




Adherence to '5-2-1-0' guidelines and multiple risky behaviours among adolescents in nine sub-Saharan African countries: evidence from Global School-based Student Health Survey 2012–2017

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ABSTRACT

Objective Overweight and obesity constitute a new challenge in low-income and middle-income countries. The obesity prevention programme, called '5-2-1-0', promotes healthy eating habits, physical activity and limited screen time among young people.

This study aimed to assess adherence to the '5-2-1-0' recommendations and to study multiple risky behaviours among adolescents in nine countries in sub-Saharan Africa.

Methods Meta-analyses with a random effect were used to calculate overall prevalence. Non-random patterns of the co-occurrence of the four risky behaviours were explored using observed/expected prevalence ratios. Data came from the Global School-based Health Survey and 18 314 adolescents were considered.

Results Among the participants, 12.7% (95% CI 7.5% to 19.0%) had overweight and 3.2% (95% CI 1.1% to 6.1%) had obesity. In almost all countries studied, girls were more affected by overweight and obesity than boys. While only 0.2% (95% CI 0.1% to 0.4%) of the adolescents fully complied with the recommendations, 4.8% (95% CI 3.1% to 6.9%), 28.4% (95% CI 22.4% to 34.8%), 43.8% (95% CI 41.9% to 45.8%) and 17.0% (95% CI 11.8% to 23.0%), respectively, combined 1, 2, 3 and 4 risky behaviours among the four '5-2-1-0' criteria. The most observed combination was found for co-occurrence of three risky behaviours: insufficient fruit/vegetables consumption, physical activity and non-zero consumption of sugar-sweetened beverages.

Conclusion In conclusion, the insufficient adherence to '5-2-1-0' recommendations and the high prevalence of the co-occurrence of risky behaviours underscore the need to strengthen health interventions and programmes to prevent obesity among adolescents in sub-Saharan Africa.

INTRODUCTION

In recent years, prevalence rates of overweight and obesity have sharply increased in low-income and middle-income countries, constituting a new challenge in terms of prevention

WHAT IS ALREADY KNOWN ON THIS TOPIC

- ⇒ Adherence to '5-2-1-0' guidelines decreases children's risk of obesity and related morbidities in later life.
- ⇒ Adherence to '5-2-1-0' guidelines in sub-Saharan Africa is unknown.

WHAT THIS STUDY ADDS

- ⇒ More female adolescents were at risk of having overweight and obesity than males in sub-Saharan Africa.
- ⇒ Adherence to the '5-2-1-0' recommendations among adolescents was low and risky behaviours were present simultaneously.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- ⇒ Health interventions need to be strengthened among African adolescents considering the '5-2-1-0' guidelines.
- ⇒ The co-occurrence of risky behaviours needs to be considered in prevention programmes.

strategies,¹ a problem that coincides with existing problems of undernutrition. About 15% of adolescents in Africa have overweight or obesity.^{2,3} As childhood obesity has been significantly associated with cardiovascular and metabolic diseases in adulthood,⁴ representing a major public health problem that must be addressed to avoid multiple comorbidities in adulthood.⁵ It also has been shown that prevention programmes give better results in younger people, particularly when they are based on individual behaviour but also on the community aspect, and therefore, the environment.⁶

Result of genetic, socioeconomic but also cultural factors, obesity can also be partly

explained by poor lifestyle habits such as poor diet or a low level of physical activity.⁷ Therefore, it is important to understand and analyse the risky behaviours associated with obesity to reduce the existing disparities among adolescents. For instance, previous studies have shown that the prevalence of obesity is lower in adolescents with lower screen time.⁸ Other studies have shown that high consumption of sugar-sweetened beverages leads to overweight or obesity.^{9 10} Furthermore, a healthy diet and sufficient physical activity have also been shown to be particularly protective factors against overweight or obesity among adolescents.¹¹

Since its creation in 2006 by the Maine Youth Overweight Collaborative in the USA,¹² the obesity prevention programme called 'Let's go! 5-2-1-0' has been adopted as the main message in several prevention campaigns.¹³ This programme is made up of the following four criteria: 5—consume at least five fruits and vegetables per day; 2—limit recreational screen time to a maximum of 2 hours per day; 1—do at least 1 hour of physical activity per day; 0—drink zero sugar-sweetened beverages. These recommendations are also part of the recommendations of the WHO in the fight against obesity.³ In 2019, during the 60^s World Health Assembly, during high-level meetings of the United Nations General Assembly on health-related issues, these recommendations were included in the third objective. These objectives were aimed at disseminating advocacy campaigns and developing communication supports. The objectives promoted a good consumption of fruits and vegetables, a reduction in sedentary behaviour and awareness of the risks of excessive sugars intakes.¹⁴

