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# PUBLIC HEALTH RESEARCH

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## Overweight and Obesity among School-Aged Adolescents in Yaounde (Cameroon)

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### ABSTRACT

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<b>Introduction</b>	Overweight and obesity are a major public health problem due to its association with serious chronic diseases. Concerning childhood overweight/obesity, its rise in developing countries is so that there is a need to provide more evidence on its burden and associated factors in order to set preventive measures.
<b>Methods</b>	This study was designed to know the prevalence and related factors of overweight and obesity amongst adolescents in Yaoundé- Cameroon, and to draw their epidemiological profile.
<b>Results</b>	The prevalence of overweight and obesity was 13.6% and 4.3% respectively. Results revealed that practices associated with overweight and obesity are increase in age ( $R = 0.42$ , $p < 0.001$ ), female gender ( $p < 0.001$ ). In addition, the use of bikes, cars or buses to go to school compared to walking (OR: 0.26; CI: 0.14 – 0.64; $p = 0.0026$ ) increase the risk of being overweight or obese. After adjusting the multivariable logistic model for age and sex with our study variables, it reveals that the odds of being obese for those who consume alcohol once a week were nine fold higher than that of those who consumed 2-5 times a week (OR: 9.37; CI: 1.34 to 193.41).
<b>Conclusions</b>	This results show that there is a need for health education in schools so as to help in health promotion and prevention, therefore avoid chronic disease conditions at older ages.
<b>Keywords</b>	Prevalence - risks factors - obesity - overweight - adolescents - Yaoundé, Cameroon.

### INTRODUCTION

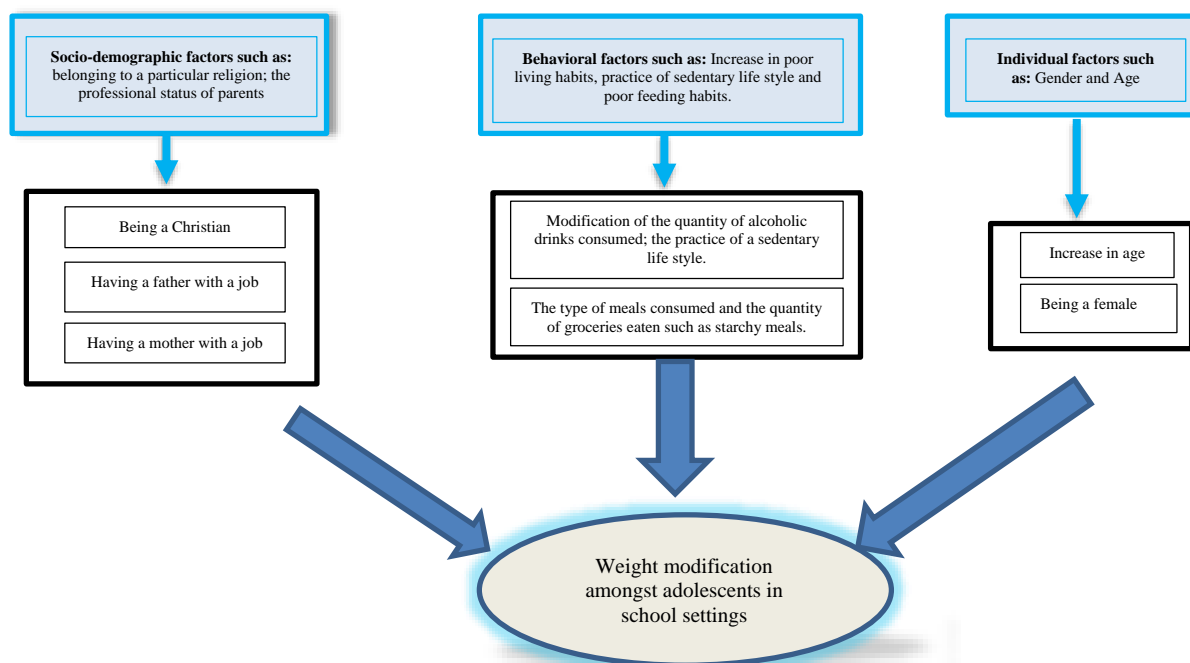
The prevalence of overweight and obesity in children has dramatically increased over the past two decades. In 2010, 43 million children were overweight or obese; of this, 35 million of whom lived in developing countries and this number is expected to reach 60 million by 2020.<sup>1</sup> Obesity has been reported to be on the rise in the world and Africa is no exception. In recent years, obesity has been reported to contribute to the increasing number of people with hypertension and diabetes mellitus and Africa has the fastest growing number of overweight and obese adolescents, with indications that in 2010, it had more than doubled since 1990. A community-based cross-sectional study conducted among adults in Magu District-North West Tanzania in 2013, showed that overweight and obesity were one of the major factors associated for hypertension. Furthermore, Otang-Mbeng et al.<sup>2</sup> report that South Africa faces a severe and growing obesity epidemic. World Health Organization states that the problem of obesity is emerging in developing economies at a time when under nutrition remains a significant problem, particularly when dealing with children whose growth may be stunted.<sup>3</sup> However, this rise is not limited to high-income countries. Low- and medium-income countries have also recently joined the obesity epidemic, and the increase has been even faster in these countries.<sup>4</sup> More precisely in Cameroon, the health sectorial strategy reports that about one-third (32%) of women were either overweight or obese in 2011, and it was greater in Yaoundé and Douala with a 46% prevalence.<sup>5</sup>

