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Prevalence and factors associated with overweight and obesity among secondary school students in Djoungolo Health District, Cameroon: a household-based cross-sectional study

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Abstract

Background

The rapid nutritional transition in sub-Saharan Africa (SSA) has escalated the burden of overweight and obesity among students. However, localised epidemiological data from urban health districts in Cameroon remain scarce. This study aimed to determine the prevalence and factors associated with overweight and obesity among secondary school students in Djoungolo Health District (HD), Yaoundé, Cameroon, and to assess the concordance between self-perceived and objectively measured weight status.

Methods

We conducted a household-based cross-sectional study from November 2024 to October 2025 among secondary school students residing in Emana and Mballa II Health Areas (HAs). We used a two-stage non-probability sampling approach, purposively selecting the HAs and then using convenience sampling of eligible participants. We collected data using a structured questionnaire. Overweight and obesity were defined using the International Obesity Task Force (IOTF) age- and sex-specific body mass index (BMI) cut-offs for participants below 18 years and standard adult thresholds (≥ 25 kg/m^2 and < 30 kg/m^2 for overweight, ≥ 30 kg/m^2 for obesity) for those aged ≥ 18 years. We used generalised estimating equations (GEE) with robust standard errors to identify factors associated with overweight and obesity. Agreement between measured BMI and self-perceived weight status was assessed using Cohen's kappa (κ) statistic.

Results

Of the 274 participants, the mean age was 15.6 ± 2.5 years (57.7% female). The overall prevalence of overweight and obesity was 14.2% (95% CI: 10.3–18.9%), comprising 11.3% overweight and 2.9% obesity. In multivariable GEE analysis, two factors were associated with overweight and obesity: female sex (adjusted odds ratio [aOR] = 3.22; 95% CI: 1.41–7.36; p = 0.005) and students aged 11–15 years (aOR = 2.54; 95% CI: 1.01–6.39; p = 0.049). Agreement between measured BMI and self-perceived weight status was moderate (κ = 0.418; p < 0.001), with 46.2% of overweight or obese students underestimating their weight status.

Conclusions

School-based interventions promoting healthy lifestyles, routine anthropometric screening, and improved body weight awareness, particularly among younger students and girls, are needed to reduce the growing burden of overweight and obesity among secondary school students in urban Cameroon.

Trial registration:

Not applicable.

Background

Non-communicable diseases (NCDs) represent an escalating global health crisis, accounting for approximately 41 million deaths annually, or 74% of all global mortality [1]. Among the modifiable risk factors driving this epidemic, overweight and obesity occupy a central position, serving as primary precursors for cardiovascular diseases, type 2 diabetes mellitus, musculoskeletal disorders, and various malignancies [2]. Historically concentrated in high-income countries, the burden of overweight and obesity has shifted rapidly toward low- and middle-income countries (LMICs), where the rate of increase among children and adolescents is particularly alarming [3]. Globally, the prevalence of overweight and obesity among children and adolescents aged 5–19 years rose from 4% in 1975 to over 18% in 2016 [4], with recent estimates confirming a fourfold surge in obesity rates since 1990 [5]. In SSA, this transition is unfolding against a persistent backdrop of undernutrition, creating a complex "double burden" of malnutrition that strains fragile health systems [6]. Rapid urbanization, dietary shifts toward energy-dense processed foods, and increasingly sedentary lifestyles are recognized as the primary drivers of this nutritional shift [7].

Cameroon vividly exemplifies this epidemiological transition. With over 51% of its population residing in urban settings [8], the country is experiencing profound shifts in dietary habits and physical activity patterns [9]. Adolescence represents a critical developmental window during which overweight and obesity frequently track into adulthood, amplifying long-term cardiometabolic risk [10]. Secondary school students are particularly susceptible to obesogenic environments as they gain increasing autonomy over dietary choices while facing sedentary academic demands and screen-based recreation [11].

Although studies across SSA report school-aged students overweight and obesity prevalence rates ranging from under 5% to over 40% [12], significant evidence gaps persist in Cameroon. First, previous investigations have predominantly focused on Douala (reporting 12.5% prevalence [13]) or the North-West Region (18.8% prevalence [14]). Data remain sparse for Yaoundé, the political capital, which possesses distinct sociodemographic, cultural, and urbanization profiles. Second, few studies have adopted an HD-level framework, the foundational operational unit for decentralized public health planning in Cameroon. Third, most existing studies have focused narrowly on socioeconomic and dietary indicators, without concurrently evaluating the combined influence of physical activity patterns, medical history, and household-level clustering [15, 16]. Finally, evidence regarding the concordance between students' self-perceived weight status and their objectively measured body mass index (BMI) remains limited in Central Africa. Internationally, body weight misperception affects one-third to one-half of youth, with overweight and obese adolescents being especially prone to underestimating their weight [17–21]. In African sociocultural contexts, where larger body size has historically been idealized as a marker of health, beauty, and prosperity, weight underestimation may diminish motivation to adopt healthy lifestyle

behaviors or engage in prevention programs [20, 21]. Understanding both the true prevalence of overweight and obesity and the extent of weight misperception is therefore critical for designing effective public health strategies.

This study aimed to determine the prevalence of overweight and obesity, identify independent associated factors, and assess the concordance between self-perceived and objectively measured weight status among secondary school students in Djoungolo HD, Yaoundé, Cameroon.

Methods

Study design and setting

A descriptive and analytical household-based cross-sectional study was conducted within the Djoungolo HD, Yaoundé, Cameroon. The broader study timeline spanned from November 2024 to October 2025, with field-based participant recruitment and data collection conducted over a three-week period from 3 to 21 August 2025. The Djoungolo HD is one of eight urban health districts in the Centre Region of Cameroon, serving an estimated population of over 420,000 inhabitants across eight HAs. It encompasses a diverse socio-economic demographic and a high density of both public and private secondary schools operating under the Francophone and Anglophone sub-systems of education. Two HAs were purposively selected for this study: Emana and Mballa II health area. Emana represents a rapidly expanding peri-urban setting in the northern zone of the district, whereas Mballa II represents a densely populated, central urban commercial and administrative setting. The selection of these two HAs was done based on three operational criteria: (1) a high concentration of secondary schools; (2) logistical accessibility for door-to-door household visits within the data collection window; and (3) sociodemographic diversity, as Emana represents a peri-urban setting, whereas Mballa II represents a central urban setting.

Study Population and Eligibility Criteria

The target population consisted of all students enrolled in secondary school classes from Form 1 to Upper Sixth (corresponding to Year 7 to Year13 in the international nomenclature or 6ème to Terminale in the French system) within the Emana and Mballa II HAs during the 2024–2025 academic year.

Inclusion criteria were: Current enrollment in secondary school during the 2024–2025 academic school year; Continuous residence within the selected HAs for at least 30 days prior to data collection; Provision of verbal parental/guardian consent and participant assent (for students < 18 years) or individual informed consent (for students aged ≥ 18 years); Willingness to undergo physical anthropometric measurements.

Exclusion criteria were: Known self-reported or parent-reported endocrine, metabolic, or chronic psychiatric disorders known to directly alter body weight regulation (e.g., severe thyroid dysfunction,

Cushing's syndrome, clinical eating disorders); Current systemic use of medications known to significantly alter weight (e.g., chronic systemic corticosteroids, antipsychotics, valproate); Current pregnancy (confirmed by self-report); Physical musculoskeletal deformities precluding accurate standing height or weight assessment.

