

Research Article

Cardiovascular Risk Factors Among Secondary School Adolescents in the City of Garoua, Cameroon

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Abstract

While traditionally considered as a period of good health, adolescence with contemporary lifestyles and environmental factors is facing an alarming rise in cardiovascular risk factors. This was a school based cross sectional study including adolescents aged 10 to 19 years old in the city of Garoua. Physical activity, smoking, overweight, obesity, elevated blood pressure, hypertension, prediabetes and diabetes were evaluated. We included 938 participants (68.8% female) with a mean age of 16 ± 2 years. The most frequent risk factor was physical inactivity (52.8%). Overweight/obesity was more frequent in private schools ($ORa = 2.76 [1.80 - 4.22]$, $p < 0.001$). Prediabetes/diabetes was significantly more frequent in the [10-15[age category, in female participants, and in private schools ($ORa = 2.16 [1.53 - 3.07]$; $p < 0.001$, $ORa = 1.50 [1.01 - 2.22]$; $p = 0.045$, and $ORa = 2.56 [1.79 - 3.66]$; $p < 0.001$ respectively). Physical inactivity was significantly more frequent in female students and in the [10-15[age category ($ORa = 2.22 [1.68 - 2.95]$; $p < 0.001$ and $ORa = 1.37 [1.04 - 1.82]$; $p = 0.026$ respectively). Male adolescents had 7-fold higher risk of smoking. There was no significant difference in the proportions of elevated blood pressure/hypertension, and abdominal obesity. Cardiovascular risk factors are present among secondary school adolescents in the city of Garoua. Public health policies should be implemented for the prevention and early management of these risk factors.

Keywords

Cardiovascular Risk Factors, School, Adolescents, Cameroon

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Cardiovascular diseases are among the leading causes of death globally, with a high burden particularly in low-middle income countries [1]. Teenagers are not left aside. Many risk factors are present since young age. While traditionally considered as a period of good health, adolescence with contemporary lifestyles and environmental factors is facing an alarming rise in cardiovascular risk factors [2]. Rodrigez et al found in the central region of Portugal, prevalences of abdominal obesity, overweight and obesity of 15.5%, 6.1% and 21.9% respectively [3]. In Sub Saharan Africa, a systematic review by Kwansa et al described high prevalence levels of childhood, and adolescence obesity in countries such as Sierra Leone 16.9%, Cameroon 15.6% and Malawi 14.5% [4]. It is well known that cardiovascular risk factors in childhood are associated to cardiovascular diseases later in life [5]. Therefore, their prevention and management may reduce the overall burden of cardiovascular disease. Much is known about these factors in developed countries but little scientific evidence exists in sub-Saharan African countries, and in Cameroon in particular. In a previous study in the southern part of the country in 2023, Kamdem et al studied 771 adolescents and found respectively 11.5%; 5.6%; 5.4%, and 3.0% for overweight/obesity, abdominal obesity, smoking, glucose homeostasis abnormalities, and high blood pressure [6]. A better characterization of both presence and number of risk factors in young people in all regions of our country can significantly contribute to the implementation of early prevention strategies that may modify their natural history, and prevent cardiovascular disease onset. This study aimed to contribute with valuable data to inform public health strategies, to reduce the burden of cardiovascular risk factors among school youth in Cameroon.

2. Materials and Methods

2.1. Study Design, Setting and Duration

We conducted a school-based cross-sectional study from February to June 2024 in the city of Garoua, Benue division, North region, Cameroon.

2.2. Participants and Sampling

We included secondary school adolescents aged 10 to 19 years who accepted to participate and whose parents gave written informed consent. Our sample was selected using a multistage cluster random sampling method. In the first stage, the population was divided in two clusters represented by the Garoua 1 and Garoua 2 health districts. In the second stage, three public and private schools respectively, were randomly selected in each health district. In the third stage, we randomly selected classes, then 100 students who fulfilled the inclusion criteria, in each school.

