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RESEARCH ARTICLE

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Prevalence and Contributing Factors of Stunting and Obesity among Schoolchildren Aged 5–18 in Kamsar, Guinea: A Cross-Sectional Survey

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ABSTRACT

The coexistence of undernutrition and obesity places a double burden on health systems in many African countries, including Guinea.We conducted a pilot cross-sectional study in Kamsar, Guinea, to determine the prevalence of stunting and obesity among adolescents and schoolchildren. The cross-sectional study was conducted from 17th to 19th January 2022 with measurements taken on children's weight, height, waist and hip circumferences. The proportion of stunting, overweight, obesity, and concurrent burden of stunting and obesity were estimated based on the anthropometric measures determined using the WHO growth reference standards. Univariable and multivariable logistic regression models were fitted to identify factors associated with stunting, obesity, and concurrent obesity and stunting. Among 298 schoolchildren Aged 5–18 included in this study, the overall prevalence of stunting was 7.8% [95% Confidence interval (CI): 5.2% - 11.4%], overweight or obesity was 31.5% [95% CI: 26.4% – 37.1%], and 3.4% [95% CI: 1.8% – 6.1%] had concurrent stunting and obesity. Age was the only factor independently associated with stunted growth [Odds Ratio (OR): 1.46; 95% CI: 1.17– 1.81]. The independent factors associated with overweight or obesity were every yearly increase in age [Adjusted OR (AOR): 1.50 ; 95% CI: 1.26 –1.80]; family history of diabetes [AOR: 3.52 ; 95% CI: 1.55 − 7.98], those who reported as not exercising in the previous week of survey [AOR: 7.64 ; 95% CI: 3.47− 16.83], those who spent more than 4 hours daily on hobbies [AOR: 4.35 ; 95% CI: 2.19 − 8.63], and those whose parents worked in the mining company [AOR: 0.14; 95% CI: 0.05 − 0.38]. The findings suggest that stunting and obesity coexist and identified factors contributing to stunting and obesity in schoolchildren are age, physical activity, family history, and where parents work. It is important to promote healthy lifestyles to reduce "obesogenic" exposures.

Key words: *Guinea, Kamsar, malnutrition, stunting, obesity*

INTRODUCTION

Childhood obesity is defined as a body mass index greater than or equal to the 95th percentile for age and gender. Child stunting refers to a child who is too short for his or her age. However, obesity is defined as BMI greater than 2 standard deviations above the WHO Growth Reference median (WHO, 2019).

Overweight and obesity are a rising health problem among young children and adolescents globally (Abarca-Gómez et al., 2017; Jaacks et al., 2019; WHO, 2019). An estimated of 390 million children and adolescents aged 5–19 years were overweight in 2022 (WHO, 2019). The confluence of nutritional transition from traditional fibre-rich diet to sugar-or-fat rich foods and increasingly sedentary lifestyle has led to many developing countries simultaneously facing the double burden of malnutrition and obesity (Mushtaq et al., 2011). Such co-existence of undernutrition and obesity exerts a double burden on the health systems and is now regarded as a serious public health concern in many African countries including Guinea (FAO, 2018; Hawkesworth & Prentice, 2013a; Maruapula et al., 2011; Mpembeni et al., 2014; Muthuri et al., 2014; Salman et al., 2011).

More than half (55.2%) of the Guineans live below the poverty line with malnutrition being one of the leading causes of childhood morbidity(FAO, 2018) The exact burden of the obesity is not known among Guinean children, however surveys conducted in recent years at different parts of the country has indicated that obesity and overweight remains a serious cause of concern (Ministère de la Santé Guinée, 2015a).

The Sustainable Development Goals (SDGs) have set targets with regard to the nutritional requirements of adolescents and young children by the year 2025, with the further aim of ending all forms of malnutrition by the year 2030, as set forth in SDG 2.2 (13).

There has been a steady increase in the prevalence of overweight and obesity among children and adolescents aged 5–19 years in Guinea since the year 2000. Notably, the prevalence among girls in this age group is more than twofold that of boys (12). The 2018 population survey indicated that 9.2% of children under the age of five were classified as experiencing malnutrition, while 5.6% exhibited symptoms of being overweight. The most prominent factors influencing an individual's nutritional status are socioeconomic conditions, including living circumstances in both urban and rural settings (EDS2018). (Globalnutritionreport.org, 2020) (United Nations, 2015) Guinea is currently implementing programmes to meet several of the goals outlined in SDGs to achieve better health outcomes among children (Cherif et al., 2019). The Ministry of health is currently running program under the 2015–2024 development plan to raise awareness on the health harms of obesity and malnutrition at primary health services and community levels and has set a target to reduce the obesity rate by 25% by 2024(Ministère de la Sante Guinée, 2015b). To realise this target, it is important to characterise the distribution and extent of the local burden of obesity and malnutrition as their distribution within a population may be non-uniform and is inevitably affected by a complex interplay of socio-economic gradient, cultural and geographical settings (Hawkesworth & Prentice, 2013b). This study was conducted with an overarching aim of understanding the scale of under-and-over nutrition among schoolchildren Aged 5–18 in the mining city of Kamsar, Guinea.