Sample size determination and Sampling strategy

The minimum required sample size was calculated using Cochran's single population proportion formula[22]:

$$\varvec{n} = \frac{\varvec{Z}^2 \times \varvec{p} \times (1 - \varvec{p})}{\varvec{d}^2}$$

where: Z = 1.96 (standard normal deviate corresponding to the 95% confidence level); p = 0.124 (estimated prevalence of overweight and obesity of 12.4% among Cameroonian urban school-aged students [23]); d = 0.05 (desired margin of error). This yielded an initial baseline sample of 167 participants. To account for potential clustering of students within households, an a priori design effect (DEFF) of 1.5 was applied in accordance with the WHO Stepwise approach to non-communicable disease risk factor surveillance guidelines for anthropometric measurements [24], increasing the required sample to 251. After incorporating a 10% contingency for non-response, the final target sample size was determined to be 275 participants.

A two-stage non-probability sampling approach was utilized. In the first stage, Emana and Mballa II HAs were purposively selected, and in the second stage, participants were selected using a convenience sampling technique. In all approached households, field investigators identified eligible secondary school students. In households containing multiple eligible students, all willing and consenting students were invited to participate. A total of 274 students completed all interview modules and anthropometric assessments and were included in the final analysis (Fig. 1).

Data collection and anthropometric procedures

Data were collected through face-to-face household interviews using a structured, study-specific questionnaire administered via KoBoCollect on Android tablets with automated range checks and validation constraints. The questionnaire was developed for the present study by adapting relevant items and domains from previously published studies [25], and further tailored to the study population and objectives. It covered six domains: (i) socio-demographics (age, sex, health area, ethnicity, religion, school type, educational sub-system, and academic cycle); (ii) socioeconomic status (maternal and paternal occupation, and estimated monthly household income in Central African CFA franc [FCFA]); (iii) dietary habits (daily meal frequency, breakfast consumption, lunch source, weekly intake of fruits, vegetables, sugar-sweetened beverages, and fast foods, family dinner frequency, and eating while

watching television); (iv) physical activity and sedentary behavior (extracurricular physical activity, school physical education frequency, mode of transport to school, and daily sitting time); (v) weight perception and medication (self-perceived weight status and use of weight-control medication); (vi) and anthropometric measurements (height, weight, and BMI). The English-language version of the study questionnaire is provided as Supplementary File 1. Anthropometric assessments were performed following standardized international protocols by trained research assistants with verified inter-observer reliability. Body weight was measured to the nearest 0.1 kg using a calibrated SECA® 874 electronic scale (SECA GmbH & Co. KG, Hamburg, Germany) with participants barefoot and in light clothing on a level surface. Height was measured to the nearest 0.1 cm using a precision, non-stretchable SECA® tape mounted vertically against a flat wall, with participants standing barefoot with heels together and head oriented in the Frankfurt horizontal plane, reading the vertex with a rigid headboard.

Study variables

Dependent variable

The dependent variable was overweight and obesity, calculated as BMI = weight (kg)/ height $(m)^2$. Participants < 18 years were classified using the International Obesity Task Force (IOTF) age- and sex-specific cut-offs [26]. For those ≥ 18 years, standard adult thresholds (≥ 25 kg/m^2 and < 30 kg/m^2 for overweight, ≥ 30 kg/m^2 for obesity) were applied. Due to data sparsity (n = 8 obese cases), overweight and obesity were combined into a single binary dependent variable (overweight/obese vs. normal/underweight)

Independent variables

To ensure statistical stability, minimize standard errors, and prevent model non-convergence, variables with low frequencies in certain strata were collapsed into logically related categories prior to analysis. The final variables analyzed across five conceptual domains were: Socio-demographics: Health area (Emana, Mballa 2); sex (male, female); age in years (11–15, 16–18, ≥ 19); school type (public, private); educational system (English, French); academic cycle (Cycle 1 [Form 1–4], Cycle 2 [Form 5–Upper Sixth]); ethnic group (Béti/Bassa/Mbam, Bamileke/Bamoun, Grassfields and others); and religion (Catholic, protestants, Muslim, and other religions). Socioeconomics: Estimated monthly household income (≤ 100,000 FCFA, > 100,000 FCFA); and maternal and paternal occupation (Formal/Salaried [public/private sector], Retail/Business, Inactive/Informal [agriculture, retired, unemployed]). Dietary Behaviors: Daily meal frequency (≤ 2, 3, > 3 meals); fast-food consumption frequency (Low [≤ 1/week], Medium [2–3/week], High [> 3/week]); lunch location (home, school, do not eat); and binary modalities (yes/no) for fruit/vegetable intake, sugary drink consumption, and regular breakfast. Lifestyle patterns included weekly frequency of family dinners (≤ 2 vs. ≥ 3 times) and eating dinner in front of the television (≤ 2 vs. ≥ 3 times). Physical Activity and Sedentary Behaviors: Extracurricular physical activity (yes/no);

weekly physical education (PE) class frequency (≤ 2 vs. ≥ 3 times); mode of transport to school categorized by energy expenditure (Active [walking/cycling] vs. Passive [motorized]); and daily sedentary sitting time (≤ 3 hours vs. > 3 hours). Weight Perception and Medical History: Use of weight-loss medication (yes/no) and weight self-perception (Underweight/Normal vs. Overweight/Obese).

Data management and statistical analysis

Data were exported from the KoBoToolbox server, verified in Microsoft Excel, and analyzed using R version 4.6.1. Descriptive statistics were computed for all study variables. Continuous variables were evaluated for distributional normality using the Shapiro–Wilk test and visual Q-Q plot inspection, and summarized as means ± standard deviations (SD) otherwise median (interquartile range). Categorical variables were presented as absolute frequencies and percentages (n, %). To account for the non-independence of observations arising from multiple students within households, GEE was used. An exchangeable working correlation structure was specified, which assumes equal correlation among individuals residing within the same household cluster. Univariable GEE analysis was first conducted to calculate crude odds ratios (cOR) and 95% confidence intervals (CI) for each potential associated factor. Variables demonstrating associations at a liberal screening threshold of $p \leq 0.20$ in univariable analysis were entered into the multivariable GEE model. aOR with corresponding 95% CIs were estimated. Statistical significance in the final multivariable analysis was defined at $p < 0.05$. Multicollinearity among potential associated factors was assessed using the Generalized Variance Inflation Factor (GVIF), with GVIF^(1/(2·df)) values < 2.0 (equivalent to standard VIF < 5.0) indicating an absence of problematic collinearity. Discrimination of the final multivariable model was evaluated using the Area Under the Receiver Operating Characteristic curve (AUC) with 95% CI. Model calibration was assessed using the Brier score (with values < 0.25 denoting acceptable calibration), and the Quasi-likelihood under the Independence Model Criterion (QIC) was used to compare working correlation structures. Concordance between objectively measured IOTF BMI status (overweight/obese vs. not) and subjective weight self-perception (perceived overweight/obese vs. not) was quantified using Cohen's kappa coefficient (κ) with 95% CI and interpreted according to Landis and Koch guidelines [27]. Self-perceived weight was excluded from regression models as it represents a cognitive consequence rather than an etiologic risk factor of overweight and obesity.

Results

Household and participant sociodemographic characteristics

A total of 274 secondary school students residing across 225 unique households completed the study. The number of enrolled students per household ranged from 1 to 4 (mean: 1.22 ± 0.51). Specifically, 185 (82.2%) households contributed one student, 32 (14.2%) contributed two students, and 8 (3.6%) contributed three or more students. The estimated intra-cluster correlation coefficient (ICC) for

overweight/obesity was 0.068, indicating modest within-household clustering that required the use of GEE analysis. The mean age of participants was 15.6 ± 2.5 years (range: 11–23 years), with 53.6% (n = 147) aged 11–15 years. Female students comprised 57.7% (n = 158) of the cohort. The majority of participants resided in the Emana Health Area (63.9%, n = 175), followed the French education sub-system (83.9%, n = 230), attended public secondary schools (56.2%, n = 154), and were enrolled in Cycle 1 (57.7%, n = 158). More than half of the households (54.4%, n = 149) reported a monthly household income ≤ 100,000 FCFA, and formal/salaried employment was the most common occupational category for both mothers (40.5%) and fathers (57.3%) (Table 1).

