrition (ESPGHAN) links sugar-sweetened beverages with obesity and cardiometabolic diseases. They recommend that children aged ≥2 to 18 years limit sugar intake to less than 5% of their energy intake and drink water or unsweetened milk instead (27).

An examination of physical activity levels and sedentary behaviors indicates that approximately two-thirds of adolescents are physically inactive, while around three-quarters engage in sedentary behaviors. These patterns are frequently linked to unhealthy dietary practices, which serve as a risk factor for obesity and related comorbidities. Globally, it is estimated that approximately 80% of adolescents are insufficiently physically active and engage insedentary behaviors (28). Previous research has empha-

sized the connection between these risk factors and obesity.

Public media can influence adolescent habits by advertising unhealthy foods and beverages. The curricula at the Sarajevo High School of Medicine, as well as in other high schools, could be designed to enhance the knowledge and skills of both teachers and students regarding healthy lifestyle habits in line with relevant recommendations.

In general there is a significant influence of public media on adolescent habits as they advertise unhealthy foods and beverages. Obesity is linked to other health risk factors. It is important to have a healthy dietary pattern and regular physical activity from an early age, as unhealthy habits can become difficult to change later. Both family practices and school activities contribute to promoting and maintaining healthy lifestyle habits.

The study's limitations include focusing on only one high school, Sarajevo High School of Medicine. The questionnaire should be expanded to include food intake quantity and subsequently validated. Objectivity requires trained personnel using validated equipment to measure anthropometric parameters. Assessing hip circumference, waist-to-height ratio, blood pressure, blood glucose, lipid profile, sleep quality and duration would provide a more comprehensive evaluation of health risks in adolescents.

Obesity poses serious health risks, necessitating focused efforts on lifestyle screening and obesity prevention in adolescents. Health education and promotion should play a greater role in school curricula, which is what we investigated.

Conclusion

This study found that approximately one-third of adolescents are overweight or obese, with higher BMI strongly associated with poor dietary habits such as irregular breakfasts, low fruit and vegetable intake, and frequent consumption of snacks, sweets, and fast food. The number of meals per day decreased with age, and most students did not meet the recommended five daily meals, while physical inactivity and high levels of sedentary behavior further contributed to excess body weight. These findings emphasize the urgent need for comprehensive strategies to promote healthier eating habits, encourage regular physical activity, and reduce sedentary lifestyles among adolescents.

Author contributions

Conceptualization and methodology (LS, AJ, JP, DzP); Data curation and formal analysis (AJ); Investigation and project administration (JP,KP, AD, RD); Writing – original draft (LS, AJ, ES, JP, DzP) and Review & editing (LS, AJ). All authors have approved the final manuscript.

Conflict of interest

The authors declare no conflicts of interest.

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