MATERIALS AND METHODS

Study location and targeted population

This is a cross-sectional study conducted in the port city of Kamsar in the Boke region of Western Guinea. The city is approximately 250 km north of the capital Conakry. The discovery of Bauxite in the region in 1963 has resulted and has expansion of the city as a major industrial centre. Kamsar is now a medium-sized port city and has a permanent access to electricity, running water, and has a well-equipped modern hospital.

The target population was schoolchildren Aged 5–18 in the mining city of Kamsar. This population is considered as representative of young and adolescent Kamsar population that constitutes of four different ethnic groups: Malinké, Peulh, Soussou, and the Forest-dwellers.

Study design and selection of schoolchildren

Of the 12 public schools in the region invited to participate, only three schools agreed. Private schools in the city and those exclusively owned or sponsored by the mining companies were not considered. The parents were informed through their association in each school about the study. A short questionnaire detailing the objectives of the study and requesting

written consent to participate were sent to the parents of all the schoolchildren Aged 5–18 of the three selected schools. The response to questionnaire from the parents were collected over the period of 1 week (5 school working days). There were approximately 2100 schoolchildren Aged 5–18 in the 3 schools that were included in this survey. A formal sample size calculation was not performed and sample size determination was based on the capacity to collect measurements over a period of 3 days with three trained staffs (medical doctors). Estimating that each staff will be able to take measurements on 35 individuals in a day, the survey aimed at obtaining anthropometric measurements on approximately 315 individuals (Supporting figure1).

Therefore, it was decided to include total of 105 schoolchildren at each of the selected schools. At each of the school, the sampling frame consisted of all schoolchildren who returned their forms back who were listed on an excel database. A random number was generated for each of the participants in the list using =RAND() command. The column of random number was then sorted in an ascending order to select 105 participants at each school. At each school, children were selected randomly for inclusion if they met the following inclusion criteria: i) being a schoolchild Aged 5–18 years, and ii) parents agreeing their children to be part of this study and willing to fill out the questionnaire.

Socio-economic characteristics of the parents including age, place of residence, maternal and paternal educational level, occupation, family size and dietary habits were extracted from the questionnaire returned by the school-children. The questionnaire included further questions regarding family history of obesity, diabetes, and hypertension.

Supporting figure1

Anthropometric data collection

Among the schoolchildren selected for this study, data collection took place from 17th to 19th January 2022. Anthropometric measurements were taken on children's weight, height, waist and hip circumferences. Body mass index (BMI) was calculated based on the height and body weight (weight/height^2). Waist circumference was measured at the mid-point between the lower margin on the last palpable rib and the top of the iliac crest using a tape measure as recommended WHO guidelines (WHO, 2008). Information regarding associated co-morbidities, dietary intake patterns, and physical activity patterns were recorded.

Assessment of nutritional status

Body mass index (BMI) was calculated from weight and height measurements. The nutritional status of the participants was calculated using the WHO growth reference using the ZANTHRO module available in Stata (Vidmar et al., 2013). Overweight was defined as Z scores greater than one standard deviation body mass index for age and sex (BMIZ < -1), and obesity as Z scores greater than two standard deviations body mass index for age and sex (BMIZ <-2). Stunting was defined as height for age (HAZ <-2) scores less than 2 standard deviations. Concurrent stunting and overweight (or obesity) was defined when a child was both stunted and overweight (or obese) at the same time.

Statistical analyses

The characteristics of the schoolchildren included were presented as median with interquartile ranges (IQR) for continuous variables, and as frequencies and proportions for categorical variables. The proportion of stunting, obese/overweight, and concurrent stunting and overweight/obesity among schoolchildren were calculated; associated 95% confidence interval was estimated using Wilson's method (Newcombe, 1998). Logistic regression was carried out to identify risk factors associated with anthropometric indicators of interest. Variables that were significant at 5% level in the univariable analysis were kept for multivariable analysis. A likelihood ratio test was then used to identify variables for the construction of final multivariable model as outlined in Collett (2015)(Collett, 2015). Non-linear relationship between continuous covariates and outcome was assessed using fractional polynomials.

The data for age collected in our survey suffered from rounding to the nearest integer year (Figure 1). In order to investigate the impact of such rounding (about participant's age), three different sensitivity analyses were carried out: i) by considering the age of the schoolchildren to be a year lower than collected, ii) by considering the age of the schoolchildren to be a year higher than collected; and iii) by predicting the age of the schoolchildren based on other observed covariates. For each of the three scenarios, the anthropometric scores were re-calculated and the prevalence of different indicators were computed. The results were reported using the STROBE checklist (Elm et al., 2007).