1. Introduction

The minimum sample size was determined using the Cochran's formula as follows:

$$n = \frac{[(Z_{crit})^2 P (1-P)] \sigma}{D^2}$$

With:

P = prevalence of Cardiovascular Risk Factors, we used the prevalence of 38.4% reported by Kamdem et al in Douala, Cameroon in 2023 [6].

D = degree of accuracy (5%)

Z = standard normal variation. With a confidence interval to be 95% and by accepting an error of 5%, level of significance (α) 0.05, it corresponds to 1.96.

n = minimum sample size = 364

Considering an anticipated 10% non-response rate, we had to include a minimum of 401 students.

2.3. Procedure

We obtained for this study an ethical clearance of the institutional ethics committee for research in human health of the University of Douala. We also had a research authorization of the school medicine inspectorate of the regional delegation for secondary education of the North region. We had a little talk with students on cardiovascular diseases and their risk factors, the importance of an early detection and management. Students selected received an information sheet, and consent form for their parents to fill and sign. The students were explained on how to fill the consent form, and told to be fasting for at least 8 hours prior to blood testing. The next morning, we collected the signed consent forms, then the questionnaires were filled. Anthropometric parameters were measured and fasting blood sugar (FBS) tested. The information collected concerned socio-demographic data (age, gender, class, school), medical history and life style (smoking, alcohol habits, physical activity), and family history (diabetes, hypertension, obesity, others). Participants were considered as occasional smoker when smoking less than one cigarette a day. Occasional alcohol consumption was considered for taking at least one drink in 7 days.

2.4. Physical Activity Assessment

Physical activity (PA) was assessed using a modified version of the International Physical Activity Questionnaire (IPAQ) short form. The questionnaire was modified according to recent validated studies. The modified version covered four domains of PA: (1) school-related PA including activity during physical education classes and breaks, (2) transportation, (3) housework and (4) leisure time. In each of the four domains, the numbers of days per week and time per day spent in walking, moderate activity and vigorous activity were recorded, and used to calculate Metabolic Equivalent

Task (METs) minutes per week. A MET is the ratio of the metabolic work rate to the resting metabolic rate. One MET is defined as 1 Kcal/kg/hour, and is roughly equivalent to the energy cost of sitting quietly. The intensity of physical activity is considered as light intensity for activities requiring less than 3.0 METs like walking at a leisure pace or standing in line at the store; moderate intensity for activities requiring 3.0 to 6.0 METs like walking briskly and vigorous intensity for activities requiring more than 6.0 METs examples walking very quickly, running [7].

Participants' PA level was classified as:

- High (vigorous-intensity activity on at least three days achieving a minimum total PA of 1500 MET min/week or seven or more days of any combination of walking, moderate intensity or vigorous intensity activities achieving at least 3000 MET min/week total PA),
- Moderate (three or more days of vigorous intensity activity and/ or walking of at least 30 min per day; or at least five days of moderate intensity activity and/or walking of at least 30 min per day or at least five days of any combination of walking, moderate intensity or vigorous intensity activities achieving a minimum total PA of 600 MET min/week).
- Low (not meeting any of the criteria for either moderate or high levels of PA).

2.5. Anthropometric Measurements

Weight was measured using a SECA® analog Scale while the student was standing at the center of the scale, and dressed in light clothes without shoes. Height was measured using a stadiometer graduated in centimeters. Students were standing upright arms hanging along the body, palms facing thighs, barefoot and head placed according to Frankfurt plan. The data obtained were projected onto world health organization curves for assessment of nutritional status. Body mass index (BMI) was calculated as the ratio of weight in kilograms divided by the square of height in meters. BMI between the 85th and 95th percentile was considered as overweight, while obesity was considered when BMI was greater than 95th percentile [8]. Waist circumference (WC) was measured with a metric tape graduated in centimeters, midway between the lowest rib and the iliac crest to the nearest 0.1 cm after inhalation and exhalation. Waist to height ratio (WHtR) was calculated as the ratio of waist and height using the cut-off value of ≥ 0.5 [9].