Obesity is involved mostly the domain of health promotion and prevention. For promotion, the Cameroon government has some deficits at this level: services for health promotion are insufficient, financial resources are lacking, and there is an absence of integrated strategies for health promotion and for communication on behavioral change. Thus, childhood overweight/obesity is increasing rapidly, leading to a need to provide more evidence on its burden and to identify associated factors in order to set preventive measures. The health implications of being overweight are very well known and experts agree that in order to stop the negative impact which obesity can have on people's health, it is vital to adopt a healthy lifestyle from early childhood.<sup>6</sup> It should be noted that, overweight and obesity have

social consequences that are more severe in women than in man during adolescence.<sup>7</sup>

There is also a significant social cost which is as a result of education underachievement, reduced social activities and job discrimination because a normal weighed person has more chances of being selected for a job than an obese counterpart.<sup>8</sup> Bhattacharya and Bundorf<sup>9</sup> showed that there are principally four main economic factors that are affected by obesity: direct medical cost, productivity cost, transportation cost and human capital accumulation. In short, effects of obesity and overweight on educational attainment – both quantity and quality of schooling – also represent a potential economic impact, one that may become increasingly significant as rates of childhood and adolescent obesity climb. Adolescence has been identified as a critical period in the development of overweight/obesity patterns, with the transition to college being another potentially important period of risk for weight increase among young adults. Obesity in childhood and adolescence has adverse consequences on premature mortality and physical morbidity in adulthood and is associated with impaired health during childhood itself. Once obesity is established in children it is hard to reverse.

This therefore made us develop this study on the epidemiological aspects of overweight and obesity amongst adolescents in school settings. In fact, make aware to the population various aspects which may lead to an obese or overweight condition or for those who are already overweight or obese, propose various strategies on how to overcome it so that they may not be affected later in life through the development of ill health status. In addition to fill the gaps in existing literature on overweight and obesity due to the absence of research on some aspects concerning overweight and obesity which will therefore be treated by this study, making the Cameroonian literature richer. Although all the risks associated to being obese are known, the prevalence amongst urban dwellers is still increasing, leading to question ourselves on what is the level of overweight and obesity amongst adolescents in Yaoundé, and what are factors that can influence the occurrence of overweight or obese conditions amongst adolescents in secondary school settings? Based on those specific study objectives, the below conceptual model was elaborated.



**Figure 1** Conceptual model for the study on epidemiological aspects of obesity and overweight amongst adolescents in urban Cameroon

## METHODS

### *Theoretical framework*

The theoretical framework introduces and describes the theory that explains why the research problem under study exists. The theories used in this study are the theory of planned behavior and the health belief model.

### *Theory of planned behavior (TPB)*

The TPB is a theory developed by Icek Ajzen (1988, 1991) which predicts deliberate behavior, because behavior can be deliberate and planned. It deals with the antecedents of attitudes, subjective norms, and perceived behavioral control, antecedents that in the final analysis determine intentions and actions. Concepts referring to behavioral dispositions such as social attitude and personality trait have played an important role in these attempts to predict and explain human behavior. TPB is the successor of the similar Theory of Reasoned Action of Ajzen and Fishbein.<sup>12</sup> As in the original theory of reasoned action, a central factor in the TPB is the individual's intention to perform a given behavior. Intentions are assumed to capture the motivational factors that influence a behavior; they are indications of how hard people are willing to try, of how much of an effort they are planning to exert, in order to perform the behavior. True to its goal of explaining human behavior, not merely predicting it, the theory of planned behavior deals with the antecedents of attitudes, subjective norms, and perceived behavioral control, antecedents which in the final analysis determine intentions and actions. At the most basic level of explanation, the theory

postulates that behavior is a function of salient information, or beliefs, relevant to the behavior. People can hold a great many beliefs about any given behavior, but they can attend to only a relatively small number at any given moment. It is this salient beliefs that are considered to be the prevailing determinants of a person's intentions and actions. According to the TPB, human behavior is guided by three kinds of considerations:

- i. Beliefs about the likely outcomes of the behavior and the evaluations of these outcomes (behavioral beliefs): Behavioral beliefs produce a favorable or unfavorable attitude towards the behavior and guide considerations of positive and negative outcomes. According to this model, attitudes develop reasonably from the beliefs people hold about the object of the attitude. Generally speaking, we form beliefs about an object by associating it with certain attributes, i.e., with other objects, characteristics, or events. In the case of attitudes toward a behavior, each belief links the behavior to a certain outcome, or to some other attribute such as the cost incurred by performing the behavior. Since the attributes that come to be linked to the behavior are already valued positively or negatively, we automatically and simultaneously acquire an attitude toward the behavior. In this fashion, we learn to favor behaviors we believe have largely desirable consequences and we form unfavorable

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- attitudes toward behaviors we associate with mostly undesirable consequences.
- ii. Beliefs about the normative expectations of others and motivation to comply with these expectations (normative beliefs): Normative beliefs result in perceived social (or peer) pressure or subjective norm. What do others expect me to do? How do they expect me to behave? Will I be supported or ridiculed? Normative beliefs are concerned with the likelihood that important referent individuals or groups approve or disapprove of performing a given behavior.
  - iii. Beliefs about the presence of factors that may facilitate or impede performance of the behavior and the perceived power of these factors (control beliefs): control beliefs produce a behavioral control by impacting performance of the behavior. It is a belief that ultimately determines intention and action. These control beliefs may be based in part on past experience with the behavior, but they will usually also be influenced by second-hand information about the behavior, by the experiences of acquaintances and friends, and by other factors that increase or reduce the perceived difficulty of performing a particular behavior. The more resources and opportunities individuals believe they possess, and the fewer obstacles or impediments they anticipate, the greater should be their perceived control over the behavior.

