



(RESEARCH ARTICLE)



PHYSICAL ACTIVITY, SEDENTARY BEHAVIOR AND WEIGHT STATUS AMONG SECONDARY SCHOOL STUDENTS IN DIVO, CÔTE D'IVOIRE: A CROSS-SECTIONAL STUDY

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ABSTRACT

Data on physical activity among Ivorian adolescents living outside Abidjan are scarce. This study assessed physical activity and sedentary behavior among secondary school students in Divo and examined their association with weight status. A cross-sectional survey was conducted from December 2024 to January 2025 among 400 students aged 11 to 22 years in two schools. Movement behaviors were collected by questionnaire, and weight and height were measured. Weight status was based on WHO 2007 BMI-for-age z-scores, with adult cut-offs for students aged 20 to 22 years. Each indicator was tested in a logistic model adjusted for sex and age, and the BMI-for-age z-score was analyzed by linear regression among 11–19-year-olds. Only 10.8% of students took part in physical activity outside physical education classes, mostly school football among boys. Most students (83.2%) walked to school, and 80.2% reported at least 5 hours of screen time per day at weekends. Lack of motivation was mainly cited by girls. Overweight or obesity affected 6.5% of students and thinness 2.0%. Four or more hours of inactivity per day was associated with overweight (aOR = 3.16; 95% CI: 1.32–7.56), and the absence of an active trip of at least 15 minutes was associated with a higher BMI-for-age z-score ($\beta = +0.37$; 95% CI: 0.21 to 0.54). Promoting school sport, especially for girls, and keeping walking to school safe should be priorities.

Keywords: Adolescents; Physical activity; Sedentary behavior; Screen time; Active commuting; Overweight

1 INTRODUCTION

In children and adolescents, physical activity is linked to better physical, psychological and cognitive health, and the benefits are clearest for moderate-to-vigorous activity [1]. The World Health Organization (WHO) recommends that young people aged 5 to 17 years accumulate an average of 60 minutes of such activity per day and limit sedentary time, particularly recreational screen time [2]. These recommendations are poorly followed. In 2016, 81.0% of school-going adolescents aged 11 to 17 years worldwide were insufficiently active, girls more than boys [3]. In sub-Saharan Africa, a study in nine communities across seven countries found low physical activity in 82% to 90% of adolescents [4].

This lack of activity occurs during a nutrition transition in which overweight is rising while undernutrition persists. Among students in nine sub-Saharan African countries, 12.7% were overweight and 3.2% obese, with girls more affected [5]. In Côte d'Ivoire, the coexistence of undernutrition and overweight has been described among adolescents in Abidjan [6] and among schoolchildren in the south-central part of the country [7], but studies on adolescent nutrition remain few, most of them focusing on younger children [8]. Systematic reviews show that high physical activity combined with low sedentary time goes with healthier adiposity in young people [9], and that adolescents who walk or cycle to school more often have a favorable body composition [10].

In Divo, a secondary town in central-western Côte d'Ivoire, there are no data on how active students are or on how their activity relates to their weight status. This study therefore asked: how physically active and how sedentary are secondary school students in Divo, and are these behaviors associated with their weight status? The general objective was to assess physical activity and sedentary behavior among these students and to analyze their association with weight status. The specific objectives were: (1) to measure, by sex, participation in physical activity outside physical education (PE), active commuting to school, play time, screen time and inactive time, and to identify barriers to activity; (2) to determine the prevalence of thinness and overweight; and (3) to analyze the association between physical activity and sedentary behavior indicators and weight status.