2.6. Blood Pressure Measurements

We used an electronic BP monitor OMRON® 705 IT for children and adolescents with adapted cuffs according to standard recommendations. The students were in a quiet room, resting in a sitting position on a chair, with both feet on the ground, for at least 10 minutes. Blood pressure was measured twice with a 5 minutes interval. The cuff was placed 2 cm above the elbow joint and covered 2/3 arm's length. The values obtained were projected onto the 2017 National High Blood Pressure (NHBP) curves with respect to age and gender. Elevated blood pressure was considered for blood pressure between 90th and the 95th percentiles, and hypertension for blood pressure greater than the 95th percentile, with respect to age and gender [10].

2.7. Fasting Blood Sugar Measurements

FBS was obtained after eight hours overnight fasting using ONETOUCH® and ACCU CHEK® glucometers with appropriate test strips. Prediabetes and diabetes were defined according to the 2018 standards of medical care in diabetes of the American Diabetes Association [11].

Data was analyzed using Statistical Package for Social Sciences (SPSS) version 26.0. Quantitative variables were presented as mean \pm standard deviation, and qualitative variables as numbers and percentages. The Student T-test was used to compare means. The Chi-square test and multivariate logistic regression analysis were employed to determine factors associated with the presence of cardiovascular risk factors. Differences were considered statistically significant at $p < 0.05$.

3. Results

Figure 1 shows the flow chart of participants. We sampled 1200 students from both 3 public and 3 private secondary schools in both Garoua 1 and Garoua 2 health districts. The number of students who completed the study was 938. We had a female predominance (68.8%), and 55.6% were in public schools. Two third of the students were in lower secondary education level. We found a family history of hypertension, diabetes and obesity in respectively 22.7, 13.0 and 8.7% of cases (Table 1). There were significantly more female participants in public than in private schools (71.6% vs 63.0%; $p = 0.005$). The mean age was 16 ± 2 years. It was significantly higher in public than in private schools (16 ± 2 vs 15 ± 2 years; $p < 0.001$).

Table 1. Sociodemographic and lifestyle characteristics of the study population.

Variables	Categories	Number	Percentage (%)
Age group	[10 – 15]	333	35.5

Variables	Categories	Number	Percentage (%)
Gender	[15 – 20]	605	64.5
	Male	302	32.2
	Female	636	68.8
Type of school	Public	522	55.6
	Private	416	44.4
Level of secondary education	Lower*	622	66.3
	Upper**	316	33.7
Family history	Hypertension	213	22.7
	Diabetes	122	13.0
	Obesity	82	8.7
Physical activity level	Low	515	53.3
	Moderate	292	30.2
	High	159	16.5
Smoking		29	3.1
Alcohol consumption		166	17.7

*Lower: form 1 to 4; **Upper: form 5, lower sixth and upper sixth

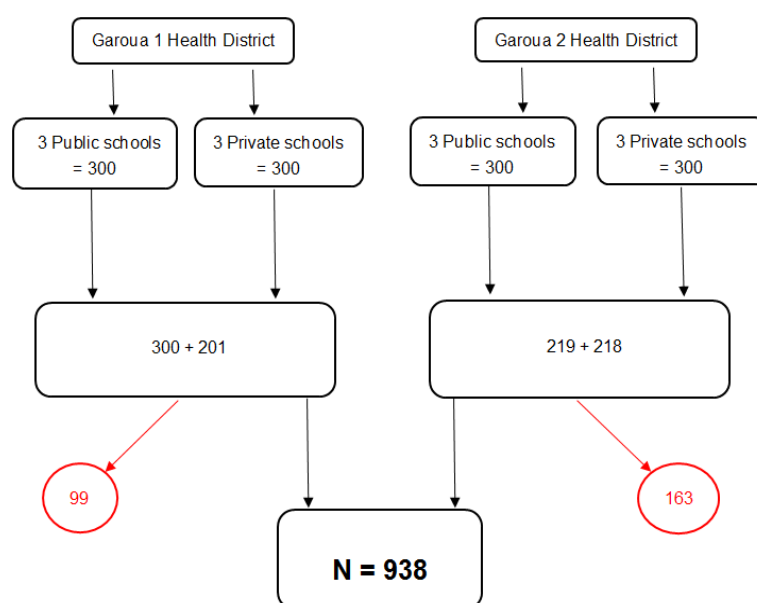


Figure 1. Flow chart of study participants.