### *The Health Belief Model (HBM)*

HBM is an intrapersonal (within the individual, knowledge and beliefs) theory, a psychological model which is used in health promotion to design intervention and prevention programs, to explain and predict health behaviors. It was developed in the 1950's by social psychologists <sup>[13-14]</sup>, who were working in the U.S. Public Health Service because they were trying to explain the failure of people's participation in health programs to prevent and detect disease especially after the failure of the free tuberculosis screening program. The model was later extended by other researchers to study people's behavioral responses to health-related conditions. The Health Belief Model continues to be one of the most popular and widely used theories in intervention science. The HBM is based on six key concepts:

- i. Perceived susceptibility: it examines the individual's opinions about how likely the behaviors they partake in are going to lead to a negative or positive health outcome. For example, look at an individual who eat fat. Fat is known to lead to overweight and

obesity. If a fat-consumer does not feel that he is at risk of developing overweight and obesity, he has no reason in his mind to make a behavior change.

- ii. Perceived severity: addresses how serious the diseases that a person is susceptible to can be. In the case of a fat-consumer, overweight and obesity are one of the leading causes of CVDs. A fat-consumer may not understand how difficult obesity can be to detect and how difficult it can be to treat.
- iii. Perceived benefits: It is a person's opinion of the value or usefulness of a new behavior in decreasing the risk of developing a disease. People tend to adopt healthier behaviors when they believe the new behavior will decrease their chances of developing a disease. You can give a positive message about the benefits of taking specific actions, including accurate information about how effective medicines are at reducing susceptibility and severity.
- iv. Perceived barriers: This is the person's perceptions of the difficulties they would encounter in taking the proposed actions, including both physical and psychological barriers. Since change is not something that comes easily to most people, perceived barriers could be defined as an individual's own evaluation of the obstacles in the way of him or her adopting a new behavior. Of all the concepts, it is the most significant in determining behavior change. These may be addressed through various means of support, from financial through reassurance and assistance.
- v. Cues to action: These are the prompts that are needed to move the person into the state where they are ready to take the prescribed action. They are events, people, or things that move people to change their behavior. Strategies to activate "readiness". These can include practical ways of nudging them, such as marked calendars, email reminders, how-to charts and so on.
- vi. Self-efficacy: It was added to the other beliefs in 2005 <sup>[15]</sup>. This is the person's confidence and belief in their own ability to take the given action. Generally, people do not try to do something new unless they think or believe they can do it. If someone believes a new behavior is useful (perceived benefit), but does not think he or she is capable of doing it (perceived barrier), then there are great chances that he will not try it.

- vii. Modifying factors, such as culture, education, etc.

1.96 for a confidence rate of 95%) - the normal central reduced law.  
 p = estimates proportion representing the studied characteristic.  
 e = error margin, traditionally fixed at 5%.

*Site of Study*

Yaoundé was revealed to the world by Germans in 1889 and was declared the capital of Cameroon in 1960. It has a population of 2,440,462 inhabitants that is approximately 2.5 million inhabitants, it is, the second most populated city after Douala. Yaoundé host most of Cameroon's important institutions. The city has grown as an administrative, service, and commercial center and a communications hub for road, rail, and air transport.

*Study design, study population, and target population*

The present study relied on a cross-sectional study among adolescents in school settings, with the use of quantitative methods. Our study populations were all secondary school students in any institution or school setting in Yaoundé aged from 10years to 18years. However, the population in which we were interested (target population) were adolescents in secondary school settings aged from 10 to 18 years in the various schools below mentioned. This population was obtained based on a sampling technic, to establish the appropriate number of pupils on whom the study will be conducted.

*Sampling techniques*

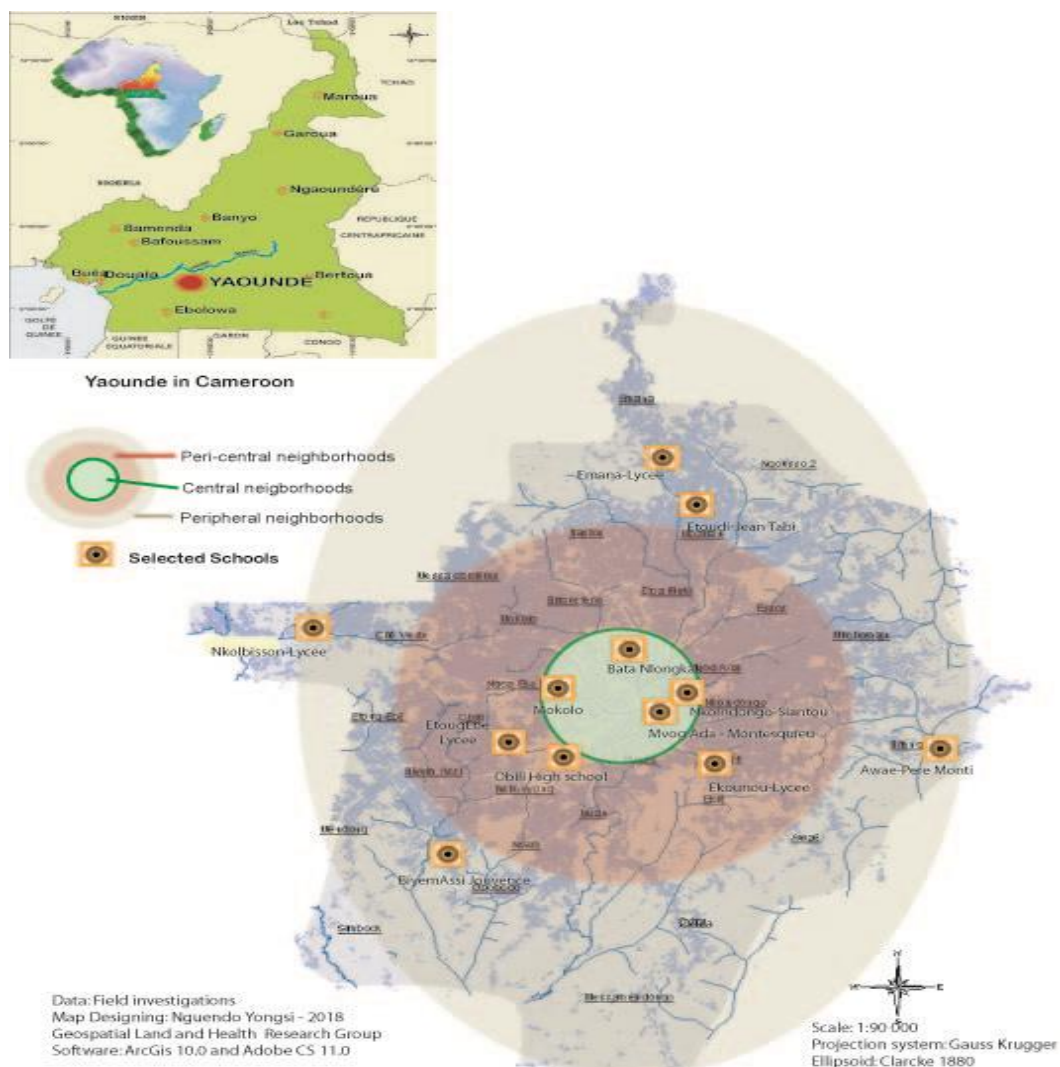
Our sampling size was determined using the following Lorentz formula:

$$n = \frac{t^2 \times p(1-p)}{e^2}$$

Where n= sample size  
 t = level of confidence deduced from the rate of confidence (traditionally fixed at

Therefore, using p= 12.5% based on the study of (Choukem et al., 2017), which has similar characteristics as our study population because its study includes adolescents in urban Cameroon; the sample size obtained was 241 which was rounded up to 260 for more accuracy and precision of results. To select those 260 students from 12 secondary schools in Yaoundé who willingly accepted to participate, we did a probabilistic sampling technic, namely the multi-stage sampling method at three stages: (i) for the first stage, due to the large number of schools in Yaounde and their spatial distribution, schools were chosen based on the “transect” method, i.e. the whole city was transectly cross-divided with concentric radii and schools chosen from various quarters according to the years of creation of neighborhoods (central neighborhoods, peri-central neighborhoods and peripheral neighborhoods; (ii) for the second stage and in order to have a representative part of the population, schools were randomly selected from the North, South, East and West of these neighborhoods which therefore made 4 schools per area summing up to 12 secondary schools (figure 2); (iii) for the third stage, since in Cameroon there are seven classes in secondary schools that is from Form One to Upper-sixth, 3 students aged 10-18years were randomly selected from each class summing up to 21 students per institution, from which data was collected. However, due to some refusals and incomplete questionnaires, our analysis sampling is made up of 252 students.

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**Figure 2** Localization of selected schools for investigation

### Data collection

#### Tools

We used the following tools: stadiometer, weighing scale, and questionnaire. For anthropometric measures we used: (i) the stadiometer, a device for measuring height that typically consists of a vertical ruler with a sliding horizontal rod or paddle which is adjusted to rest on the top of the head (merriam-webster, s.d.), (ii) the weighing scale as its name says is a measuring instrument to determine the weight or mass of an object. The height and the weight were collected so as to calculate the BMI of each participant; which is:  $BMI = \text{Weight} / \text{Square of the height}$ . For other socio-economic and lifestyle information, we used a well-structured and standardized questionnaire. The questionnaire was divided into six sections: the first section which was for the collection of parameters, that is the height and weight and this was done only by the research team. The second section was based on socio-demographic and individual characteristics where we obtained

information such as sex, gender, class, age, etc. The third section was on people's perception about obesity that is if they are at least aware of the term obesity. The fourth section, fifth and sixth section was on nutritional habits so as to know how they feed, physical activity in order to find out if they practice any form of physical activity which could help in weight loss and the mode of life were asked such as alcohol consumption habits etc.

#### Measurements

Information was obtained in the following way: students were randomly selected from their classes and in other cases with the use of a pre-establish class list, and they were all gathered in one area where we proceeded by first explaining to them what the study was all about and then we began by taking their parameters first, which involved measuring the weight and height. (1) *Weight*: The weight was measured with very light dresses (school attire) and with shoes off. After having weighed the scales, the participant climbed naked

feet in the center of the scale, left the arms all the length of the body and looked straight in front of him. This allowed the observer placed in front of the participant to bend and read the figure worn next to the needle representing the weight in kilograms; (2) *Height*: We asked the student to remove his shoes, made sure the subject's feet was on the base, feet together and against the vertical part of the board, with arms dangling along the body, ensuring that the heels, buttocks, scapula and occiput were against the vertical surface of the board, while the participant kept his eyes fixed on the straight angle in front of him, the height was then read on the highest point of the subject's head up to two decimal places; reading the height in meters. After this was done, the student immediately received his or her questionnaire to be filled, and then handed over the research team. Overweight and obesity were defined using the international body mass index cut-off points established for children and youth [16]. These cut-off points are based on health related adult definitions of overweight ( $\geq 25 \text{ kg/m}^2$ ) and obesity ( $\geq 30 \text{ kg/m}^2$ ) but are adjusted to specific age and sex categories for children [17].