The promotion of physical activity was already part of the first global action plan created by the WHO in 2018 which planned to reduce physical inactivity by 15% by 2030.¹⁵ In its latest publication of the plan 'Ending Childhood Obesity', the WHO has also defined six areas of action to fight obesity, including the promotion of healthy diets and regular physical activity, including in schools.¹⁶

These recommendations must also be monitored to avoid other health problems such as psychological distress,¹⁷ cardiovascular diseases, etc. For example, adolescents are the most sedentary paediatric population, spending more than half of their time engaging in sedentary activities after school.¹⁸ Another beneficial indicator for mental health, a good consumption of fruits and vegetables, as suggested by criterion 5 of the '5-2-1-0' programme, is also associated with a so-called cardio protective effect, thus limiting the risks of cardiovascular diseases.¹⁹ The screen time, associated with a strong sedentary lifestyle, is also associated with a decrease in the perceived quality of life among adolescents.²⁰

As the first generation to have access to high computer technology,²¹ African adolescents are increasingly exposed to significant screen time, and therefore, to an increased risk of health problems. Likewise, higher consumption of sugar-sweetened beverages has also been observed in recent years in certain regions of Africa.²²

This higher consumption is partly linked to an expansion of the urbanisation.²³

Several studies have shown that these risky behaviours are often present simultaneously²⁴ and increase the risk of overweight and obesity.^{25 26} However, despite the existence of these results, very few studies have comprehensively studied this public health question taking into account data from several African countries.^{27 28}

The objectives of this study were to assess the proportion of individuals who met the '5-2-1-0' criteria and the prevalence of co-occurrence of risky behaviours among adolescents from nine countries in sub-Saharan Africa (Benin, Ghana, Liberia, Mauritania, Mauritius, Mozambique, Namibia, Seychelles and Tanzania).

MATERIALS AND METHODS

Data

The study used the Global School-based Student Health Survey (GSHS) database, set up by the WHO and the Centers for Disease Control and Prevention. This survey aims to establish programmes, health policies and preventive interventions to be used and evaluated, and health promotion in the school environment.^{29 30}

Since 2003, the GSHS survey has been carried out in eighteen countries in sub-Saharan Africa. Among these countries, only 9 (50.0%) gathered all necessary information to study the '5-2-1-0' recommendations (online supplemental table A1) and only 6 gathered all necessary information for a study including both overweight and obesity. In countries where several studies carried out over different years were available; the most recent version was then chosen.

Data from 2010 and 2017 for the following surveys were used: Benin (2016), Ghana ('Junior' and 'Senior', 2012), Liberia (2017), Mauritania (2010), Mauritius (2017), Mozambique (2015), Namibia (2013), Seychelles (2015), Tanzania (2014). Two data tables were available for Ghana, one corresponding to 'Junior' type establishments (the youngest) and the other to 'senior' type establishments.

In each country, secondary schools were selected with a probability proportional to the number of enrolments in each establishment. Then the classes were selected at random. All students of the selected classes were eligible to participate. For each participant, the design variables (primary sampling unit and 'strata' variables) and associated weights, calculated by the WHO, were provided and used in the analysis.

For each country, the GSHS survey has been approved by a government administration (most often the Ministry of Health or Education) and an institutional review board or ethics committee. Participants and parents, or legal guardians, had to give a verbal or written consent.

Measures

Self-administered questionnaires were distributed to participating adolescents in each country and several

questions on sociodemographic characteristics, lifestyle habits, family and social environment were asked.

Sociodemographic data were age, sex and socioeconomic status. The socioeconomic status was obtained according to the level of hunger the individual reported, as has been done in other studies,^{31–33} using the following question: ‘Over the last 30 days, how often did you go hungry because there was not enough food in your home?’. Socioeconomic status was considered high if there was never or rarely a feeling of hunger and low if the answer to the question was sometimes, most of the time or always, as already done in previous studies.³³

Height and weight of adolescents were self-reported in the questionnaire. Overweight and obesity were determined using WHO’s growth reference curves. An adolescent was considered as having overweight according to the following criterion: ‘>+1 SD from the median for body mass index (BMI) by age and sex’ and had obesity if the criterion ‘>+2 SD from the median for BMI by age and sex’ was observed. The calculations for the reference curves were made by the WHO software AnthroPlus³⁴ and only the associated categories (overweight or not, obesity or not) were given.