Ethics approval and consent to participate and consent for publication

Ethics approval was obtained from the national ethics board for health research (CNERS) of Conakry, Guinea (No:023/CNERS/21). Administrative approval was obtained from the participating school's parent's board. All the schoolchildren and their parents were given information regarding the purpose of the study and regarding the anthropometric measurements. Written informed consent was obtained from all the parents whose children participated in the study. Consent forms containing detailed information including the publication of results from the study were given to children to take to their parents. The children returned signed consent forms on the scheduled day for data collection.

RESULTS

Sociodemographic characteristics of study participants

Of the planned 315 measurements, data collection could only be completed on 298 schoolchildren. The characteristics of 298 schoolchildren included in this study are presented in Table 1. The overall mean age was 14.4 years (standard deviation: 2.06; range: 10–19y) with 148 (49.2%) being females. Physical activities (dancing or taking sports) were reported as hobbies by 27 (9.1%) and the remaining 271 (90.9%) reported surfing on internet/watching TV/listening to music as their hobbies. The anthropometric scores estimated for the study population is presented in the Figure 1.

Stunting

Stunting was present in 23 (7.8%) [95% CI: 5.2% – 11.4%] schoolchildren with the prevalence being 6.8% [95% CI: 3.7% – 12.1%] among males and 8.6% [95% CI: 5.1% – 14.2%] among females. In univariable logistic regression, there were two predictors associated with stunted growth: age [Odds Ratio (OR): 1.46; 95% Confidence Interval (CI): 1.17– 1.81] and being from Soussou ethnicity (compared to the Malinké) [OR: 5.21; 95% CI: 1.14 – 23.85]. In multivariable analysis, age was the only predictor associated with stunting [Adjusted odds ratio (AOR): 1.45; 95% CI: 1.17–1.81] (Figure 1; Table 2).

Overweight (pre-obesity) and obesity

The prevalence of pre-obesity (overweight) was 21.2% [95% CI: 16.9% – 26.3%]; this was 30.1% [95% CI: 23.2% – 38.0%] among females and 12.3% [95% CI: 7.9% – 18.6%] among males. The prevalence of obesity was 11.6% [95% CI: 8.4% – 15.8%] with this being 15.1% [95% CI: 10.2% – 21.8%] among females and 8.2% [95% CI: 4.7% – 13.8%] among males. Taking a composite endpoint of obesity or overweight, the prevalence of either overweight or obesity was 31.5% [95% CI: 26.4% – 37.0%] in the overall study population; 21.2% [95% CI: 15.4% – 28.6%] among males and 41.8% [95% CI: 34.1% – 49.9%] among females.

In univariable analysis, there were ten predictors associated with being obese or overweight: age, ethnicity, gender, those with history of obesity or diabetes or hypotension in the family, those who reported as not exercising, those with sedentary hobbies (such as watching TV/ surfing internet or listening to music), spending more than 4 hours on the hobbies, and children who father were not an employee of the nearby mining company. In multivariable analysis, only five variables remained independently associated with overweight or obesity: every yearly increase in age [AOR: 1.50 ; 95% CI: 1.26 –1.80]; those with a family history of diabetes [AOR: 3.52 ; 95% CI: 1.55 − 7.98], those who reported as not exercising in the previous week of survey [AOR: 7.64 ; 95% CI: 3.47− 16.83], those who spent more than 4 hours daily on their hobbies [AOR: 4.35 ; 95% CI: 2.19 − 8.63], and those whose father worked in the nearby mining company [AOR: 0.14; 95% CI: 0.05 − 0.38] (Figure 2, Table 3).

Concurrent stunting and obesity/overweight

In total, there were 10 (3.4%) schoolchildren who were concurrently stunted and overweight or obese; the prevalence was 2.1% [95% CI: 0.70 – 5.86] among males and 4.7% [95% CI: 2.3% – 9.3%] among females. In univariable analysis, there were three predictors associated with the concurrent burden: age, those who reported as not exercising and those who spent more than 4 hours daily on hobbies. In multivariable analysis, only two factors remained independently associated with the concurrent burden: every yearly increase in age [AOR: 2.09; 95% CI: 1.31–3.33] and those who spent more than 4 hours daily on their hobbies [AOR: 5.86; 95% CI: 1.14− 30.21] (Figure 3; Table 4)

Sensitivity analyses for exploring the impact of age rounding

The results of the sensitivity analysis are presented in Figure 3. The estimated 95% confidence interval

were overlapping for the derived estimated of the prevalence of the nutritional indicator irrespective of the choice of the sensitivity analyses for all the anthropometric indicators. The differences were more pronounced for the prevalence estimates of obesity or overweight (Figure 4).