*Data entry and analysis*

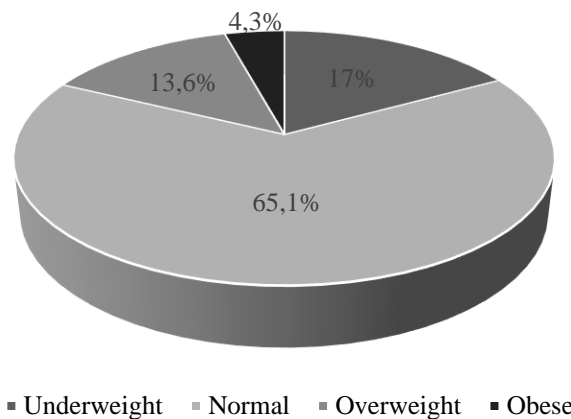
Data was entered using software CPro version 7, because it allows making the mask for data entry. However, data was analyzed using the software "R Studio"; so as to measure the relationship between our dependent and independent variables, and also

to proceed bivariate analyzes and the binomial logistic regression model. SPSS 21 was to sort variables and to recode them. The SPAD software was used to describe the profile of adolescents who may or may not be at risk for obesity/overweight. In short, the statistical processing of data was done in the following way: (a) descriptive statistics was used for univariate analysis; the bivariate analysis and multivariate analysis through Factorial Analysis of Multiple Correspondences (AFCM) helped to verify the association between the dependent variable and each independent variable; (b) explanatory analysis was done using linear regression. The fisher's test was used to calculate the degree of significance. The Spearman's test was used to test for correlation between variables, whereas the fisher's test was used to calculate the degree of significance. Odds ratio were obtained and the level of significance of the p-value was set at 0.05.

**RESULTS**

*Sample characteristics*

Of the 260 targeted school-attended adolescents in Yaoundé, 252 (96.9%) finally participated in the study. According to WHO cutoff points of obesity and overweight which we adopted, figure 3 shows that the prevalence of overweight and obesity is 13.6% and 4.3% respectively at a 95% CI; OR (13.46 to 23.17).



**Figure 3** Prevalence of Overweight and Obesity among school-going adolescents in Yaoundé

Because our research focused on overweight and obesity, 206 underweight and normal students were not analyzed. So said and on

an average, girls had higher BMI than boys, and most were of christian religion (Table 1).

**Table 1** Overweight and obese among school-going adolescents according to their gender and religion

	BMI Status				Total	P value
	Overweight		Obese			
	number	%	number	%		
Girls	30	75	10	25	40 (86.9%)	0.061

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Boys	5	83.4	1	16.6	6 (13.1%)	
Total	35 (76.1%)		11 (23.9%)			
Christian	32	76.2	10	23.8	42 (91.3%)	0.266
Muslim	3	75	1	25	4 (08.7%)	
Total	35 (76.1%)		11 (23.9%)			

### Overweight and obesity-related factors

Using the crude multivariate analysis, table 2.a shows that the odds of a person consuming alcohol once a week to become obese are 7.38 times higher than those who consume a couple of times a week. Also, the odds of those who hardly ever or never consumed sweet drinks to be obese were 2.12 higher than those who consumed every day. What stands out also in this table is that, those who walked to go to school had 74% lesser chances of being obese than those who used buses, bikes or cars as means of transport to school (p-value = 0.0026 at a 95% CI (0.14 to 0.64)). It is seen that the odds of become obese increased by 51% for those who studied for 3 to 4 hours than those who studied for 1 to 2 hours at a 95% CI (0.73 to 3.11), although not statistically significant p-value = 0.25. Furthermore, those who watched television everyday had 7% lesser odds of being obese than those who watched TV a 2 to 5 times a week (CI: 0.44 to 1.99; p-value: 0.86) while those who hardly or never watched TV had 24% higher chances of being obese than those who watched TV 2 to 5 times a week (CI: 0.17 to 5.96; p-value: 0.30). It can also be deduced from this table that, those who do sports for 02days after school had 14% lesser chances of being obese as compared to those who don't do sports after school (CI: 0.31 to 2.15; p-value 0.70); same with those who do sports for 04days after school with 3% lesser chances (CI: 0.18 to 4.17; p-value: 0.98). Finally looking at that table, it is apparent that, those who consumed fruits everyday were more likely to be obese than those who consumed fruits hardly ever or never, some days or most days with odds of 70%, 30% and 1% respectively. However, the odds of being obese increased by 12% for those who eat take-away or imported meals most days than those who eat about 2 to 3 times per week (CI: 0.35 to 3.84; p-value: 0.84). In contrast, the odds of being obese decreased by 10% for those who ate imported food once a month as compared to those who ate 2 to 3 times a week (CI: 0.23 to 3.36; p-value: 0.87). As it

can be seen, the odds of being obese increased for those that ate fufu and eru than those who ate fufu corn and ndole, okok and cassava, rice and groundnut and others by 66%, 49%, 25% and 31% respectively; although none of the results were statistically significant. In the contrary, the odds of being obese increased by 43% for those that consumed more of pastry than eru and fufu (CI: 0.30 to 6.31; p-value 0.63). The odds of being obese increased for those who brought fruits and vegetables (more than two fold, CI: 0.60 to 11.12; p-value: 0.18), Pastry (by 60%; CI: 0.063 to 4.72; p-value: 0.34), sweets and candies (by 12%; CI: 0.28 to 4.40; p-value: 0.86), Others (more than two fold; CI: 0.26 to 14.00; p-value: 0.41) than those who brought cooked food to school.

Table 2.b which present the adjusted multivariable analysis for mode of life, physical activity and diet adjusted for age and sex respectively had no significant difference with the crude table 2.a, but for a factor which shows after adjustment that the odds of being obese for those who consume alcohol once a week were nine fold higher than that of those who consumed 2-5 times a week (CI: 1.34 to 193.41; p-value = 0.05). The other results obtained in the various tables simply confirmed all what was already stated during the crude analysis.

However, it would be risky to be limited to these descriptive results alone to highlight the factors influencing obesity / overweight. This requirement is all the more justified because at this level of analysis, it is difficult to identify and prioritize the explanatory factors of the behavior studied. In addition to these constraints, the associations and interdependencies that have been identified by these descriptive analyzes can be misleading. In this sense, we use multivariate explanatory analysis using linear regression to highlight the elements that actually influence adolescents in Yaoundé. This is the main goal of the next section.