2 MATERIALS AND METHODS

2.1 Study design, setting and population

A cross-sectional study was conducted from 12 December 2024 to 13 January 2025 in Divo, capital of the Lôh-Djiboua region. The report follows the STROBE recommendations for cross-sectional studies [11]. Participants were general secondary school students, from the first year of lower secondary (6^e) to the final year (Terminale), enrolled at Lycée Moderne 3 de Divo (public) and Cours Secondaire Élite de Divo (private). Sampling was non-probabilistic (convenience sampling). The classes surveyed were those on the timetable of student teachers from the École Normale Supérieure d'Éducation Physique et Sportive (ENSEPS), and all students present during the PE classes of these groups were invited to take part. Of the 435 survey forms collected, 35 were excluded because they were incomplete (missing sociodemographic, dietary or anthropometric data) or unusable (illegible or inconsistent answers), leaving 400 students for analysis (Figure 1). No sample size was calculated beforehand; with 400 students, a prevalence of 50% is estimated with a precision of ± 4.9 percentage points (95% confidence interval).

2.2 Data collection

The ENSEPS student teachers administered a questionnaire during PE classes. It covered sociodemographic characteristics (sex, age, class) and movement behaviors: PE participation and weekly duration, exemption, physical activity outside PE (type, setting, training time), mode and duration of the trip between home and school, time spent playing after school, time spent walking around and doing housework at weekends, daily inactive time, daily screen time at weekends and the main barrier to physical activity.

Weight was measured with a SECA bathroom scale, with the student standing barefoot in light clothing. Height was measured with a wall-mounted stadiometer, with the student barefoot, heels, buttocks and back of the head against the board and the head in the Frankfort plane. Weight was recorded to the nearest kilogram and height to the nearest centimeter. Waist and hip circumferences were also measured with a tape measure, but were not analyzed for the reasons given in the discussion. Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2).

2.3 Definition of variables

For students aged 11 to 19 years (350 students), the BMI-for-age z-score was calculated from the LMS parameters of the WHO 2007 growth reference [12]. Because age was known only in completed years, mid-year age (age + 6 months) was used; for 19-year-olds, the last value of the reference (228 months) was applied. Thinness was defined as a z-score < -2 , overweight as $> +1$ and obesity as $> +2$ [12]. For the 50 students aged 20 to 22 years, adult BMI cut-offs were used

(thinness < 18.5; overweight 25–29.9; obesity ≥ 30 kg/m²). Overweight and obesity were combined as excess weight. No z-score fell outside the WHO plausibility limits (–5 and +5).

Physical activity and sedentary behavior indicators were defined before analysis: physical activity outside PE (yes/no); active commuting (walking or cycling); an active trip of at least 15 minutes; after-school play of at least 60 minutes, the reference duration in the WHO recommendations [2]; at least one hour of housework at weekends; at least 5 hours of screen time per day at weekends; and at least 4 hours of inactive time per day. The last two thresholds correspond approximately to the medians of the observed distributions.