DISCUSSION

Child stunting, obesity and Overweight are traditionally considered a major problem in Africa. However, in our study, 21.2% of schoolchildren were either pre-obese or obese. The odds of pre-obesity/obesity was found to be associated with the level of engagement of schoolchildren in physical activities. Nearly one-fifth of the schoolchildren reported that they didn't participate in any physical exercises in the past week of survey and were at 7.64-fold increased odds of pre-obesity/obesity. This is explained by the fact that 90% of the schoolchildren in our study reported sedentary choices as their hobbies (watching TV/listening to music or surfing internet) as opposed to physical activities such as sports or dancing (Table 1). The sedentary hobbies inevitably leads to a low energy loss compared to participating in sports or dancing. Such low energy expenditure coupled with excess energy causes imbalance in the energy equation. Such fundamental imbalance in energy equation over a number of years leads to obesity (Hawkesworth & Prentice, 2013b). An approach to increase energy expenditure such as adding physical activities as part of the school curriculum might be an effective strategy to tackle the rising burden of obesity.

In our study population, nearly one in every 12 schoolchildren were found to have stunted growth with every yearly increase in age associated with 1.5-fold increased odds of stunting. Similarly, year increase in age was also associated with increased odds of obesity, and >2-fold increased odds of concurrent stunting and obesity. While the age-association with stunting is possibly explained by the condition being largely irreversible, the association with obesity is less explicable. This could possibly be a result of systematic neglect of nutritional and overall health-related issues of adolescents and requires further exploration into the problem. The preponderance of the programmatic activities in Guinea has primarily focused on young children less than 5 years old thus resulting in a systematic neglect of the adolescent schoolchildren. While the prevalence of pre-obesity and obesity was high, the concurrent existence of stunting and obesity/pre-obesity was relatively low (3.4%). Such concurrent existence of under-and-over nutrition is considered a growing concern among young children in several countries in Sub-Saharan Africa (Keino et al., 2014).

Despite these limitations, our data suggests that prevalence of obesity and pre-obesity is not unsubstantial and there is a concurrent existence of stunting and obesity among schoolchildren in our setting. The Guinean government has set a target to reducing obesity among children by 25% by the year 2024 and is currently implementing work packages to meet several of the goals outlined in SDGs to achieve better health outcomes among children (Cherif et al., 2019). Effective treatment strategies for tackling pre-obesity/obesity must focus on weight loss and raising awareness regarding health-harms of obesogenic exposure if Guinea is to achieve these outlined targets.

CONCLUSIONS

Our study focusing on prevalence of stunting and obesity among schoolchildren aged 5-18 years and it contributing factors, shows high prevalence of pre-obesity and coexistence of stunting and obesity in Kamsar, Guinea. An integrated approach to promote good nutrition and physical activity, and to raise awareness of the health consequences of obesity among school children and their parents, could help to reduce this double burden of malnutrition.

Declarations

Availability of Data and Materials

Data generated and analysed for this study is available from the corresponding author on reasonable request.

Competing Interests

The authors declare that they have no competing interests.

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Figure 1: Overweight, obesity, and stunting in the study dataset

Legend: Stunting (left panel) and pre-obesity/obesity (right panel) status among boys (top panel) and girls (bottom panel).

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Table 1: Characteristics of the schoolchildren included in the study (N=298)

Characteristics	Boys (n=146)	Girls (n=152)	Overall (N=298)
	Median (Min-Max) or N (%)	Median (Min-Max) or N (%)	Median (Min-Max) or N (%)
Age(y)	14.0 (10.0- 18.0)	14.0 (10.0- 19.0)	14.0 (10.0- 19.0)
Weight(kg)	49.0 (24.0- 116.0)	53.0 (25.0- 112.0)	50.0 (24.0- 116.0)
Height(cm)	160.0 (132.0- 193.0)	153.5 (115.0- 178.0)	156.0 (115.0- 193.0)
Waist circumference(cm)	70.0 (55.0- 113.0)	74.0 (48.0- 130.0)	72.0 (48.0- 130.0)
Hip circumference(cm)	76.0 (55.0- 126.0)	78.0 (59.0- 130.0)	77.5 (55.0- 130.0)
Ethnicity			
Malinké	39 (26.7 %)	38 (25.0 %)	77 (25.8 %)
Peulh	41 (28.1 %)	33 (21.7 %)	74 (24.8 %)
Soussou	45 (30.8 %)	59 (38.8 %)	104 (34.9 %)
Forest-dwellers	16 (11 %)	9 (5.9 %)	25 (8.4 %)
Other African foreigner	5 (3.4 %)	13 (8.6 %)	18 (6 %)
Family history of obesity			
Yes	80 (54.8 %)	93 (61.2 %)	173 (58.1 %)
No	66 (45.2 %)	59 (38.8 %)	125 (41.9 %)
Family history of diabetes			
Yes	22 (15.1 %)	37 (24.3 %)	59 (19.8 %)
No	124 (84.9 %)	115 (75.7 %)	239 (80.2 %)
Family history of hypotension			
Yes	60 (41.1 %)	62 (40.8 %)	122 (40.9 %)
No	86 (58.9 %)	90 (59.2 %)	176 (59.1 %)
Number of exercise per week			
No exercise	18 (12.3 %)	51 (33.6 %)	69 (23.2 %)
≥1	128 (87.7 %)	101 (66.4 %)	229 (76.8 %)
Time spent on hobbies			
≥ 4 hrs/ day	42 (28.8 %)	58 (38.2 %)	100 (33.6 %)
<4 hrs/day	104 (71.2 %)	94 (61.8 %)	198 (66.4 %)
Type of hobbies			
Sedentary hobbies (TV/Internet/Listening music)	129 (88.4 %)	142 (93.4 %)	271 (90.9 %)
Dancing/Sports	17 (11.6 %)	10 (6.6 %)	27 (9.1 %)
Father's profession			
Not a miner	50 (34.2 %)	37 (24.3 %)	87 (29.2 %)
Miner	96 (65.8 %)	115 (75.7 %)	211 (70.8 %)