Table 2 presents the prevalences of cardiovascular risk factors in the study population. The tree most frequent cardiovascular risk factors were low physical activity, which was present in more than half of the participants, prediabetes and overweight. Of note, 29 (3.1%) participants were smokers. We looked for factors associated with the presence of cardiovascular risk factors (Table 3). Low physical activity was significantly more frequent in female students and in the

[10-15[age category. The differences persisted even after multivariate analysis (ORa = 2.22 [1.68 – 2.95]; $p < 0.001$ and ORa = 1.37 [1.04 – 1.82]; $p = 0.026$ respectively). Overweight/obesity was more frequent in private schools and the difference persisted after adjustment for gender and age category (ORa = 2.76 [1.80 – 4.22], $p < 0.001$). Prediabetes/diabetes was significantly more frequent in the [10-15[age category, in female participants, and in private schools, even

after multivariate analysis (ORa = 2.16 [1.53 – 3.07]; $p < 0.001$, ORa = 1.50 [1.01 – 2.22]; $p = 0.045$, and ORa = 2.56 [1.79 – 3.66]; $p < 0.001$ respectively). Male students had 7-fold higher risk of smoking and were all aged 15 years or

more. There was no significant difference in the proportions of abdominal obesity. There was no significant difference in the proportion of elevated blood pressure/hypertension with respect to gender, age category and school type.

Table 2. Cardiovascular risk factors in the study population.

Variables	Number (Percentage)		
	Male (n=302)	Female (n=636)	All gender (N=938)
Overweight	31 (10.3)	62 (9.8)	93 (9.9)
Obesity	4 (1.3)	12 (1.9)	16 (1.7)
Elevated blood pressure	25 (8.3)	41 (6.5)	66 (7.0)
Hypertension	7 (2.3)	13 (2.0)	20 (2.1)
Prediabetes	44 (14.6)	115 (18.3)	159 (17.1)
Diabetes	0 (0.0)	3 (0.5)	3 (0.3)
Abdominal obesity (WC)	13 (4.3)	42 (6.6)	55 (5.9)
Abdominal obesity (WHtR)	12 (4.0)	46 (7.2)	58 (6.2)
Smoking	17 (5.6)	12 (1.9)	29 (3.1)
Low physical activity	119 (39.4)	376 (59.1)	495 (52.8)

WC: waist circumference; WHtR: waist to height ratio

Table 3. Factors associated to cardiovascular risk factors.

	Overweight and Obesity	Elevated blood pressure and hypertension	Prediabetes and diabetes
Gender			
Male	35 (11.6)	32 (10.6)	45 (14.9)
Female	75 (11.8)	55 (8.6)	125 (19.7)
OR (95% CI)	0.98 (0.64-1.50)	1.25 (0.79-1.98)	0.72 (0.49-1.04)
<i>p-value</i>	0.928	0.337	0.077
Age categories			
10-14	40 (12.1)	35 (10.6)	91 (27.6)
15-19	70 (11.5)	52 (8.6)	79 (13.0)
OR (95% CI)	1.06 (0.70-1.60)	1.27 (0.81-1.99)	2.55 (1.82-3.58)
<i>p-value</i>	0.782	0.301	<0.001
School type			
Public	38 (7.3)	43 (8.2)	60 (11.5)
Private	72 (17.3)	44 (10.6)	110 (26.4)
OR (95% CI)	0.37 (0.25-0.57)	0.76 (0.49-1.18)	0.36 (0.26-0.51)
<i>p-value</i>	<0.001	0.220	<0.001

OR: odds ratio; CI: confidence interval

Table 3. Continued.