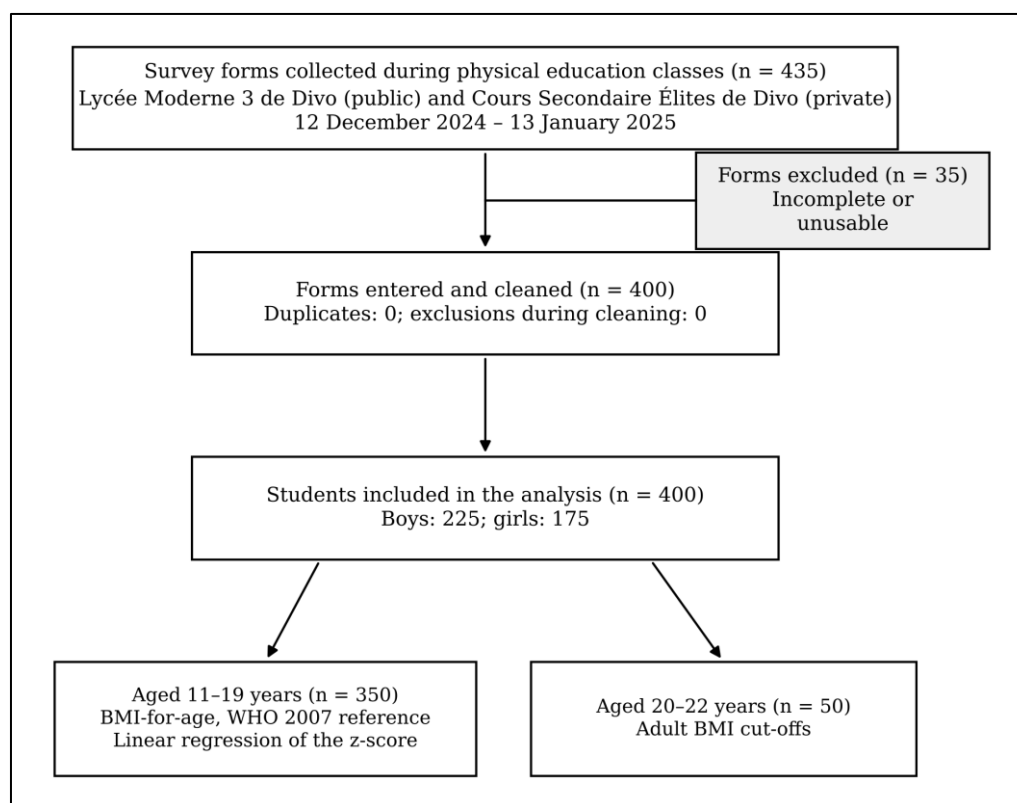


Figure 1: Flow diagram of participants

2.4 Control of bias

The same questionnaire and measurement protocol were used in both schools, during PE classes. Forms were anonymous, to reduce social desirability bias. Data entry errors were corrected with a reproducible script, and anthropometric values were checked against the WHO plausibility limits. Sex and age, potential confounders, were included in the regression models.

2.5 Statistical analysis

Categorical variables were described as counts and percentages, and durations as medians with interquartile ranges [IQR]. Prevalences were given with their 95% confidence intervals (95% CI, Wilson method). Boys and girls were compared with Pearson's χ^2 test (or Fisher's exact test, or a Monte Carlo χ^2 test when expected counts were below 5), Welch's t-test for anthropometric measures and the Mann-Whitney test for durations. Given the small number of students with excess weight (26), each indicator was tested separately in a logistic regression model adjusted for sex and age group, which limits the number of parameters estimated [13]. In addition, the BMI-for-age z-score of 11–19-year-olds was analyzed as a continuous outcome by linear regression adjusted for sex and age. Results are expressed as crude (cOR) and adjusted (aOR) odds ratios and as regression coefficients (β) with their 95% CI. No data were missing for the variables analyzed. As sampling was not probabilistic, no weighting was applied, and no sensitivity analysis was performed. Statistical significance was set at 5%. Data were cleaned and analyzed with reproducible Python scripts (pandas, SciPy, statsmodels), and each correction was recorded in a cleaning log.

3 RESULTS

3.1 Characteristics of the students

The 400 students included 225 boys (56.2%) and 175 girls (43.8%), with a mean age of 16.2 ± 2.5 years; 53.8% were in lower secondary school (Table 1).

Table 1: Characteristics of the students by sex, n (%)

Characteristic	Boys	Girls	Total	p
Number	225 (56.2)	175 (43.8)	400 (100)	
Age (years), mean $\pm$ SD	16.4 $\pm$ 2.5	15.9 $\pm$ 2.4	16.2 $\pm$ 2.5	0.059
Age group				0.050
11–14 years	54 (24.0)	46 (26.3)	100 (25.0)	
15–17 years	99 (44.0)	92 (52.6)	191 (47.8)	
18–22 years	72 (32.0)	37 (21.1)	109 (27.2)	
School cycle				0.695
Lower secondary	119 (52.9)	96 (54.9)	215 (53.8)	
Upper secondary	106 (47.1)	79 (45.1)	185 (46.2)	
Family type				0.200
Two-parent	158 (70.2)	133 (76.0)	291 (72.8)	
Single-parent	59 (26.2)	40 (22.9)	99 (24.8)	
Not specified	8 (3.6)	2 (1.1)	10 (2.5)	
Mother's education				0.069
No schooling	46 (20.4)	42 (24.0)	88 (22.0)	
Primary	60 (26.7)	45 (25.7)	105 (26.2)	
Secondary	54 (24.0)	57 (32.6)	111 (27.8)	
Higher	31 (13.8)	17 (9.7)	48 (12.0)	
Not specified	34 (15.1)	14 (8.0)	48 (12.0)	
Student's source of money				< 0.001
None	101 (44.9)	39 (22.3)	140 (35.0)	
Pocket money	98 (43.6)	114 (65.1)	212 (53.0)	
Small jobs/other	26 (11.6)	22 (12.6)	48 (12.0)	