Table 1
Sociodemographic characteristics of secondary school students in Emana and Mballa II HAs, Cameroon (N = 274).

Variable	N = 274(%)
Health area	
Emana	175 (63.9)
Mballa II	99 (36.1)
Age group (years)	
11–15	147 (53.6)
16–18	95 (34.7)
≥ 19	32 (11.7)
Sex	
Male	116 (42.3)
Female	158 (57.7)
Ethnic group	
Béti/Bassa/Mbam	154 (56.2)
Bamileke/Bamoun	71 (25.9)
Grassfields and others	49 (17.9)
Religion	
Catholic	163 (59.5)
Muslim	26 (9.5)
Protestant	43 (15.7)
Others	42 (15.3)
School type	
Public	154 (56.2)
Private	120 (43.8)
Education system	
English	44 (16.1)
French	230 (83.9)

Variable	N = 274(%)
Health area	
Cycle	
Cycle 1 (Form 1 to Form 4)	158 (57.7)
Cycle 2 (Form 5 to Upper Sixth)	116 (42.3)
Mother's occupation	
Formal/Salaried	111 (40.5)
Retail/Business	107 (39.1)
Inactive/Agri/Other	56 (20.4)
Father's occupation	
Formal/Salaried	157 (57.3)
Retail/Business	47 (17.2)
Inactive/Agri/Other	70 (25.5)
Household income (CFA)	
≤ 100,000 CFA	149 (54.4)
> 100,000 CFA	125 (45.6)

Prevalence of overweight and obesity

The prevalence of overweight was 11.3% (n = 31; 95% CI: 7.8–15.7%) and obesity was 2.9% (n = 8; 95% CI: 1.3–5.7%), yielding an overall combined overweight and obesity prevalence of 14.2% (n = 39; 95% CI: 10.3–18.9%;). Overweight and obesity was more prevalent among females than males (19.0% vs. 7.8%), younger adolescents aged 11–15 years (19.0% vs. 8.4% for 15–18 and 9.4% for ≥ 19 years), and students in Cycle 1 compared to Cycle 2 (17.1% vs. 10.3%). Subgroup variations were also observed by health area (Mballa II: 17.2% vs. Emana: 12.6%), ethnic group (Bamileke/Bamoun: 21.1% vs. Béti/Bassa/Mbam: 10.4%), religion (Muslim: 23.1% vs. Catholic: 13.5%), school type (public: 15.6% vs. private: 12.5%), and education subsystem (English: 15.9% vs. French: 13.9%; Table 2).

Table 2
Distribution of secondary school students by overweight and obesity status in Emana and Mballa II HAs, Cameroon (N = 274)

Variable	Overweight and Obese n = 39 (%)[1]	Not overweight and obese n = 235 (%)[1]	Overall n = 274 (%)[1]
Health area			
Mballa II	17 (17.2)	82 (82.8)	99 (100)
Emana	22 (12.6)	153 (87.4)	175 (100)
Age group (years)			
11–15	28 (19)	29 (81)	147 (100)
16–18	8 (8.4)	87 (91.6)	95 (100)
≥ 19	3 (9.4)	29 (90.6)	32 (100)
Sex			
Male	9 (7.8)	107 (92.2)	116 (100)
Female	30 (19.0)	128 (81.0)	158 (100)
Ethnic group			
Grassfields and others	8 (16.3)	41 (83.7)	49 (100)
Béti/Bassa/Mbam	16 (10.4)	138 (89.6)	154 (100)
Bamileke/Bamoun	15 (21.1)	56 (78.9)	71 (100)
Religion			
Others	5 (11.9)	37 (88.1)	42 (100)
Catholic	22 (13.5)	141 (86.5)	163 (100)
Muslim	6 (23.1)	20 (76.9)	26 (100)
Protestant	6 (14.0)	37 (86.0)	43 (100)
School type			
Private	15 (12.5)	105 (87.5)	120 (100)
Public	24 (15.6)	130 (84.4)	154 (100)

[1]n (row%) for categorical variables. Row percentages show the proportion of each subgroup that is overweight and obese vs. not. P-values are intentionally omitted: Chi-square and Fisher tests assume independence, which is violated by the clustered design (students nested within households). Valid p-values from GEE analysis accounting for clustering are reported in Table 4.

Variable	Overweight and Obese n = 39 (%)[1]	Not overweight and obese n = 235 (%)[1]	Overall n = 274 (%)[1]
Health area			
Education system			
English	7 (15.9)	37 (84.1)	44 (100)
French	32 (13.9)	198 (86.1)	230 (100)
Cycle			
Cycle 2 (Form 5 to Upper Sixth)	12 (10.3)	104 (89.7)	116 (100)
Cycle 1 (Form 1 to Form 4)	27 (17.1)	131 (82.9)	158 (100)
Mother's occupation			
Inactive/Agri/Other	10 (17.9)	46 (82.1)	56 (100)
Formal/Salaried	15 (13.5)	96 (86.5)	111 (100)
Retail/Business	14 (13.1)	93 (86.9)	107 (100)
Father's occupation			
Inactive/Agri/Other	11 (15.7)	59 (84.3)	70 (100)
Formal/Salaried	22 (14.0)	135 (86.0)	157 (100)
Retail/Business	6 (12.8)	41 (87.2)	47 (100)
Household income (FCFA)			
≤ 100,000	23 (15.4)	126 (84.6)	149 (100)
> 100,000	16 (12.8)	109 (87.2)	125 (100)
Number of meals per day			
≤ 2 meals	11 (12.4)	78 (87.6)	89 (100)
3 meals	16 (14.7)	93 (85.3)	109 (100)
> 3 meals	12 (15.8)	64 (84.2)	76 (100)
Consumes fruits and vegetables			

[1]n (row%) for categorical variables. Row percentages show the proportion of each subgroup that is overweight and obese vs. not. P-values are intentionally omitted: Chi-square and Fisher tests assume independence, which is violated by the clustered design (students nested within households). Valid p-values from GEE analysis accounting for clustering are reported in Table 4.

Variable	Overweight and Obese n = 39 (%)[1]	Not overweight and obese n = 235 (%)[1]	Overall n = 274 (%)[1]
Health area			
Yes	31 (13.3)	202 (86.7)	233 (100)
No	8 (19.5)	33 (80.5)	41 (100)
Snack/fast-food frequency			
Low (≤ 1/week)	15 (20.0)	60 (80.0)	75 (100)
Medium (2–3/week)	10 (13.0)	67 (87.0)	77 (100)
High (> 3/week)	14 (11.5)	108 (88.5)	122 (100)
Consumes sugary drinks			
No	5 (23.8)	16 (76.2)	21 (100)
Yes	34 (13.4)	219 (86.6)	253 (100)
Takes breakfast			
No	9 (13.0)	60 (87.0)	69 (100)
Yes	30 (14.6)	175 (85.4)	205 (100)
Lunch location			
Do not eat	4 (9.8)	37 (90.2)	41 (100)
Buy food at school	14 (16.1)	73 (83.9)	87 (100)
Eat at home	21 (14.4)	125 (85.6)	146 (100)
Family dinner frequency			
≤ 2 times/week	11 (11.6)	84 (88.4)	95 (100)
≥ 3 times/week	28 (15.6)	151 (84.4)	179 (100)
Dinner in front of the TV			
≤ 2 times/week	14 (16.9)	69 (83.1)	83 (100)
≥ 3 times/week	25 (13.1)	166 (86.9)	191 (100)

[1]n (row%) for categorical variables. Row percentages show the proportion of each subgroup that is overweight and obese vs. not. P-values are intentionally omitted: Chi-square and Fisher tests assume independence, which is violated by the clustered design (students nested within households). Valid p-values from GEE analysis accounting for clustering are reported in Table 4.