Table 2: Univariable and multivariable risk factors for stunting

Characteristics	n/N[a]	Univariable analysis OR [95% CI]	Multivariable analysis AOR (95% CI)
Age (years)	7.7%(23/296)	1.46 (1.17- 1.81)	1.45 (1.17- 1.81)
Ethnicity			
Peulh	6.8% (5/74)	2.64 (0.5- 14.09)	
Soussou	12.5% (13/104)	5.21 (1.14- 23.85)	
Forest-dwellers	8% (2/25)	3.17 (0.42- 23.81)	
Other African foreigner	5.6% (1/18)	2.15 (0.18- 25.08)	
Malinké	2.7% (2/75)	Reference	
Gender			
Female	8.7% (13/150)	1.29 (0.55- 3.04)	1.11 (0.46- 2.69)
Male	6.8% (10/146)	Reference	Reference
Family history of obesity			
Yes	8.2% (14/171)	1.15 (0.48- 2.75)	
No	7.2% (9/125)	Reference	
Family history of diabetes			
Yes	6.8% (4/59)	0.83 (0.27- 2.55)	
No	8% (19/237)	Reference	
Family history of hypotension			
Yes	6.6% (8/122)	0.74 (0.31- 1.81)	
No	8.6% (15/174)	Reference	
Number of exercise per week			
0	8.8% (6/68)	1.20 (0.45- 3.18)	
≥1	7.5% (17/228)	Reference	
Time spent on hobbies (hours)			
<4 hrs	10.1% (10/99)	1.59 (0.67- 3.77)	
≥ 4 hrs	6.6% (13/197)	Reference	
Type of hobbies			
TV/Internet/Listening music	7.8% (21/269)	1.06 (0.23- 4.78)	
Dancing/Sports	7.4% (2/27)	Reference	
Father's profession			
Not a miner	9.2% (8/87)	1.31 (0.53- 3.21)	
Miner	7.2% (15/209)	Reference	

[a] n = number of stunted children; N= Number of schoolchildren in the given group; OR = odds ratio

Table 3: Univariable and multivariable risk factors for obesity or overweight

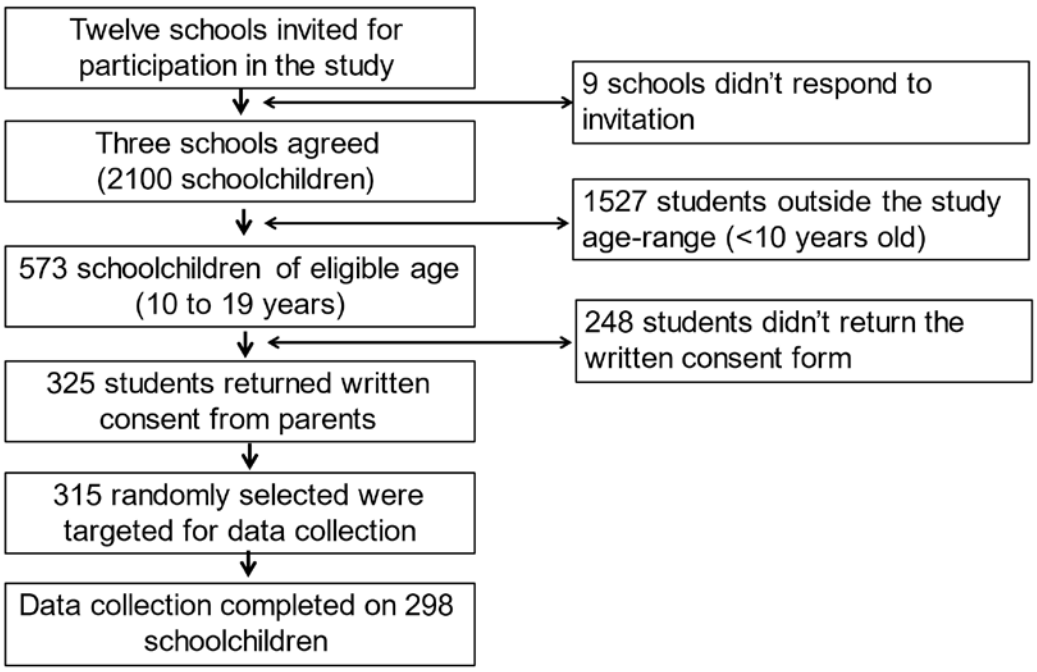
Characteristics	n/N[a]	Univariable analysis OR [95% CI]	Multivariable analysis AOR (95% CI)
Age (years)	31.5% (92/292)	1.49 (1.3- 1.72)	1.5 (1.26- 1.8)
Ethnicity			
Peulh	31.5 % (23/73)	1.38 (0.67- 2.83)	
Soussou	38.6 % (39/101)	1.89 (0.98- 3.64)	
Forest-dwellers	20.8 % (5/24)	0.79 (0.26- 2.4)	
Other African foreigner	33.3 % (6/18)	1.50 (0.49- 4.55)	
Malinké	25 % (19/76)	Reference	
Gender			
Female	41.8 % (61/146)	2.66 (1.59- 4.46)	1.62 (0.81- 3.24)
Male	21.2 % (31/146)	Reference	Reference
Family history of obesity			
Yes	41.1 % (69/168)	3.06 (1.77- 5.29)	
No	18.5 % (23/124)	Reference	
Family history of diabetes			
Yes	50 % (28/56)	2.69 (1.48- 4.88)	3.52 (1.55- 7.98)
No	27.1 % (64/236)	Reference	Reference
Family history of hypotension			
Yes	42.4 % (50/118)	2.31 (1.4- 3.82)	
No	24.1 % (42/174)	Reference	
Number of exercise per week			
0	73.8 % (48/65)	11.74 (6.17- 22.35)	7.64 (3.47- 16.83)
≥1	19.4 % (44/227)	Reference	
Time spent on hobbies (hours)			
<4 hrs	55.6 % (55/99)	5.27 (3.09- 8.99)	4.35 (2.19- 8.63)
≥ 4 hrs	19.2 % (37/193)	Reference	Reference
Type of hobbies			
TV/Internet/Listening music	34 % (90/265)	6.43 (1.49- 27.75)	
Dancing/Sports	7.4 % (2/27)	Reference	
Father's profession			
Not a miner	7.1 % (6/85)	0.11 (0.04- 0.26)	0.14 (0.05- 0.38)
Miner	41.5 % (86/207)	Reference	Reference