SD: standard deviation. p: Student's t-test (age); Pearson's χ^2 or Monte Carlo χ^2 test (family type).

3.2 Physical activity and sedentary behavior

Almost all students took part in PE (399 of 400), for 2 hours per week in 398 cases. This is the official PE time in general secondary education [14], which was still in force at the time of the survey. This near-universal participation partly reflects the recruitment of students during PE classes. Outside PE, 43 students (10.8%) were physically active, boys more often than girls (15.1% vs 5.1%; $p = 0.001$). The activity was football in 40 of 43 cases, practiced within the Ivorian School and University Sports Office (OISSU) by 39 students, with 2 hours of training per week. Students walked to school in 83.2% of cases, with a median trip of 15 minutes [IQR: 10–20]; 61.2% made an active trip of at least 15 minutes, with no difference between boys and girls (Table 2).

Girls spent more time than boys playing after school (60 minutes or more: 21.7% vs 9.3%; $p < 0.001$) and, above all, doing housework at weekends (one hour or more: 83.4% vs 9.3%; $p < 0.001$). Weekend screen time was high across the sample: no student reported less than 3 hours per day, 80.2% reported at least 5 hours and 14.8% at least 6 hours. At least 4 hours of inactive time per day was reported by 42.5% of students, more often by girls (48.6% vs 37.8%; $p =$

0.030). Lack of time was the most frequently cited barrier (58.5%), followed by lack of motivation (30.8%), which was reported by 43.4% of girls and 20.9% of boys ($p < 0.001$). Only 10.0% of students reported no barrier.

Table 2: Physical activity, sedentary behavior and barriers to activity by sex, n (%)

Indicator	Boys (n = 225)	Girls (n = 175)	Total (n = 400)	p
Physical activity outside PE				0.001
Yes	34 (15.1)	9 (5.1)	43 (10.8)	
No	191 (84.9)	166 (94.9)	357 (89.2)	
Mode of travel to school				0.853
Active (walking, cycling)	188 (83.6)	145 (82.9)	333 (83.2)	
Motorized	37 (16.4)	30 (17.1)	67 (16.8)	
Active trip ≥ 15 min				0.386
Yes	142 (63.1)	103 (58.9)	245 (61.2)	
No	83 (36.9)	72 (41.1)	155 (38.8)	
Active play after school				< 0.001
≥ 60 min	21 (9.3)	38 (21.7)	59 (14.8)	
< 60 min	204 (90.7)	137 (78.3)	341 (85.2)	
Housework at weekends				< 0.001
≥ 1 h	21 (9.3)	146 (83.4)	167 (41.8)	
< 1 h	204 (90.7)	29 (16.6)	233 (58.2)	
Weekend screen time (per day)				0.516
< 5 h	47 (20.9)	32 (18.3)	79 (19.8)	
≥ 5 h	178 (79.1)	143 (81.7)	321 (80.2)	
Inactive time per day				0.030
< 4 h	140 (62.2)	90 (51.4)	230 (57.5)	
≥ 4 h	85 (37.8)	85 (48.6)	170 (42.5)	
Main barrier to physical activity				< 0.001
Lack of time	144 (64.0)	90 (51.4)	234 (58.5)	
Lack of motivation	47 (20.9)	76 (43.4)	123 (30.8)	
Lack of facilities	0 (0.0)	3 (1.7)	3 (0.8)	
None	34 (15.1)	6 (3.4)	40 (10.0)	
Durations, median [IQR] (minutes)				
Home-school trip	15 [10–20]	15 [10–20]	15 [10–20]	0.051
Play after school (per day)	10 [10–20]	20 [12–30]	20 [10–30]	< 0.001
Walking around at weekends	120 [120–180]	180 [120–180]	180 [120–180]	0.003
Housework at weekends	20 [10–30]	60 [60–120]	30 [10–60]	< 0.001
Inactive time (per day)	180 [180–240]	180 [180–240]	180 [180–240]	0.015
Screen time at weekends (per day)	300 [300–300]	300 [300–300]	300 [300–300]	0.010