Variable	Overweight and Obese n = 39 (%)[1]	Not overweight and obese n = 235 (%)[1]	Overall n = 274 (%)[1]
Health area			
Restaurant frequency (weekly)			
Rarely (< 1/week)	31 (15.1)	174 (84.9)	205 (100)
Weekly (1+)	8 (11.6)	61 (88.4)	69 (100)
Takes weight-control medication			
No	37 (13.9)	230 (86.1)	267 (100)
Yes	2 (28.6)	5 (71.4)	7 (100)
Practices physical activity			
Yes	26 (12.9)	175 (87.1)	201 (100)
No	13 (17.8)	60 (82.2)	73 (100)
Mode of travel to school			
Active (Walk/Bike)	23 (13.6)	146 (86.4)	169 (100)
Passive (Car/Motor)	16 (15.2)	89 (84.8)	105 (100)
Daily sitting hours			
≤ 3 hours	16 (17.4)	76 (82.6)	92 (100)
> 3 hours	23 (12.6)	159 (87.4)	182 (100)
Physical education class frequency			
3 + times	4 (6.8)	55 (93.2)	59 (100)
≤ 2 times	35 (16.3)	180 (83.7)	215 (100)

[1]n (row%) for categorical variables. Row percentages show the proportion of each subgroup that is overweight and obese vs. not. P-values are intentionally omitted: Chi-square and Fisher tests assume independence, which is violated by the clustered design (students nested within households). Valid p-values from GEE analysis accounting for clustering are reported in Table 4.

Lifestyle, dietary, and physical activity behaviors

Descriptive analyses revealed widespread exposure to obesogenic dietary and sedentary behaviors (Table 3). Overall, 92.3% (n = 253) of students reported regular consumption of sugar-sweetened beverages, 44.5% (n = 122) consumed fast food or commercial snacks more than three times weekly, and 69.7% (n = 191) ate dinner in front of the television three or more times per week. Most participants

reported consuming three meals daily (39.8%) and eating breakfast regularly (74.8%). Regarding physical activity, 73.4% (n = 201) engaged in physical activity outside of school, predominantly in an unstructured format (73.1%), and 61.7% (n = 169) actively commuted to school. However, 66.4% (n = 182) spent more than three hours daily in sedentary sitting activities, and 78.5% (n = 215) participated in two or fewer physical education classes per week at school.

Table 3
Physical activities and dietary-related habits of secondary school students in Emana and Mballa II HAs, Cameroon (N = 274)

Variable	N = 274
Number of meals per day	
≤ 2 meals	89 (32.5)
3 meals	109 (39.8)
> 3 meals	76 (27.7)
Consumes fruits and vegetables	
Yes	233 (85.0)
No	41 (15.0)
Snack/fast-food frequency	
Low (≤ 1/week)	75 (27.4)
Medium (2–3/week)	77 (28.1)
High (> 3/week)	122 (44.5)
Consumes sugary drinks	
Yes	253 (92.3)
No	21 (7.7)
Takes breakfast	
Yes	205 (74.8)
No	69 (25.2)
Lunch location	
Buy food at school	87 (31.8)
Eat at home	146 (53.3)
Do not eat	41 (15.0)
Family dinner frequency	
≤ 2 times/week	95 (34.7)
≥ 3 times/week	179 (65.3)
Dinner in front of TV	

Variable	N = 274
Number of meals per day	
≤ 2 times/week	83 (30.3)
≥ 3 times/week	191 (69.7)
Restaurant frequency (weekly)	
Rarely (< 1/week)	205 (74.8)
Weekly (1+)	69 (25.2)
Takes weight-control medication	
Yes	7 (2.6)
No	267 (97.4)
Practices physical activity	
Yes	201 (73.4)
No	73 (26.6)
Type of physical activity	
Structured (club)	54 (26.9)
Unstructured	147 (73.1)
Missing	73
Frequency of physical activity per week	
≤ 2 times	100 (49.8)
> 2 times and ≤ 7 times	59 (29.4)
> 7 times	42 (20.9)
Missing	73
Mode of travel to school	
Active (Walk/Bike)	169 (61.7)
Passive (Car/Motor)	105 (38.3)
Daily sitting hours	
≤ 3 hours	92 (33.6)
> 3 hours	182 (66.4)
Physical education class frequency	

Variable	N = 274
Number of meals per day	
≤ 2 times	215 (78.5)
3 + times	59 (21.5)

Table 4
Univariable and multivariable GEE factors associated with overweight or obesity among secondary school students in Emana and Mballa II HAs, Cameroon (N = 274)

Variable	Univariable GEE			Multivariable GEE	
	N	cOR (95% CI)[1]	p-value	aOR (95% CI)[1]	p-value
Health area	274				
Mballa 2		1			
Emana		0.69 (0.34–1.39)	0.293		
Age group	274				
16–18 years		1		1	
11–15 years		2.55 (1.10–5.91)	**0.029**	2.54 (1.01–6.39)	**0.049**
≥ 19 years		1.12 (0.29–4.42)	0.869	1.14 (0.29–4.52)	0.848
Sex	274				
Male		1		1	
Female		2.76 (1.24–6.13)	**0.013**	3.22 (1.41–7.36)	**0.005**
Ethnic group	274				
Grassfields and others		1			
Béti/Bassa/Mbam		0.59 (0.24–1.46)	0.257		
Bamileke/Bamoun		1.39 (0.56–3.45)	0.482		
Religion	274				
Others		1			
Catholic		1.17 (0.41–3.34)	0.763		

[1]cOR: Crude odds ratio; aOR: Adjusted odds ratio; CI: 95% confidence interval. Both analysis use GEE with exchangeable correlation structure to account for clustering of students within households. The multivariable analysis includes variables with $p < 0.20$ from univariable analysis: sex, age group, school cycle, snack/fast-food frequency, sugary drink consumption, and physical education class frequency. Bold p-values: statistically significant at $p < 0.05$. Empty cells in multivariable columns indicate variables not selected for the analysis.

Variable	Univariable GEE			Multivariable GEE	
	N	cOR (95% CI)[1]	p-value	aOR (95% CI)[1]	p-value
Muslim		2.24 (0.63–7.99)	0.214		
Protestant		1.23 (0.36–4.24)	0.741		
School type	274				
Private		1			
Public		1.29 (0.63–2.65)	0.486		
Education system	274				
English		1			
French		0.85 (0.35–2.10)	0.727		
School cycle	274				
Cycle 2 (Form 5 to Upper Sixth)		1		1	
Cycle 1 (Form 1 to Form 4)		1.77 (0.86–3.64)	0.118	1.02 (0.40–2.63)	0.960
Mother's occupation	274				
Inactive/Agri/Other		1			
Formal/Salaried		0.73 (0.31–1.73)	0.471		
Retail/Business		0.70 (0.29–1.66)	0.413		
Father's occupation	274				
Inactive/Agri/Other		1			
Formal/Salaried		0.87 (0.40–1.90)	0.720		

[1]cOR: Crude odds ratio; aOR: Adjusted odds ratio; CI: 95% confidence interval. Both analysis use GEE with exchangeable correlation structure to account for clustering of students within households. The multivariable analysis includes variables with $p < 0.20$ from univariable analysis: sex, age group, school cycle, snack/fast-food frequency, sugary drink consumption, and physical education class frequency. Bold p-values: statistically significant at $p < 0.05$. Empty cells in multivariable columns indicate variables not selected for the analysis.