[a] n = number of obese or overweight children; N= Number of schoolchildren in the given group; OR = odds ratio

Table 4: Univariable and multivariable risk factors for concurrent burden of stunting and pre-obesity/obesity

Characteristics	n/N[a]	Univariable analysis OR [95% CI]	Multivariable analysis AOR (95% CI)
Age (years)	3.4% (10/290)	2.24 (1.42- 3.53)	2.09 (1.31- 3.33)
Ethnicity			
Peulh	2.7 % (2/73)	2.06 (0.18- 23.19)	
Soussou	5 % (5/101)	3.8 (0.43- 33.25)	
Forest-dwellers	4.2 % (1/24)	3.17 (0.19- 52.78)	
Other African foreigner	5.6 % (1/18)	4.29 (0.26- 72.16)	
Malinké	1.4 % (1/74)	Reference	
Gender			
Female	4.9 % (7/144)	2.44 (0.62- 9.61)	1.69 (0.39- 7.42)
Male	2.1 % (3/146)	Reference	Reference
Family history of obesity			
Yes	4.8 % (8/166)	3.09 (0.64- 14.8)	
No	1.6 % (2/124)	Reference	
Family history of diabetes			
Yes	5.4 % (3/56)	1.84 (0.46- 7.33)	
No	3 % (7/234)	Reference	
Family history of hypotension			
Yes	2.5 % (3/118)	0.61 (0.16- 2.43)	
No	4.1 % (7/172)	Reference	
Number of exercise per week			
0	7.8 % (5/64)	3.75 (1.05- 13.37)	
≥1	2.2 % (5/226)	Reference	
Time spent on hobbies (hours)			
<4 hrs	8.2 % (8/98)	8.44 (1.76- 40.58)	5.86 (1.14- 30.21)
≥ 4 hrs	1 % (2/192)	Reference	Reference
Type of hobbies			
TV/Internet/Listening music	3.8 % (10/263)	No data	
Dancing/Sports	0 % (0/27)	Reference	
Father's profession			
Not a miner	1.2 % (1/85)	0.26 (0.03- 2.08)	
Miner	4.4 % (9/205)	Reference	

[a] n = number of concurrently stunted and obese/overweight school children; N= Number of schoolchildren in the given group; OR = odds ratio