	Abdominal obesity (WHtR)	Tobacco	Low physical activity
Gender			
Male	12 (4.1)	22 (7.3)	119 (39.4)
Female	46 (7.3)	7 (1.1)	376 (59.1)
OR (95% CI)	1.86 (0.97-3.56)	7.06 (2.98-16.72)	0.45 (0.34-0.59)
<i>p</i> -value	0.59	<0.001	<0.001
Age categories			
10-14	23 (7.1)	0 (0.0)	195 (59.1)
15-19	35 (5.8)	29 (4.8)	300 (49.3)
OR (95% CI)	0.81 (0.47-1.40)	/	1.48 (1.13-1.95)
<i>p</i> -value	0.445	<0.001	0.004
School type			
Public	35 (6.7)	21 (4.0)	267 (51.1)
Private	23 (5.7)	8 (1.9)	228 (54.8)
OR (95% CI)	0.83 (0.48-1.43)	2.14 (0.94-4.88)	0.86 (0.67-1.12)
<i>p</i> -value	0.502	0.065	0.265

WHtR: waist to height ratio; OR: odds ratio; CI: confidence interval

4. Discussion

We conducted this study in order to contribute with valuable data, to a better understanding of the burden of cardiovascular risk factors in adolescents in Cameroon. Some studies have been done in southern Cameroon [6, 12], but never in the North, which is geographically and culturally different. Similarly, we had a female predominance in our sample. The prevalence of low physical activity was also similar to the result of Kamdem et al [6], and its association to female gender has well-documented in the literature [13-15].

Overweight/obesity on the other hand was less frequent, and this may be explained by the fact that Cameroonians originating from the North are constitutionally thinner than in the South. Moreover, overweight/obesity was more frequent in private schools, likewise prediabetes/diabetes. This can be explained by the fact that adolescents in private schools, are more likely to come from high-income families, with easy access to high caloric food. It is known that private schools are expensive in Cameroon, and cannot be afforded by everyone [16]. Prediabetes/diabetes was also more frequent in younger students. This is concordant with the recent findings of Kandemir et al, in a report of 50-year experience in Turkey showing that the mean age at diagnosis of type 1 diabetes, the most frequent type of diabetes in adolescents, is

under 10 [17].

Regarding smoking, we found a low prevalence, like Kamdem et al, compare to the findings in Europe, Asia, America, and even in other sub-Saharan countries [6, 18-20]. Smoking is not well perceived in the Cameroonian society in general. We also found, like in the literature, a significantly higher risk of smoking in male adolescents.

Elevated blood pressure and hypertension prevalences were similar to the results of Chelo et al, and Kamdem et al in Cameroon [6, 21]. But it was lower than the findings of Ejike et al in Nigeria and Sungwa et al in Tanzania [22, 23]. This difference may be explained by different population characteristics, and differences in methodology. Moreover, we did not find any factors associated to elevated blood pressure/hypertension. In contrary, Sungwa et al found that, older age, female gender, obesity, overweight, eating fried food and not eating fruits, all increased significantly the odds of elevated blood pressure [23]. Some of these factors were not studied in our research.

5. Strengths and Limitations

This was a school-based study, and we used a multistage cluster random sampling method for the selection of participants. Our results can therefore be extrapolated to all the population of school adolescents of 10 to 19 years. However, our sample does not represent the entire population of equally

aged adolescents, since some of them are not enrolled in school. Moreover, we did not determine lipid profile. This is mainly due to the reticence of students and their parents, who did not want us to collect and carry their blood to the lab.

6. Conclusions

We conducted this study to contribute with valuable data, in order to inform public health strategies targeting cardiovascular risk factors among school adolescents in Cameroon. We found that cardiovascular risk factors are frequent among secondary school adolescents in the city of Garoua. Many appear to be more frequent in private schools, female and younger adolescents. Smoking odds was 7-fold higher in male students. Public health policies should be implemented for the prevention and early management of these risk factors. Long term follow-up studies are also needed, to determine outcomes in the affected students.