**Table 2** Overweight and obesity-related factors among school-going adolescents in Yaoundé

Related factors	Crude multivariate analysis		Multivariate analysis adjusted for age and sex	
	OR (CI at 95%) unadjusted	P-value	OR (CI at 95%) adjusted	P-value
Alcohol consumption				
A couple of times a week	1	1	1	



Hardly ever or Never	3.17 (0.61 to 58.42)	0.27	3.41 (0.6 to 65.12)	0.25
Once a week	7.38 (1.18 to 144.26)	0.07	9.37 (1.34 to 193.41)	0.05
Sweet drinks consumption				
Everyday	1	1	1	
Hardly ever or Never	2.12 (0.57 to 7.1)	0.23	2.53 (0.64 to 9.48)	0.16
Once a week	1.36 (0.45 to 3.88)	0.55	1.10 (0.34 to 3.30)	0.86
A couple of times a week	1.98 (0.45 to 2.21)	0.97	0.89 (0.40 to 2.08)	0.79
Physical activity				
Taxi, bike, bus, ...	1	1	1	
Walking	0.26 (0.14 to 0.64)	0.0026	0.39 (0.17 to 0.83)	0.018
Study hours				
1 to 2 hours	1	1	1	
3 to 4 hours	1.51 (0.73-3.11)	0.25	1.20 (0.56 to 2.56)	0.63
More than 4 hours	1.47 (0.43 to 4.39)	0.50	1.61 (0.44 to 5.14)	0.43
Tv in bedroom				
No	1	1		
Yes	1.65 (0.67 to 3.90)	0.26	1.83 (1.71 to 4.54)	0.19
TV hours				
2 to 5 times a week	1	1		
Hardly ever or Never	1.24 (0.17 to 5.96)	0.79	1.30 (0.17 to 6.53)	0.76
Once a week	0.53 (0.13 to 1.65)	0.30	0.61 (0.15 to 2.01)	0.44
Everyday	0.93 (0.44 to 1.99)	0.86	0.86 (0.39 to 1.90)	0.72
Sports				
0-1 day	1	1	1	
2-4 days	1.08 (0.41 to 2.79)	0.87	0.93 (0.35 to 2.50)	0.89
5 days and more	0.82 (0.31 to 2.15)	0.70	1.54 (0.39 to 5.54)	0.52
Dietary habits				
Everyday	1	1	1	
Hardly ever or never	0.30 (0.01 to 2.17)	0.31	0.25 (0.01 to 1.87)	0.24
Somedays	0.70 (0.26 to 2.01)	0.498	0.68 (0.24 to 2.03)	0.47
Most days	0.99 (0.34 to 3.01)	0.99	0.95 (0.30 to 3.11)	0.94
Imported food				
2-3 times per week	1	1	1.21 (0.38 to 4.17)	0.74
Hardly ever or Never	1.15 (0.38 to 3.78)	0.80	1.13(0.28 to 4.60)	0.85
Once a month	0.90 (0.23 to 3.36)	0.87	1.57 (0.46 to 5.68)	0.47
Most days	1.42 (0.45 to 4.86)	0.55	1.31 (0.38 to 4.72)	0.66
meal usually consumed				
Eru and fufu	1	1	1	1
Fufu corn and Ndole	0.44 (0.05 to 2.26)	0.36	0.76 (0.09 to 4.37)	0.77
Okok and cassava	0.51 (0.14 to 1.69)	0.27	0.75 (0.20 to 2.72)	0.66
Pastry (cakes, pizza, etc)	1.43 (0.30 to 6.31)	0.63	1.60 (0.30 to 7.72)	0.55
Rice and ground-nut soup	0.75 (0.28 to 2.09)	0.56	1.00 (0.36 to 3.00)	0.99
Other	0.69 (0.20 to 2.28)	0.55	0.83 (0.23 to 2.93)	0.77
Food brought to school				
Cooked food	1	1	1	1
Fruits and vegetables	2.61 (0.60 to 11.12)	0.18	2.51 (0.53 to 11.60)	0.23
Pastry (chips, bread, etc)	1.60 (0.63 to 4.72)	0.34	1.45 (0.54 to 4.39)	0.47
Sweets and candies	1.12 (0.28 to 4.40)	0.86	1.10 (0.26 to 4.46)	0.88
Other	2.19 (0.26 to 14.00)	0.41	3.55 (0.33 to 31.52)	0.25

*Profile of adolescents being at risk of obesity/overweight*

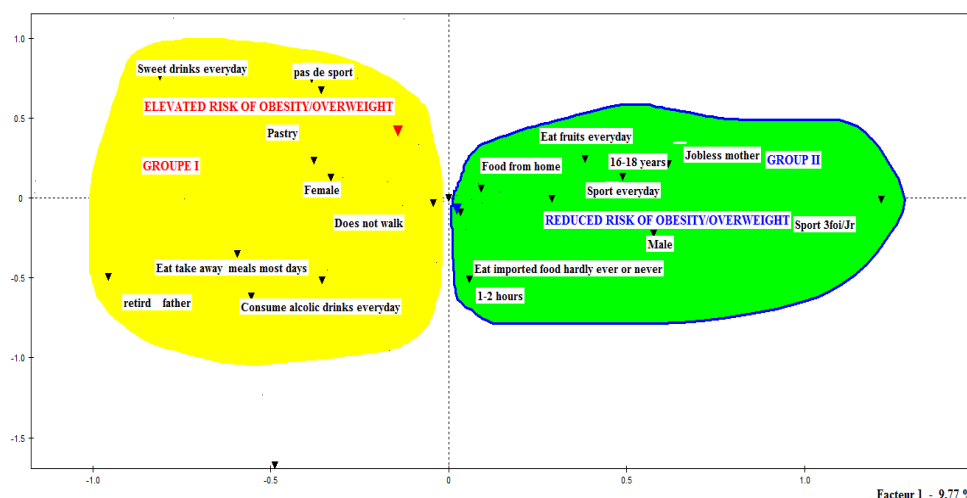
It would be risky to be limited to these descriptive and explanatory results alone to highlight factors influencing obesity/overweight. This requirement is all the more justified because at this level of analysis, it is difficult to identify and prioritize the explanatory factors of the behavior studied. In addition to these constraints, associations that have been identified by these descriptive and multivariate analyzes can be misleading. Therefore,