Supporting Figure 1: Design of the study

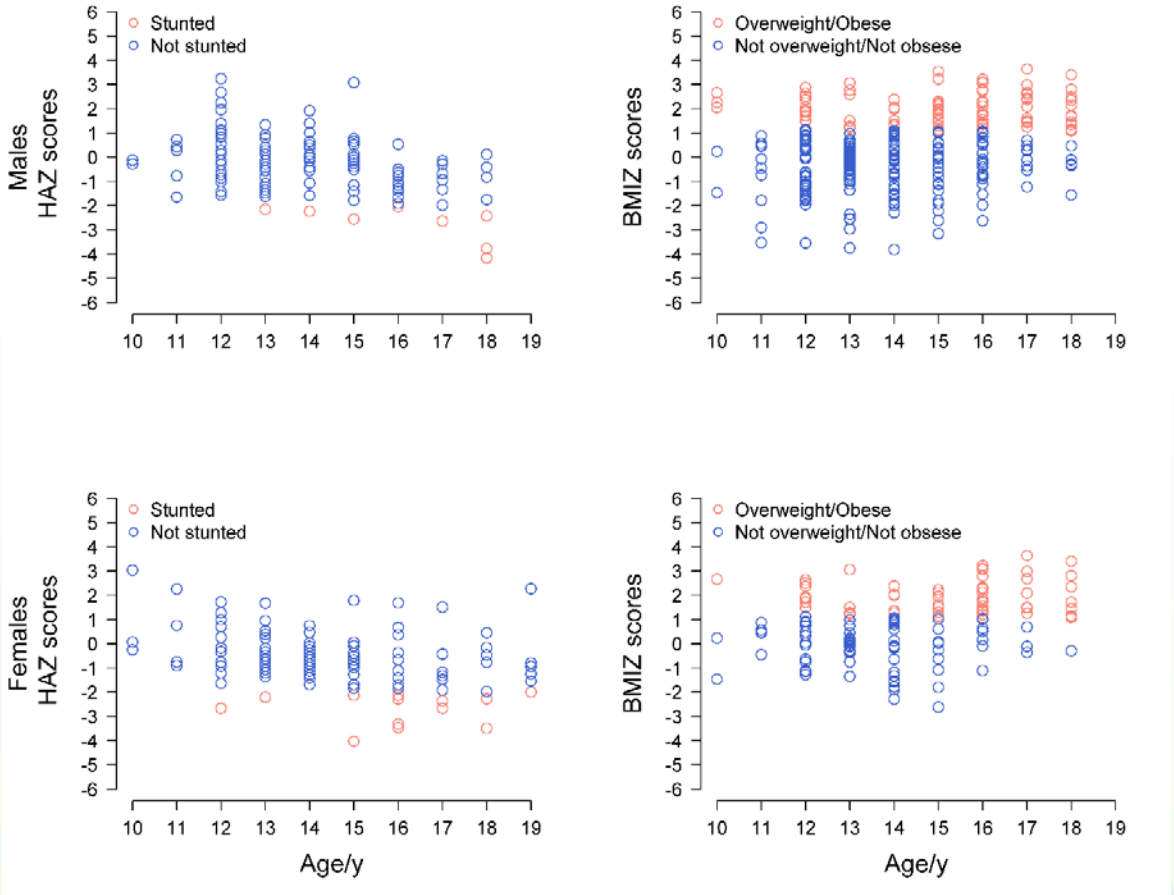


Figure 1: Overweight, obesity, and stunting in the study dataset

Legend: Stunting (left panel) and pre-obesity/obesity (right panel) status among boys (top panel) and girls (bottom panel).