PE: physical education; IQR: interquartile range. p: Pearson's χ^2 test (Monte Carlo χ^2 for barriers); Mann-Whitney test for durations.

3.3 Weight status

Mean BMI was $20.4 \pm 2.3 \text{ kg/m}^2$, with no difference between boys and girls ($p = 0.369$). Among 11–19-year-olds, the mean BMI-for-age z-score was -0.19 ± 0.80 . Excess weight affected 26 students, or 6.5% (95% CI: 4.5–9.4), including 25 overweight and 1 obese students; thinness affected 8 students (2.0%; 95% CI: 1.0–3.9). Weight status did not differ by sex ($p = 0.455$) or by age group ($p = 0.428$) (Table 3).

Table 3: Anthropometric measures and weight status by sex

Variable	Boys (n = 225)	Girls (n = 175)	Total (n = 400)	p
Height (cm)	162.8 ± 8.8	159.7 ± 6.8	161.4 ± 8.1	< 0.001
Weight (kg)	54.4 ± 8.9	51.7 ± 7.7	53.2 ± 8.5	0.001
BMI (kg/m^2)	20.4 ± 2.2	20.2 ± 2.3	20.4 ± 2.3	0.369
BMI-for-age z-score, 11–19 years (n = 350)	-0.18 ± 0.82	-0.20 ± 0.77	-0.19 ± 0.80	0.754
Weight status, n (%)				0.455
Thinness	6 (2.7)	2 (1.1)	8 (2.0)	
Normal	206 (91.6)	160 (91.4)	366 (91.5)	
Overweight	12 (5.3)	13 (7.4)	25 (6.2)	
Obesity	1 (0.4)	0 (0.0)	1 (0.2)	
Excess weight (overweight + obesity)	13 (5.8)	13 (7.4)	26 (6.5)	

Mean $\pm$ standard deviation. BMI: body mass index. Weight status: WHO 2007 BMI-for-age for 11–19-year-olds (thinness < -2 z; overweight $> +1$ z; obesity $> +2$ z), adult cut-offs for 20–22-year-olds. p: Welch's t-test; Monte Carlo χ^2 test for weight status.

3.4 Association between physical activity, sedentary behavior and weight status

Excess weight was more frequent among students reporting at least 4 hours of inactive time per day (10.6%) than among the others (3.5%), and the association remained after adjustment for sex and age (aOR = 3.16; 95% CI: 1.32–7.56; $p = 0.010$). These students also had a higher BMI-for-age z-score ($\beta = +0.20$; 95% CI: 0.04 to 0.37; $p = 0.018$). Not making an active trip of at least 15 minutes ($\beta = +0.37$; 95% CI: 0.21 to 0.54; $p < 0.001$) and motorized travel to school ($\beta = +0.32$; 95% CI: 0.10 to 0.54; $p = 0.005$) were also associated with a higher z-score, although their association with excess weight was not statistically significant (aOR = 1.84; 95% CI: 0.82–4.13 and aOR = 1.60; 95% CI: 0.61–4.18). In the bivariate analysis, excess weight was more frequent among students who played for at least 60 minutes after school (13.6% vs 5.3%; $p = 0.038$), but the difference disappeared after adjustment for sex and age. Physical activity outside PE, housework and screen time were associated neither with excess weight nor with the z-score (Table 4).