Variable	Univariable GEE			Multivariable GEE	
	N	cOR (95% CI)[1]	p-value	aOR (95% CI)[1]	p-value
Retail/Business		0.81 (0.28–2.29)	0.685		
Household income (FCFA)	274				
≤ 100,000 CFA		1			
> 100,000 CFA		0.80 (0.39–1.62)	0.533		
Number of meals per day	274				
≤ 2 meals		1			
3 meals		1.21 (0.52–2.83)	0.657		
> 3 meals		1.31 (0.54–3.16)	0.549		
Consumes fruits and vegetables	274				
Yes		1			
No		1.60 (0.68–3.73)	0.278		
Snack/fast-food frequency	274				
Low (≤ 1/week)		1		1	
Medium (2–3/week)		0.58 (0.25–1.36)	0.212	0.58 (0.23–1.43)	0.235
High (> 3/week)		0.51 (0.23–1.12)	0.092	0.46 (0.19–1.13)	0.092
Consumes sugary drinks	274				
No		1		1	
Yes		0.51 (0.18–1.46)	0.20	0.61 (0.23–1.63)	0.325

[1]cOR: Crude odds ratio; aOR: Adjusted odds ratio; CI: 95% confidence interval. Both analysis use GEE with exchangeable correlation structure to account for clustering of students within households. The multivariable analysis includes variables with $p < 0.20$ from univariable analysis: sex, age group, school cycle, snack/fast-food frequency, sugary drink consumption, and physical education class frequency. Bold p-values: statistically significant at $p < 0.05$. Empty cells in multivariable columns indicate variables not selected for the analysis.

Variable	Univariable GEE			Multivariable GEE	
	N	cOR (95% CI)[1]	p-value	aOR (95% CI)[1]	p-value
Takes breakfast	274				
No		1			
Yes		1.18 (0.52–2.65)	0.696		
Lunch location	274				
Do not eat		1			
Buy food at school		1.75 (0.52–5.93)	0.366		
Eat at home		1.55 (0.49–4.90)	0.459		
Family dinner frequency	274				
≤ 2 times/week		1			
≥ 3 times/week		1.43 (0.68-3.00)	0.350		
Dinner in front of TV	274				
≤ 2 times/week		1			
≥ 3 times/week		0.75 (0.37–1.51)	0.416		
Restaurant frequency (weekly)	274				
Rarely (< 1/week)		1			
Weekly (1+)		0.75 (0.32–1.76)	0.504		
Takes weight-control medication	274				
No		1			
Yes		2.37 (0.42–13.4)	0.329		

[1]cOR: Crude odds ratio; aOR: Adjusted odds ratio; CI: 95% confidence interval. Both analysis use GEE with exchangeable correlation structure to account for clustering of students within households. The multivariable analysis includes variables with $p < 0.20$ from univariable analysis: sex, age group, school cycle, snack/fast-food frequency, sugary drink consumption, and physical education class frequency. Bold p-values: statistically significant at $p < 0.05$. Empty cells in multivariable columns indicate variables not selected for the analysis.

Variable	Univariable GEE			Multivariable GEE	
	N	cOR (95% CI)[1]	p-value	aOR (95% CI)[1]	p-value
Practices physical activity	274				
Yes		1			
No		1.43 (0.70–2.90)	0.326		
Mode of travel to school	274				
Active (Walk/Bike)		1			
Passive (Car/Motor)		1.12 (0.56–2.25)	0.748		
Daily sitting hours	274				
≤ 3 hours		1			
> 3 hours		0.70 (0.35–1.38)	0.300		
Physical education class frequency	274				
3 + times		1		1	
≤ 2 times		2.77 (0.94–8.16)	0.065	2.80 (0.89–8.76)	0.077

[1]cOR: Crude odds ratio; aOR: Adjusted odds ratio; CI: 95% confidence interval. Both analysis use GEE with exchangeable correlation structure to account for clustering of students within households. The multivariable analysis includes variables with p < 0.20 from univariable analysis: sex, age group, school cycle, snack/fast-food frequency, sugary drink consumption, and physical education class frequency. Bold p-values: statistically significant at p < 0.05. Empty cells in multivariable columns indicate variables not selected for the analysis.

Factors associated with overweight and obesity

In univariable GEE analysis, two variables were significantly associated with overweight and obesity : female sex (cOR = 2.76; 95% CI: 1.24–6.13; p = 0.013) and students aged 11–15 years compared to 16–18 years (cOR = 2.55; 95% CI: 1.10–5.91; p = 0.029; **Table 4**). Applying the pre-specified screening threshold of p < 0.20, six candidate risk factors were retained for the multivariable analysis: sex, age group, school cycle, snack/fast-food frequency, sugary drink consumption, and physical education class frequency. All remaining sociodemographic, dietary, and sedentary variables were not associated (all p > 0.20; **Table 4**).

In the multivariable GEE analysis, two factors remained independently associated with overweight and obesity (**Table 4**). Female students had over threefold higher adjusted odds of overweight and obesity

compared with males (aOR = 3.22; 95% CI: 1.41–7.36; p = 0.005). Younger adolescents aged 11–15 years had 2.54 times higher odds compared with those aged 16–18 years (aOR = 2.54; 95% CI: 1.01–6.39; p = 0.049). Attending physical education classes ≤ 2 times/week showed a borderline association (aOR = 2.80; 95% CI: 0.89–8.76; p = 0.077), as did high fast-food consumption (> 3/week: aOR = 0.46; 95% CI: 0.19–1.13; p = 0.092). School cycle, sugary drink consumption, and age ≥ 19 years were not independently associated after adjustment (all p > 0.30). The model demonstrated acceptable discrimination (AUC = 0.719; 95% CI: 0.635–0.803; Fig. 2) and good calibration (Brier score = 0.112; exchangeable QIC = 219).

Concordance between objective BMI and weight self-perception

Of the 274 participants, 85.8% (n = 235) were objectively classified as not overweight or obese and 14.2% (n = 39) as overweight or obese. In subjective assessments, 83.9% (n = 230) self-perceived as not overweight or obese, while 16.1% (n = 44) perceived themselves as overweight or obese (Fig. 3). Among the 39 students with measured overweight or obesity, 21 (53.8%) correctly identified themselves as overweight or obesity, whereas 18 (46.2%) underestimated their weight status, perceiving themselves as normal or underweight. Among the 235 students who were not overweight or obese, 212 (90.2%) accurately classified themselves, while 23 (9.8%) overestimated their weight. Cohen's kappa coefficient indicated moderate overall concordance between objective BMI and subjective weight perception (κ = 0.418; 95% CI: 0.271–0.566; z = 5.57; p < 0.001).

Discussion

This study aimed to determine the prevalence of overweight and obesity, identified associated factors, and assessed the concordance between self-perceived and objectively measured weight status among secondary school students in Djoungolo HD, Yaoundé, Cameroon. We found an overall overweight and obesity prevalence of 14.2% (11.3% overweight and 2.9% obesity). Two associated factors were found: Female sex and students aged 11–15 years. Furthermore, nearly half of overweight or obese students underestimated their weight status, demonstrating substantial discordance between weight perception and clinical reality.

The 14.2% prevalence observed in this study aligns with broader evidence of the ongoing nutritional transition across SSA. In a comprehensive systematic review of school-aged youth across the subcontinent, Muthuri et al. documented a weighted overweight and obesity prevalence of 10.6%, with urban estimates spanning from under 5% to over 40% [12]. Within Cameroon, our findings are slightly higher than the 12.5% reported by Choukem et al. in urban Douala [13], but lower than the 18.8% observed by Navti et al. among schoolchildren in the North-West Region [14]. Our prevalence also mirrors findings from other West and Central African urban centers, including southern Nigeria (12.3%) [28] and urban Ghana (16.4%) [29], while remaining markedly lower than rates reported in Southern African youth cohorts (> 25%) [30–32]. These variations are likely attributable to methodological and

demographic differences. Specifically, Choukem et al. investigated a younger cohort (aged 3–13 years), whereas our study encompassed older secondary school students (aged 11–23 years), an age bracket characterized by greater personal autonomy over food choices and distinct pubertal metabolic changes. Also, the difference may reflect the use of different diagnostic criteria (e.g., IOTF vs. WHO vs. center for diseases control and prevention (CDC) growth standards), which are known to yield divergent classifications for the same adolescent populations [12].