it is important to highlight relations of interdependencies between all the variables. In this sense we resorted to Factorial Analysis of Multiple Correspondence (FAMC) using SPAD 5.5 software allowed drawing and confirming the profile of school-attending adolescents in Yaoundé. Examination of Figure 3 highlights two groups of individuals who may or may not be at risk of obesity/overweight. The first group includes female adolescents who are more likely to be at risk for obesity/overweight. It involves female adolescents

## Overweight and Obesity among Adolescents

who usually eat pastries for lunch, sweet gaseous drinks every day, as well as alcoholic drinks. They do not often walk, do not do sports yet consume take away meals most days (pizza, hamburger). In addition, they have retired fathers. The second group consists of adolescents who have a low risk of obesity/overweight. It is comprised of

adolescents aged 16-18 year old, who play sports every day or three times per day, study about 1-2 hours daily. They have jobless mothers and often consume home-made food. This profile could be used as a basis for reorienting the content of programs focused on alimentation or nutrition.



**Figure 4** Profile of adolescents being at risk or not of obesity/overweight

## DISCUSSION

The prevalence of overweight and obesity in adolescent population of Yaoundé is 13.6% and 4.3% respectively. This result indicates that the prevalence of obesity is increasing because the study conducted in 2010 by Wamba et al.<sup>18</sup> Tchoubi et al. on urban Cameroonian children and adolescents aged 8 years to 15 years showed a 12.4% overweight and 1.9% obesity.<sup>19</sup> This concludes that from 2010 to 2017, the prevalence amongst urban adolescents is increasing. These prevalence rates of overweight or obesity seem similar or lower than findings from middle income countries,<sup>20-21</sup> and much lower than studies from high income countries (among 13-year-olds 10% in girls and 16% in boys and among 15-year-olds 10% in girls and 17% in boys).<sup>22-23</sup> This study found a higher prevalence rate of overweight or obesity in female than male adolescents, which concurs with studies among adolescents in low and middle income countries but the opposite hold true in high income countries where adolescent boys had higher rates of overweight or obesity than girls.<sup>24</sup>

Possible reasons for this may be cultural differences in beliefs regarding body image. In a study among Black African adolescent girls it was found that two thirds of the girls perceived fatness as a sign of happiness and wealth. Socially, fatness was accepted but one third of the girls had contradictory views about its advantages. Among obese girls who believed that being obese was preferable, the dominant reasons were that being fat allowed one to engage in sport activities that need

strength and also makes one look respectable.<sup>25</sup> After breaking down the BMI cut-off points into obese, overweight, normal and underweight, we noticed that women are more obese than men. Such results confirm other findings such as that of Benkeser et al.<sup>26</sup> which showed that women are more obese than men with 64.9% and 35.1% respectively. Although not statistically significant, it was observed that Christians are more likely to be obese than Muslims, and those who had parents (father and mother) who are workers were also more likely to be obese than those with retired or jobless parents. This results can be explained by the fact that those who have jobs are more likely to be more financially stable than those with no jobs or retired parents and thereby, their children too are more likely to have money which they can use to buy sweets and candies and other grocery products when and how they want which favors weight gain and obese conditions.

There are various ways of living that could influence the occurrence of obesity or overweight, but in this study we focus on two factors: alcoholic drink consumption and sweet drinks consumption. We noticed that, there is a positive association between alcohol consumption and obesity as it appeared that those who consume alcoholic drinks a couple of times a week have higher chances of being obese than those who consume once a week ( $p < 0.001$ ). But, this result doesn't concord with that of Kamadjeu et al. who shows a negative association between obesity and alcohol consumption.<sup>27</sup> This can be explained by the fact that the study population was not the same,

because the age groups and study area were different. Concerning sweet drink consumption, what stands out is that, those who consumed sweet drinks everyday were less likely to be obese than those who consumed fewer times per week: this finding is very contradictory to that of many studies notably that of Cohen et al. (2017) where it was found out that sweet drinks consumption was in relation to the risk of becoming obese.<sup>28</sup>

Looking at influence of physical activity on increase prevalence of obesity and overweight amongst adolescents, those who walked to go to school had 74% lesser chances of being obese than those who used buses, bikes or cars as means of transport to school. This result was very significant and could make us believe that the more walked to school the less you could become obese, because walking everyday can be termed as a physical activity practiced. In terms of school environment, the association between obesity levels and frequency of physical education classes was striking. This finding supports policies that increase the frequency of physical education classes, such as those recently announced for all elementary schools in Cameroon. This is better explained by the theory of planned behavior as outlined by Neighbors & Fossos (2013) which suggests that behavior is determined by intentions, attitudes and subjective norms.<sup>29</sup> Intentions are assumed to capture the motivational factors that influence a behavior; they are indications of how hard people are willing to try, of how much of an effort they are planning to exert, in order to perform the behavior.