Table 4: Association between physical activity and sedentary behavior indicators and weight status (each indicator tested separately, adjusted for sex and age)

Indicator	Excess weight n/N (%)	cOR (95% CI)	aOR (95% CI)	p	BMI z-score, adjusted β (95% CI) (n = 350)	p
Physical activity outside PE						
Yes	4/43 (9.3)	1 (Ref.)	1 (Ref.)		0 (Ref.)	
No	22/357 (6.2)	0.64 (0.21– 1.95)	0.53 (0.16– 1.72)	0.287	-0.08 (-0.34 to 0.18)	0.554
Mode of travel to school						
Active (walking, cycling)	20/333 (6.0)	1 (Ref.)	1 (Ref.)		0 (Ref.)	
Motorized	6/67 (9.0)	1.54 (0.59– 3.99)	1.60 (0.61– 4.18)	0.336	+0.32 (0.10 to 0.54)	0.005
Active trip ≥ 15 min						

Yes	12/245 (4.9)	1 (Ref.)	1 (Ref.)		0 (Ref.)	
No	14/155 (9.0)	1.93 (0.87–4.29)	1.84 (0.82–4.13)	0.137	+0.37 (0.21 to 0.54)	< 0.001
Play after school						
≥ 60 min	8/59 (13.6)	1 (Ref.)	1 (Ref.)		0 (Ref.)	
< 60 min	18/341 (5.3)	0.36 (0.15–0.86)	0.40 (0.14–1.09)	0.072	-0.10 (-0.34 to 0.14)	0.417
Housework at weekends						
≥ 1 h	14/167 (8.4)	1 (Ref.)	1 (Ref.)		0 (Ref.)	
< 1 h	12/233 (5.2)	0.59 (0.27–1.32)	0.47 (0.15–1.47)	0.195	-0.08 (-0.32 to 0.16)	0.513
Screen time at weekends (per day)						
< 5 h	5/79 (6.3)	1 (Ref.)	1 (Ref.)		0 (Ref.)	
≥ 5 h	21/321 (6.5)	1.04 (0.38–2.84)	1.05 (0.38–2.88)	0.928	+0.08 (-0.13 to 0.29)	0.434
Inactive time (per day)						
< 4 h	8/230 (3.5)	1 (Ref.)	1 (Ref.)		0 (Ref.)	
≥ 4 h	18/170 (10.6)	3.29 (1.39–7.75)	3.16 (1.32–7.56)	0.010	+0.20 (0.04 to 0.37)	0.018

cOR: crude odds ratio; aOR: adjusted odds ratio (logistic regression, n = 400, adjusted for sex and age group); β : difference in BMI-for-age z-score (linear regression among 11–19-year-olds, adjusted for sex and age in years); Ref.: reference category; PE: physical education.

4 DISCUSSION

Secondary school students in Divo move mainly to get to school; very few take part in physical activity outside PE, and their weekend screen time is high. Excess weight remains uncommon (6.5%), but it is associated with inactive time and, when weight status is measured on a continuous scale, with the absence of an active trip to school.

The low level of physical activity outside PE (10.8%) is in line with global findings, where four in five school-going adolescents are insufficiently active [3], and with sub-Saharan Africa, where low physical activity affects 82% to 90% of adolescents [4]. With 2 hours per week, the time set for all levels of general secondary education [14], PE provides on average only about 17 minutes of activity per day, only part of which is moderate to vigorous. This is far below the 60 minutes per day recommended by WHO [2]. The figure also contrasts with the 41.5% of out-of-school sport participation reported among obese adolescents in Abidjan [15]. In Divo, physical activity outside school relies almost entirely on football organized by the OISSU and involves mostly boys: only 9 of 175 girls were active outside PE.

This gap between boys and girls is found in most countries [3]. Lack of motivation, cited by more than four girls in ten, and the time girls spend on housework at weekends suggest that social and domestic constraints weigh on their activity. A synthesis of qualitative studies among adolescents in sub-Saharan Africa and India also stressed the weight of social influences and body image, particularly among girls [16]. A school sport offer centered on football does not seem to meet girls' expectations.