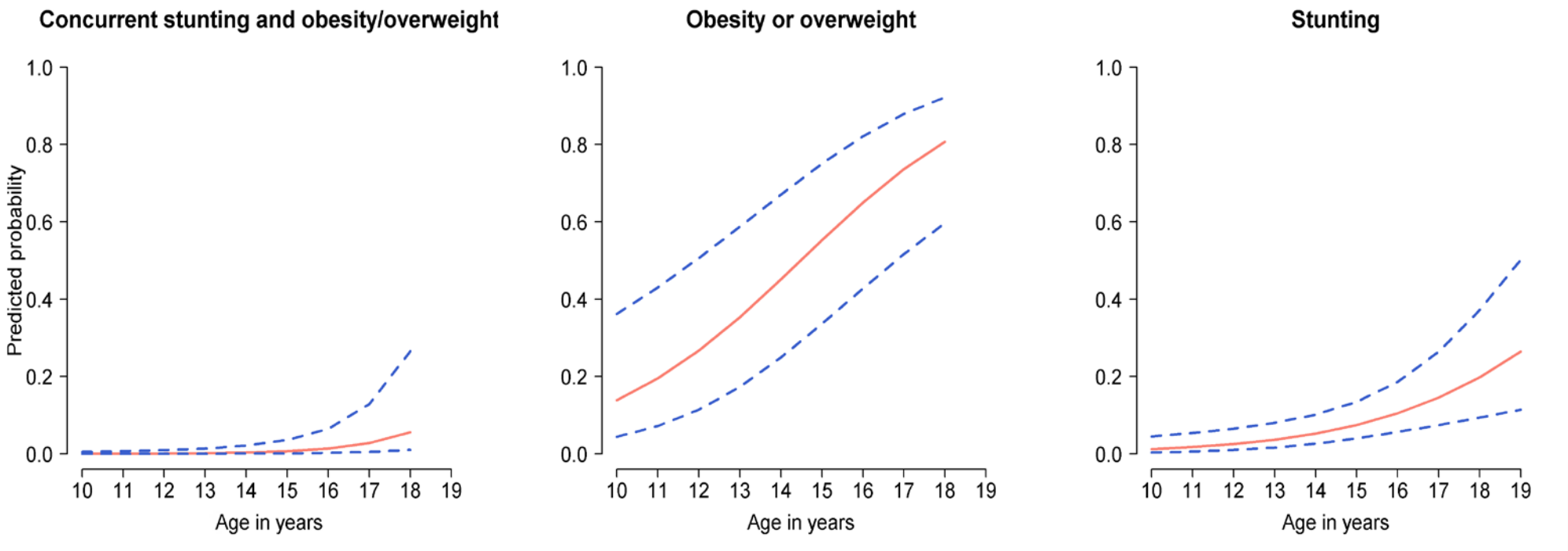


Figure 3: Predicted probability of stunting; overweight; and concurrent stunting and overweight by age

Legend: The predicted probabilities were estimated from the respective multivariable model presented in Tables 2, 3, and 4.

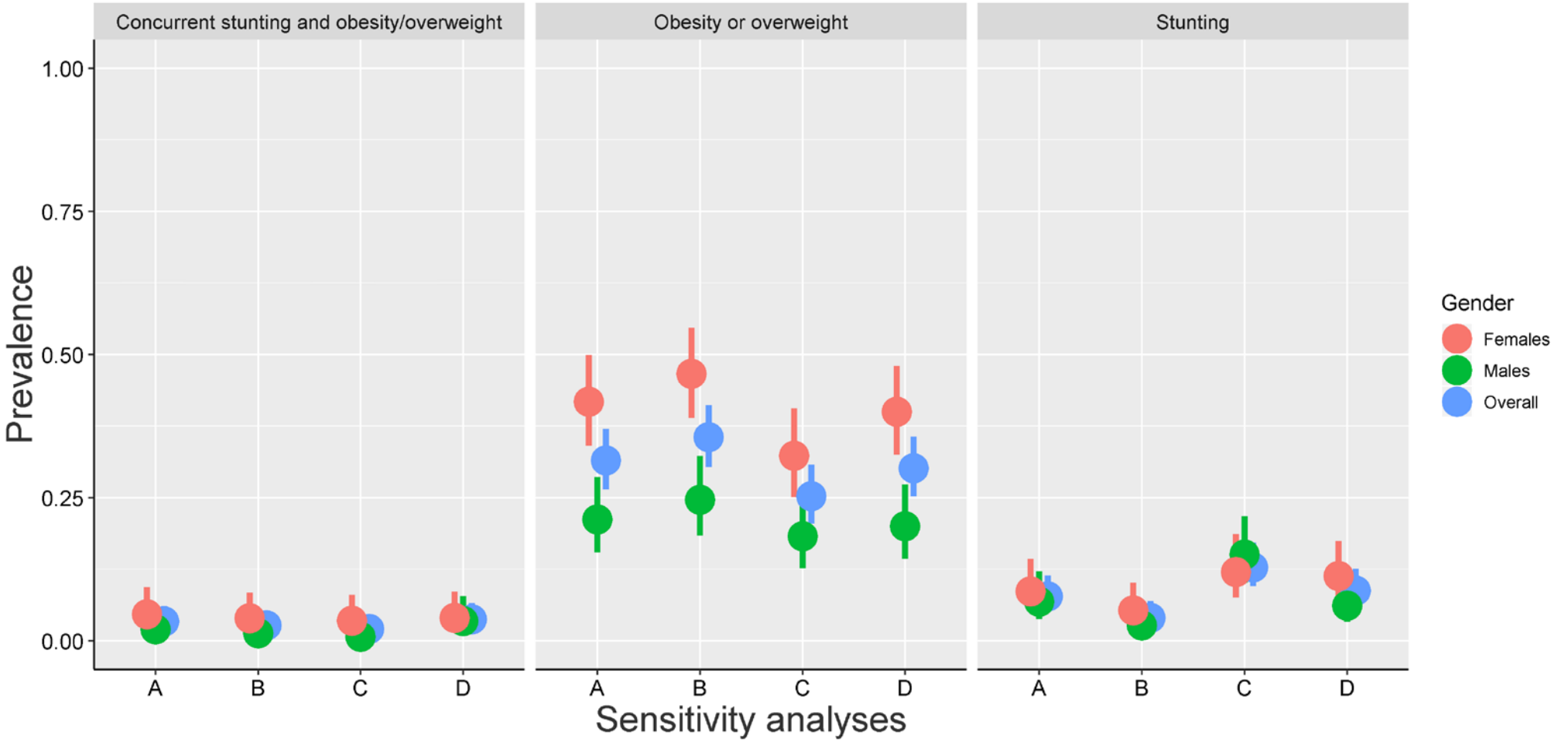


Figure 4: Sensitivity analyses

Legend: A= Main analysis; B = Age taken as the lower value of the range; C = Age taken as the upper value of the range; D = age as predicted from the regression model