A key finding of this study was the statistical association between younger students and overweight and obesity. Students aged 11–15 years had 2.54 times higher odds of being overweight or obese compared with those aged 16–18 years (aOR = 2.54; 95% CI: 1.01–6.39; p = 0.049), while those aged ≥ 19 years showed no significant difference (aOR = 1.14; p = 0.848). This finding is initially counterintuitive, as one might expect cumulative exposure to obesogenic environments to increase overweight and obesity prevalence with advancing age. However, this pattern is consistent with evidence documenting a peak in adiposity accumulation during early-to-mid puberty, followed by a relative stabilisation or decline in late adolescence. Adair, in a comprehensive review of developmental trajectories of childhood and adolescent obesity, demonstrated that the pubertal transition is a critical window of accelerated fat mass gain, driven by hormonal surges in growth hormone that promote adipocyte proliferation and lipogenesis [33]. Similarly, Lobstein et al., in their analysis of global childhood overweight and obesity trends, describe that increases in BMI-for-age are most pronounced during late childhood and early adolescence, often followed by a plateau or slight decline during late adolescence as linear growth slows and lean mass accumulation becomes predominant, especially in boys [34]. In the African context, Manyanga et al., examining overweight and obesity among school-aged children in seven Africa countries, documented a higher prevalence among early adolescents (≤ 12 years) compared to older peers, attributing this pattern to the interaction between pubertal hormonal changes and the early adoption of sedentary, screen-based lifestyles during the transition to secondary school [35]. In our study, the attenuation of overweight or obesity risk among students aged ≥ 19 years may further reflect a selection effect, whereby older students who remain enrolled in secondary school may represent a more health-conscious or socioeconomically advantaged subset, or may have undergone lifestyle modifications in response to weight-related feedback from family or healthcare providers.

Female sex also emerged as an independent associated factor with overweight and obesity in multivariable GEE analysis (aOR = 3.22; 95% CI: 1.41–7.36; p = 0.005). Notably, the strength of this association increased after controlling for potential confounders, indicating negative confounding in crude estimates. This female preponderance is consistent with numerous investigations across SSA [5, 35, 36]. Biological mechanisms provide a primary explanation: pubertal maturation triggers divergent hormonal and body composition trajectories, whereby oestrogen promotes subcutaneous adipose tissue deposition in females, whereas testosterone stimulates lean muscle mass accretion in males [37, 38]. Consequently, girl students experience a physiologically higher percentage of body fat, increasing their vulnerability to overweight or obesity when caloric intake exceeds energy expenditure [37]. Sociocultural and behavioural dynamics further reinforce this biological vulnerability. Although physical activity practice did not reach statistical significance in multivariable analysis, evidence across the continent

indicates that girl students face substantial sociocultural barriers to recreational sports, higher domestic chore burdens, and safety concerns that restrict active outdoor play [39, 40]. Additionally, traditional sociocultural body ideals in parts of Central and West Africa have historically valorized larger female body sizes as symbols of health, fertility, beauty, and affluence, which may inadvertently reduce motivation for weight maintenance among girl students [41]. Contrary to expectations, neither socioeconomic indicators (household income, parental occupation) nor dietary and physical activity behaviors were independently associated with overweight and obesity. While limited physical education attendance (≤ 2 sessions/week) exhibited almost significant association with overweight and obesity (aOR = 2.80; p = 0.077), other lifestyle variables did not retain significance. Similar non-significant findings between socioeconomic status and, overweight and obesity have been documented in other LMICs undergoing rapid nutritional transition [42]. In rapidly expanding urban centers such as Yaoundé, exposure to obesogenic environments including ultra-processed street foods and motorized transport tends to be relatively uniform across social strata, which may attenuate socioeconomic gradients in overweight and obesity risk [43]. Furthermore, the lack of statistical significance for specific dietary variables should not be mistaken as an absence of etiologic importance. Dietary assessment via retrospective self-report is vulnerable to recall bias, social desirability bias, and meal complexity misclassification among students [44]. Crucially, our descriptive data revealed high exposure to obesogenic habits: over 92% of students regularly consumed sugar-sweetened beverages, nearly 45% consumed fast food more than three times weekly, and two-thirds spent more than three hours daily in sedentary sitting activities. These patterns highlight a ubiquitous background of unhealthy lifestyle practices that elevates cardiometabolic risk across the entire student population of this study [45, 46]. A crucial secondary finding was the moderate concordance between objectively measured BMI and subjective weight perception ($\kappa = 0.418$; $p < 0.001$). While 90.2% of non-overweight students accurately perceived their weight, 46.2% of overweight or obese students failed to recognize their weight, categorizing themselves as normal or underweight. This high rate of weight underestimation is consistent with findings from other developing and African settings [17, 21, 47]. Weight underestimation represents a major public health barrier; students who do not recognize their overweight or obese status are unlikely to seek dietary modifications, engage in structured physical activity, or participate in weight-control interventions [47, 48]. Conversely, approximately 10% of non-overweight students overestimated their weight, which can precipitate inappropriate restrictive dieting and psychological distress [49]. These findings underscore the clinical inadequacy of relying on self-reported weight status for students health monitoring, reinforcing WHO recommendations for routine, objective anthropometric screening in school health programs [50].

These findings have direct policy implications for Cameroon's decentralised health system. Interventions must move beyond generic health messaging and adopt gender- and age-sensitive approaches that specifically target early secondary school students (Cycle 1) and female adolescents, who constitute the highest-risk groups identified in this study. School administrations and the ministry of public health should prioritize the regulation of school food environments, limiting the sale of sugar-sweetened beverages and energy-dense snacks within and around school premises while enforcing structured

physical education curricula and routine annual anthropometric screening. Concurrently, body weight literacy programmes should be integrated into the school curriculum to address the high prevalence of weight underestimation among overweight and obese students.

Strengths and Limitations

This study possesses several key strengths. First, it provides timely epidemiological data from two contrasting HAs of Yaoundé, addressing a recognized geographic gap in Central African student and adolescent health literature. Second, height and weight were measured directly using calibrated digital instruments and standardized protocols, eliminating the substantial reporting errors inherent in self-reported anthropometry. Third, the application of GEE allowed us to appropriately account for within-household clustering, preventing inflated type I error rates. Fourth, the multivariable model demonstrated satisfactory discrimination (AUC = 0.719) and calibration (Brier score = 0.112). Finally, electronic data capture via KoBoCollect with pre-programmed validation constraints minimized data entry errors.
Several limitations must be acknowledged. First, the cross-sectional design precludes causal inference regarding the observed associations. Second, dietary intake and physical activity were assessed using self-reported recall, which is subject to social desirability and recall biases. Third, the modest sample size (N = 274) and the relatively small absolute number of overweight and obesity cases (n = 39, including only 8 obese participants) limited the statistical power to detect subtle behavioral associations, necessitating the combination of overweight and obesity into a single composite outcome. Fourth, sampling was non-probabilistic: the purposive selection of two HAs followed by convenience-based household recruitment limits the statistical generalizability of our findings to the broader Djoungolo HD or other urban centers in Cameroon. Fifth, data collection was conducted from the 3 to the 21 August 2025 during the school vacation period. While this household approach captured students who might not be reachable through school-based sampling during holidays, it may have introduced selection bias if traveling students differed systematically from those who remained at home, and required retrospective recall of school-term behaviors (such as mode of transport to school and physical education). Finally, height was measured using a precision wall-mounted tape rather than a transportable rigid stadiometer, which, despite strict adherence to the Frankfurt plane protocol, may have introduced minor measurement variability

Conclusions

This study provides important evidence on the epidemiology of overweight and obesity among secondary school students in Djoungolo HD, Yaoundé. These findings underscore the need for comprehensive school-based interventions that integrate nutrition education, promotion of regular physical activity, routine anthropometric screening, and strategies to improve body weight awareness, particularly among younger students and adolescent girls. Strengthening school health programmes and creating supportive environments for healthy behaviours should form part of national strategies aimed at preventing childhood obesity and reducing the future burden of non-communicable diseases in Cameroon. Future longitudinal and multicentre studies are warranted to better understand the temporal

relationships between behavioural, environmental and biological factors and the development of overweight and obesity among Cameroonian secondary school children. Such evidence will be essential for designing effective, context-specific interventions to curb the growing burden of secondary school children obesity in the country.