Walking to school (83.2%) is the main source of daily physical activity for these students. This proportion is well above the average of 55% observed among adolescents in 31 Asian countries [17], and it probably reflects a lack of transport more than a health choice. Students who did not make an active trip of at least 15 minutes had a higher BMI z-score (β = +0.37; 95% CI: 0.21 to 0.54). This agrees with the study by Martin-Moraleda et al. [10], in which most studies linked active commuting to a more favorable body composition. Keeping this mode of travel as the town becomes more motorized is therefore a prevention issue.

Weekend screen time was high, although WHO recommends limiting recreational screen time [2]. It was not associated with weight status, probably because it varied little (most students reported 5 hours) and covered only weekends. Daily inactive time, on the other hand, was associated with excess weight (aOR = 3.16; 95% CI: 1.32–7.56). This is consistent

with the study by Saunders et al. [9], in which the combination of low physical activity and high sedentary time went with less healthy adiposity in young people. The bivariate link between long play time and excess weight, which disappeared after adjustment, is most likely explained by sex and age: girls and younger students reported more play time and were slightly more often overweight.

The prevalence of excess weight (6.5%) is lower than among students in nine sub-Saharan African countries (12.7% overweight and 3.2% obese) [5], the 16% found among adolescents in low-income neighborhoods of Abidjan [6] and the 15% overweight reported among schoolchildren in Taabo [7]. It is higher, however, than the 1.82% of overweight students recorded at school medical visits in the Koumassi district of Abidjan, where different classification criteria were used [15], and close to national values in Senegal, where 5.9% of adolescents were overweight and 1.8% obese [18]. Thinness (2.0%) was much less frequent than in Senegal (21.7%) [18]. Divo thus appears to be at an intermediate stage of the nutrition transition: excess weight is still limited, but behaviors that favor its rise (inactivity, high screen time, little sport) are already well established.

This study has several limitations. Its cross-sectional design does not establish the direction of the associations, since excess weight may itself reduce activity. Physical activity and sedentary behavior were measured with a non-validated questionnaire, without measuring intensity or estimating energy expenditure, and the reported durations are subject to recall error. Screen time covered weekends only. The small number of students with excess weight (26) limited statistical power and did not allow a full multivariable model. Age was known only in completed years, which makes the z-scores approximate, and students aged 20 to 22 years were classified with adult cut-offs. Waist circumference was measured but not used: mean values were higher in girls (78.0 cm) than in boys (70.5 cm) and weakly correlated with BMI ($r = 0.36$ in girls and 0.20 in boys), which suggested measurement error. Convenience sampling, limited to the classes of ENSEPS student teachers in two schools, does not ensure that the sample represents all students in Divo, and because each student teacher surveyed his or her own classes, an interviewer effect cannot be excluded. Recruitment during PE classes may have under-represented exempted or absent students, who may also be the least active. Finally, the study covers a single town.

5 CONCLUSION

Secondary school students in Divo are not very active outside PE and the trip to school, and their weekend screen time is high. Daily inactive time is associated with excess weight, and the absence of an active trip to school with a higher BMI. Broadening school sport beyond football to reach girls, making walking routes to school safe and reducing weekend screen time are priorities for action.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

Statement of ethical approval

The survey was carried out following a request for authorization sent by the Director of ENSEPS to the heads of the schools where ENSEPS students were completing their teaching placements. The forms did not include students' names and the data were processed anonymously.

Statement of informed consent

Verbal informed consent was obtained from the students or their parents before the questionnaire was administered.

Authors' contributions

Koffi DIALLO: study design and first draft of the manuscript; Rebecca ASSA épouse YAO: correction of the manuscript; Béhiblo Antoinette YOBOUET: review of the data analyses; Gbehe Jean Jaurès GNABRO: survey and processing of the forms; N'Guessan KOUAME, Doudjo SORO and Nogbou Emmanuel ASSIDJO: supervision. All authors read and approved the final manuscript.

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