Abbreviations

BMI	Body Mass Index
FBS	Fasting Blood Sugar
IPAQ	International Physical Activity Questionnaire
MET	Metabolic Equivalent Task
NHBP	National High Blood Pressure
PA	Physical Activity
SPSS	Statistical Package for Social Sciences
WC	Waist Circumference
WhtR	Waist to Height Ratio

Author Contributions

Ba Hamadou: Conceptualization, Methodology, Validation

Jocelyn Tony Nengom: Conceptualization, Methodology, Validation

Dasso Pendo Maryam: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Validation

Jean Bugin: Conceptualization, Methodology, Validation

Chris Nad ège Nganou-Gnindjio: Visualization, Writing – original draft, Writing – review & editing

Dieudonn éDanwe: Visualization, Writing – original draft, Writing – review & editing

F òicit éKamdem: Supervision

Data Availability Statement

Data supporting the results of this study is available upon reasonable request to the corresponding author.

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The authors did not receive any fund for this study.

Conflicts of Interest

The authors declare no conflicts of interest.

References

- [1] Naghavi M, Ong KL, Aali A, Ababneh HS, Abate YH, Ababafati C, et al. Global burden of 288 causes of death and life expectancy decomposition in 204 countries and territories and 811 subnational locations, 1990–2021: a systematic analysis for the Global Burden of Disease Study 2021. *The Lancet*. 2024; 403(10440): 2100–32. [https://doi.org/10.1016/S0140-6736\(24\)00367-2](https://doi.org/10.1016/S0140-6736(24)00367-2)
- [2] Hecht EM, Williams A-YP, Abrams GA, Passman RS. Cardiovascular Risk Factors in Young Adolescents: Results from the National Health and Nutrition Examination Survey 1988–2016. *South Med J*. 2021; 114(5): 261–5. <https://doi.org/10.14423/smj.0000000000001244>
- [3] Rodrigues D, Padez C, Machado-Rodrigues AM. Prevalence of abdominal obesity and excess weight among Portuguese children and why abdominal obesity should be included in clinical practice. *Acta Med Port*. 2018; 31(3): 159–64. <https://doi.org/10.20344/amp.9000>
- [4] Kwansa AL, Akparibo R, Cecil JE, Solar GI, Caton SJ. Risk Factors for Overweight and Obesity within the Home Environment of Preschool Children in Sub-Saharan Africa: A Systematic Review. *Nutrients*. 2022; 14(9). <https://doi.org/10.3390/nu14091706>
- [5] Kartiosuo N, Raitakari OT, Juonala M, Viikari JSA, Sinaiko AR, Venn AJ, et al. Cardiovascular Risk Factors in Childhood and Adulthood and Cardiovascular Disease in Middle Age. *JAMA Netw Open*. 2024; 7(6): e2418148. <https://doi.org/10.1001/jamanetworkopen.2024.18148>
- [6] Kamdem F, Bika L òe EC, Mekoulou Ndongo J, Ba H, Obe Meyong MAP, Fenkeu Kweban J, et al. Cardiovascular risk factors among Cameroonian adolescents: Comparison between public and private schools and association with physical activity practice—a cross-sectional study. *JRSM Cardiovasc Dis*. 2023; 12: 20480040231210371. <https://doi.org/10.1177/20480040231210371>
- [7] Robert-McComb JJ, Carnero EÁ, Iglesias-Guti érez E. Estimating Energy Requirements. In: Robert-McComb JJ, Norman RL, Zumwalt M, éditeurs. *The Active Female* [Internet]. New York, NY: Springer New York; 2014 [cit é 9 f évr 2025]. p. 411–49. Disponible sur: http://link.springer.com/10.1007/978-1-4614-8884-2_27
- [8] Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ*. 2000; 320(7244): 1240–3. <https://doi.org/10.1136/bmj.320.7244.1240>