Abbreviations

aOR Adjusted Odds Ratio

AUC-ROC Area Under the Receiver Operating Characteristic Curve

BMI Body Mass Index

CDC Centers for Disease Control and Prevention

CI Confidence Interval

cOR Crude Odds Ratio

FCFA Central African CFA Franc

GEE Generalized Estimating Equations

GVIF Generalized Variance Inflation Factor

HAs Health Areas

HD Health District

ICC Intra-Cluster Correlation Coefficient

IOTF International Obesity Task Force

LMICs Low- and Middle-Income Countries

NCDs Non-Communicable Diseases

QIC Quasi-likelihood under the Independence Model Criterion

SD Standard Deviation

SSA Sub-Saharan Africa

WHO World Health Organization

Declarations

Ethics approval and consent to participate

Ethical clearance was granted by the Institutional Ethics Committee for Research on Human Health of the University of Douala (Ref: 5095/IEC-UDo/07/2025/M). Administrative approval was officially obtained from the Djoungolo HD Service. The study was conducted in strict compliance with the principle of the Declaration of Helsinki. Prior to data collection, study objectives, anthropometric procedures, and confidentiality measures were communicated in French and English via standardized information sheets. For students under 18 years of age, verbal informed consent was obtained from a parent or legal guardian, and verbal informed assent was obtained directly from the students. Students aged 18 years and older provided independent verbal informed consent. Participation was entirely voluntary, and participants were assured that withdrawal at any stage would incur no penalty.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Study conception: LD, FFO. Data collection: LD, SCNN, VSIN. Data analysis and interpretation: LD, FFO, DH, HCND, SCNN, VSIN. Manuscript writing: LD, FFO, DH, HCND, SCNN, VSIN. Revision of the manuscript: LD, FFO, DH, HCND, SCNN, VSIN. Approval for submission: LD, FFO, DH, HCND, SCNN, VSIN.

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Figures

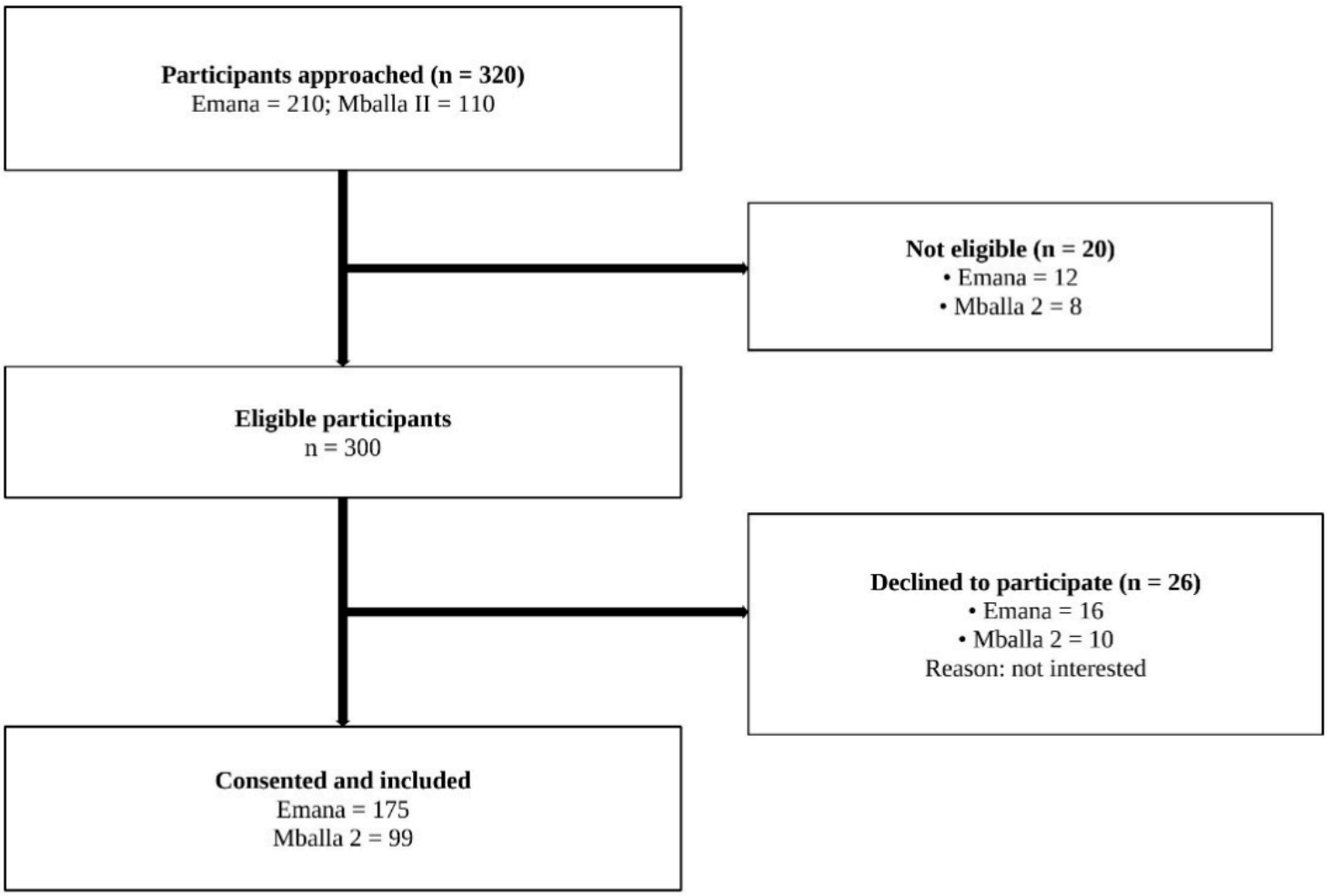


Figure 1

Participant recruitment and enrollment flow diagram.

Legend: Flowchart depicting the sampling procedure, household visits, eligibility screening, and final enrollment of 274 secondary school students across the Emana and Mballa II HAs, Djoungolo HD, Yaoundé, Cameroon.