Therefore, this students may perform behaviors such as taking bikes, buses or cars to school because they believe that it will help them go faster to school without knowing that such behaviors predisposes them to becoming obese. The results of this study reaffirms facts which Pasquet et al., (2006) revealed as regard the mode of transportation.<sup>30</sup> When studying, there is no movement done, thereby it is considered as a sedentary life style because no physical efforts are being exerted. We realized that those who had longer studies hours were more predisposed than those with shorter study hours. This is supported by the health belief model theory which is an intrapersonal (within the individual, knowledge and beliefs) theory, most especially by one of its key concepts, that of perceived susceptibility, which is the person's assessment of the chances of something getting the given condition. The greater the risk, the greater chances the person has to engage in behaviors to decrease the risk. It is only logical that when people believe they are at risk for a disease, they will become more likely to do things so as to prevent it from happening.<sup>31</sup> We can therefore understand that these students don't think that studying longer can affect their health by becoming obese. So they study longer hours so as

to have better performances in school but which indirectly exposes them to greater risk of being obese. Besides, students who had and watched TV in their bedrooms had 65% more odds of being obese than those who did not have. Lack of free space for playing, increased television viewing and computer usage has made life sedentary. We can therefore identify this as a problem as this means that these obese students had much inactive time because they have the possibility of staying in their bedrooms and distract themselves by watching television. The HBM quietly explains this because persons must evaluate their perceptions of susceptibility and severity of developing a disease, because it is this perception that makes the person to feel threatened. Environmental factors can contribute as well as cues to action such as television ads or caring relatives. Also, the benefits to change must be weighed against the barriers to change behavior in order to determine that taking action will be worthwhile. Therefore, the fact that they are ignorant of the risk involved in watching television in bedroom or in other words of being more physically inactive, make them not to perceive any severity of developing the disease. From the time spent doing sports after school, we deduced that those who do sports for 02 days after school had 14% lesser chances of being obese as compared to those who don't do sports after school (CI: 0.31 to 2.15; p-value 0.70), same with those who do sports for 04 days after school with 3% lesser chances (CI: 0.18 to 4.17; p- value: 0.98). Though, these values were not statistically significant, we can summon the TPB to explain the fact that students carry out sports activities even after school because as the theory enounces, in the case of attitudes toward a behavior, each belief links the behavior to a certain outcome, or to some other attribute such as the cost incurred by performing the behavior. In this fashion, we learn to favor behaviors we believe have largely desirable consequences and we form unfavorable attitudes toward behaviors we associate with mostly undesirable consequences. The possible risk factors in causing childhood obesity are sedentary lifestyle which makes them stay physically inactive. Often parents are working and unable to concentrate on balanced nutritional food for their children. They find it easier to let their children consume junk and fast foods. Even the burden of school work and academic competitiveness has decreased the participation in sports and other form of physical activities in urban area which leads to high frequency of overweight and obesity. Therefore, applying the TPB to physical activity we can simply say that students consider this extra sports time as leisure time for them where they can actually meet with friends and make fun; so, they do this because it has desirable consequences for

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them, and they in turn promote their health by reducing their chances of being obese.

With regard to influence of diet on the occurrence of obesity and overweight in adolescents, results obtained showed that the more fruits consumed the more chances of being obese a student was. But this result was not statistically significant. It is even contradictory to Otang-Mbeng et al's findings who revealed that, low fruit and vegetable consumption was a significant risk factor of obesity, and also to that of Maka (2016) who showed that one of the factors associated to NCDs was insufficient consumption of fruits and vegetables in nearly 70.6% of cases.<sup>32</sup> Concerning take-away meals, the odds of being obese increased by 12% for those who eat take-away or imported meals most days than those who eat about 2 to 3 times per week (CI: 0.35 to 3.84; p-value: 0.84). In contrast, the odds of being obese decreased by 10% for those who ate imported food once a month as compared to those who ate 2 to 3 times a week (CI: 0.23 to 3.36; p-value: 0.87). Some facts of this study explain that there is a greater percentage of students who frequent restaurants or fast foods to be at risk of being obese. This can be explained by concepts referring to behavioral dispositions such as social attitude and personality trait which have played an important role in these attempts to predict and explain human behavior which we find in the theory of planned behavior. According to this theory, students may go to fast foods because of their social attitudes, that because they are already used to doing that and also due to their personality. The kind of meal often consumed determined the risk of becoming obese, as it was noticed that the odds of being overweight and obese increased for adolescents that ate fufu and eru than those who ate fufu corn and ndole, okok and cassava, rice and ground-nut and others by 66%, 49%, 25% and 31% respectively. Besides, we observed that, those who brought fruits and vegetables to school, or pastries or sweet and candies had higher chances of being obese than those who brought cooked food to school. Applying the TPB, beliefs about the presence of factors that may facilitate or impede performance of the behavior and the perceived power of these factors (control beliefs). These control beliefs produce a behavioral control by impacting performance of the behavior; therefore, it is a belief that ultimately determines intention and action.

## CONCLUSION

The present findings indicate that obesity among school-attending in Yaoundé is a serious problem, which requires immediate attention, creating an awareness program in the schools and parents encouraging their children to be involved in more physical exercises, sports and outdoor activities, thus avoiding the march towards obesity. In fact,

overweight and obesity are pronounced risk factors for non-communicable diseases, especially for cardiovascular diseases which are a great public health problem. This condition is mostly observed in adult population, and to prevent this, overweight and obesity are to be treated at younger ages because those who are obese at younger ages have greater chances of being obese at adult ages. Recommendations for action include more physical education classes and promotion of healthy lunches at schools and of family suppers at home. Preventive public health actions should be targeted first toward low-income neighborhoods.

## ETHICAL CONSIDERATIONS

This study was done amongst secondary school adolescents, therefore a set of legal actions were done before the study is carried out. For the respect of ethics during research on human subjects, an ethical clearance was obtained from the ethical committee of the Catholic University of Central Africa following appropriate measures (N° 2017/0617/CEIRSH/ESS/MSP). Also, the school signed an agreement (the informed consent) since as they were considered as the pupil's guardians, which permitted us to work with their students.

## COMPETING INTERESTS

The authors declare that they have no competing interests.

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