- [9] Eslami M, Pourghazi F, Khazdouz M, Tian J, Pourrostami K, Esmaeili-Abdar Z, et al. Optimal cut-off value of waist circumference-to-height ratio to predict central obesity in children and adolescents: A systematic review and meta-analysis of diagnostic studies. *Front Nutr* [Internet]. Frontiers; 2023 [cité 9 févr 2025]; 9. Disponible sur: <https://www.frontiersin.org/journals/nutrition/articles/10.3389/fnut.2022.985319/full>
- [10] National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents. *Pediatrics*. 2004; 114(2 Suppl 4th Report): 555-76.
- [11] American Diabetes Association. 2. Classification and Diagnosis of Diabetes: Standards of Medical Care in Diabetes — 2018. *Diabetes Care*. 2017; 41(Supplement_1): S13-27. <https://doi.org/10.2337/dc18-s002>
- [12] Wamba PCF, Enyong Oben J, Cianflone K. Prevalence of Overweight, Obesity, and Thinness in Cameroon Urban Children and Adolescents. *J Obes*. 2013; 2013: 737592. <https://doi.org/10.1155/2013/737592>
- [13] Wenthe PJ, Janz KF, Levy SM. Gender Similarities and Differences in Factors Associated with Adolescent Moderate-Vigorous Physical Activity. *Pediatr Exerc Sci*. 2009; 21(3): 291-304. <https://doi.org/10.1123/pes.21.3.291>
- [14] Lenhart CM, Hanlon A, Kang Y, Daly BP, Brown MD, Patterson F. Gender Disparity in Structured Physical Activity and Overall Activity Level in Adolescence: Evaluation of Youth Risk Behavior Surveillance Data. *ISRN Public Health*. 2012; 2012: 1-8. <http://dx.doi.org/10.5402/2012/674936>
- [15] Shao T, Zhou X. Correlates of physical activity habits in adolescents: A systematic review. *Front Physiol*. Frontiers; 2023; 14. <https://doi.org/10.3389/fphys.2023.1131195>
- [16] Eboue R, Dudjo Yen GB. L'impact de l'offre privée d'éducation sur le taux de scolarisation au secondaire : cas du Cameroun. *Rev Econ Gest Soci* 2021; 1(31). <https://doi.org/10.48382/IMIST.PRSM/regs-v1i31.27632>
- [17] Kandemir N, Vuralli D, Ozon A, Gonc N, Ardicli D, Jalilova L, et al. Epidemiology of type 1 diabetes mellitus in children and adolescents: A 50-year, single-center experience. *J Diabetes*. 2024; 16(5): e13562. <https://doi.org/10.1111/1753-0407.13562>
- [18] Morgenstern M, Sargent JD, Engels RCME, Florek E, Hanewinkel R. Smoking in European adolescents: Relation between media influences, family affluence, and migration background. *Addict Behav*. 2013; 38(10): 2589-95. <https://doi.org/10.1016/j.addbeh.2013.06.008>
- [19] Han J, Chen X. A Meta-Analysis of Cigarette Smoking Prevalence among Adolescents in China: 1981-2010. *Int J Environ Res Public Health*. 2015; 12(5): 4617-30. <https://doi.org/10.3390/ijerph120504617>
- [20] Tezera N, Endalamaw A. Current Cigarette Smoking and Its Predictors among School-Going Adolescents in East Africa: A Systematic Review and Meta-Analysis. *Int J Pediatr*. 2019; 2019: 4769820. <https://doi.org/10.1155/2019/4769820>
- [21] Chelo D, Mah EM, Chiabi EN, Chiabi A, Koki Ndombo PO, Kingue S, et al. Prevalence and factors associated with hypertension in primary school children, in the centre region of Cameroon. *Transl Pediatr*. 2019; 8(5): 391-7. <https://doi.org/10.21037/tp.2019.03.02>
- [22] Ejike CE, Ugwu CE, Ezeanyika LU. Variations in the prevalence of point (pre)hypertension in a Nigerian school-going adolescent population living in a semi-urban and an urban area. *BMC Pediatr*. 2010; 10: 13. <https://doi.org/10.1186/1471-2431-10-13>
- [23] Sungwa EE, Kibona SE, Dika HI, Laisser RM, Gemuhay HM, Kabalimu TK, et al. Prevalence and factors that are associated with elevated blood pressure among primary school children in Mwanza Region, Tanzania. *Pan Afr Med J*. 2020; 37: 283. <https://doi.org/10.11604/pamj.2020.37.283.21119>