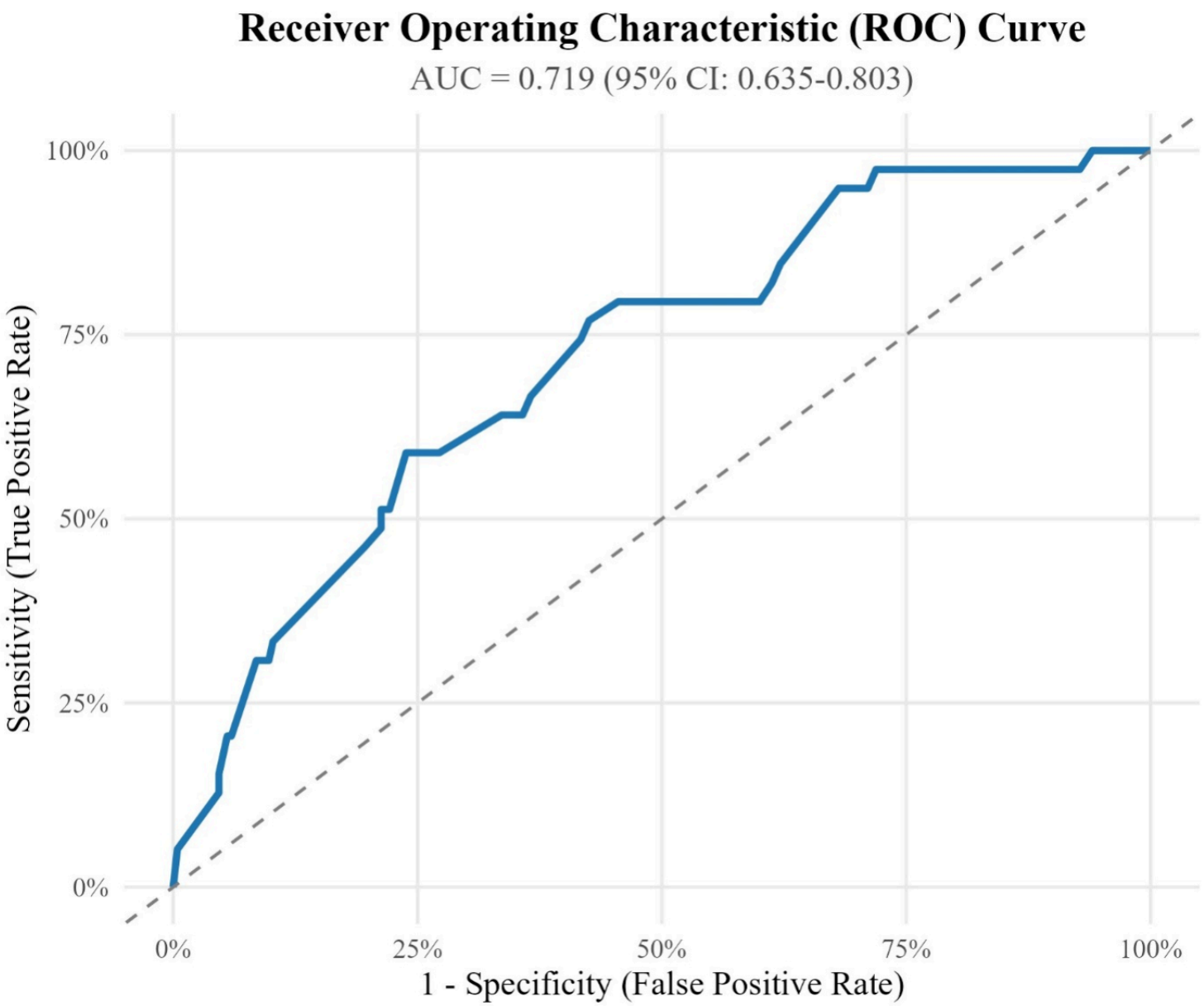


Figure 2

Receiver Operating Characteristic curve of the multivariable GEE model.

Legend: Discriminative performance of the multivariable Generalized Estimating Equations model predicting overweight and obesity in secondary school children. The model achieved an Area Under the Curve (AUC) of 0.719 (95% CI: 0.635-0.803), indicating acceptable diagnostic discrimination.

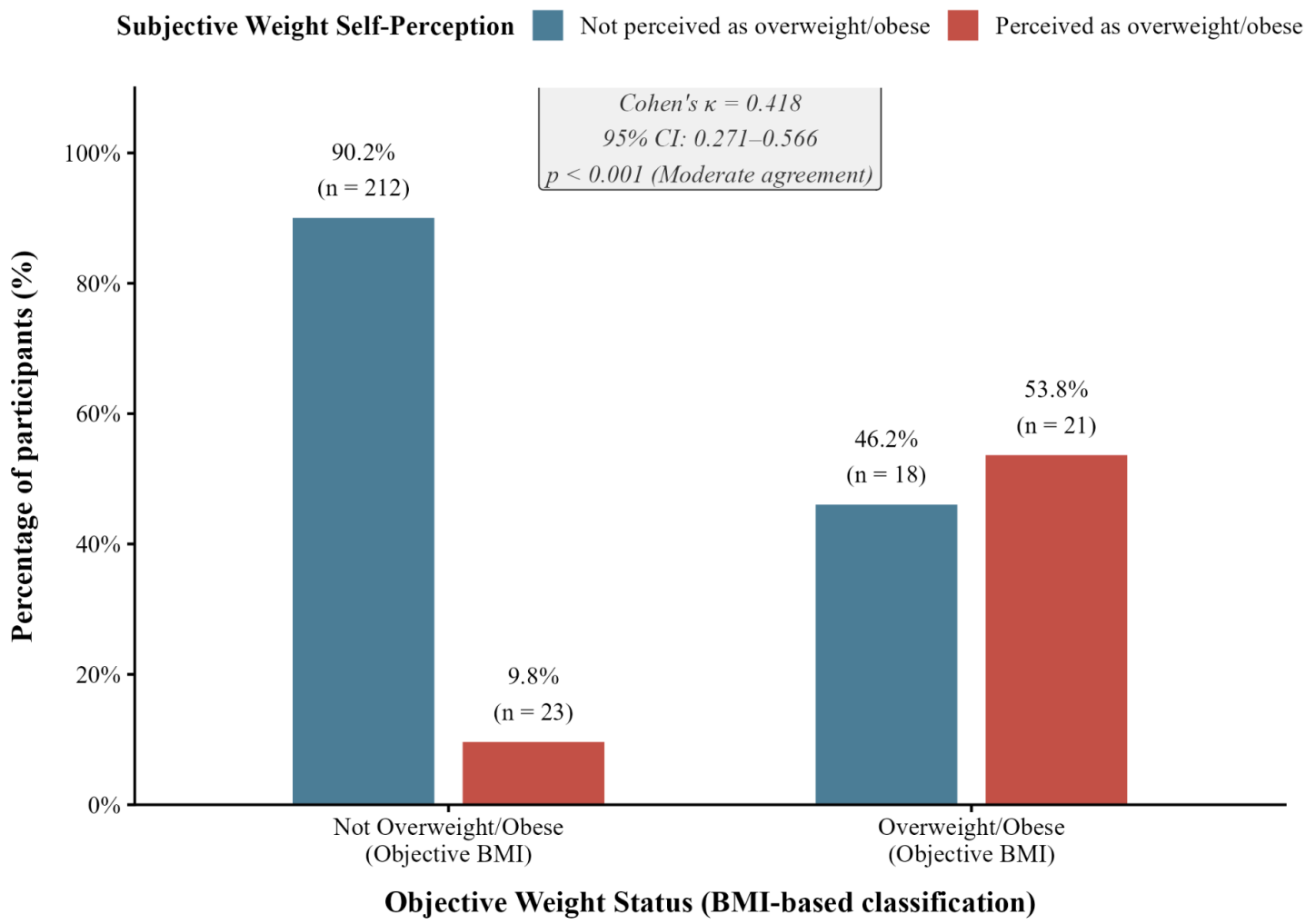


Figure 3

Distribution of self-perceived weight status versus objectively measured BMI.

Legend: Concordance between subjective and objective body weight (Cohen's kappa κ = 0.418; 95% CI: 0.271–0.566; p < 0.001), with 46.2% of overweight/obese participants underestimating their weight status.

Supplementary Files

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- SupplementaryFile1.docx