To obtain the data associated with the ‘5-2-1-0’ criteria, the same questions were used in each of the countries studied, which allowed making cross-country comparisons. Fruit and vegetable consumption were estimated through the following questions: ‘During the past 30 days, how many times per day did you usually eat fruit?’ and ‘During the past 30 days, how many times per day did you usually eat vegetables?’. The variable related to criterion 5 was thus separated into two categories: ‘at least five fruits and vegetables per day’ and ‘less than five fruits and vegetables per day’. Screen time was obtained by answering the following question: ‘How much time do you spend during a typical or usual day sitting and watching television, computer games, or doing other sitting activities?’. Each country took as an example in the question, in addition to screen time, activities such as chess, card games, etc. Two categories were provided: less than 2 hours per day/more than 2 hours per day.

For criterion 1, related to physical activity, the question ‘During the past 7 days, on how many days were you physically active for a total of at least sixty minutes per day?’ was asked. Only respondents indicating ‘7 days’ were considered as having done sufficient physical activity. For criterion 0, related to the consumption of sugar-sweetened beverages, two categories were also created (no consumption/consumption) based on the following question: ‘During the past thirty days, how many times per day did you usually drink carbonated soft drinks?’. If an adolescent answered ‘I did not drink carbonated soft drinks during the past 30 days’, the category considered was ‘no consumption’. Otherwise, if he or she answered ‘less than one time per day’ or ‘one time per day’ or ‘three times per day’, the category considered was ‘consumption’.

For this study, a ‘5-2-1-0’ score from 0 to 4 was calculated to assess the number of cumulative risky behaviours

in adolescents. An adolescent obtained a maximal score of 4 if he or she did not meet any recommendation corresponding with the presence of four risky behaviours. On the contrary, an adolescent respecting the four recommendations had a final score of 0 since he did not accumulate any risky behaviour. Each possible combination according to the total number of risky behaviours could then be examined.

Statistical analysis

All the overall prevalence rates, including sociodemographic characteristics, overweight and obesity or criteria 5-2-1-0, for the selected countries were obtained by a meta-analysis with a random effect using the ‘meta’ and ‘metaphor’ packaged, V.4.19.0 and V.3.0.2, respectively, in R software (V.4.0.3).

To determine the prevalence by country of the various sociodemographic characteristics, outcomes and criteria of the ‘5-2-1-0’ model, the weights and other design factors were considered using the ‘survey’ package, V.4.0. Differences of this prevalence according to gender were tested for each country using a χ^2 test.

To determine the co-occurrence of these four risky behaviours, a comparison of the observed/expected ratio for each possible score combination was made. The expected prevalence rates were obtained by multiplying the probabilities of each risky behaviour defined in the combination according to its distribution in the population studied. Thus, it was possible to identify the combinations with higher prevalence (ratio>1) or lower (ratio<1) than the expected prevalence.

RESULTS

Sociodemographic characteristics

This study included 26 769 adolescents. The mean age was 15.3 years (SD: ± 0.06). Overall, 49.9% of the adolescents were boys, 51.3% were fifteen or younger and 38.3% had a low socioeconomic status (table 1).

More specifically, the mean age was higher in Benin, Ghana (data from ‘Senior’) and Liberia (16.5 (SD: ± 0.11), 17.2 (SD: ± 0.10) and 16.5 (SD: ± 0.13) years, respectively). On the contrary, the youngest adolescents (from ‘Junior’ type establishments) in Ghana, Mauritius, Seychelles and Tanzania were representative of younger adolescents with a mean age of less than 15 years. All the countries had a fairly balanced distribution of boys and girls, except for Benin where the proportion of adolescent boys was higher (73.0%). Finally, more than 60% of the adolescents from Ghana and Liberia had a low socioeconomic status, while this proportion was lower in Namibia, Benin, Mauritania, Mauritius, Seychelles, Mozambique and Tanzania.

Relevance of overweightness and obesity

In the 6 countries for which information was available, the prevalence of overweight and obesity was 12.7% (95% CI 7.5% to 19.0%) and 3.2% (95% CI 1.1% to 6.1%), respectively (table 2). Mauritania, Mauritius and Seychelles

Table 1 Survey characteristics of GSHS according to country

	Survey year	Response rate (%)	Sample size	Boys (%)	Mean age (±SD)	≤15 years old (%)	Low socioeconomic status (%)
Benin	2016	78.0	2536	73.0	16.5 (±0.11)	24.9	34.9
Ghana Junior	2012	82.0	1648	52.4	14.7 (±0.17)	68.7	58.5
Ghana Senior	2012	71.0	1984	49.8	17.2 (±0.10)	10.1	61.5
Mauritania	2010	70.0	2063	54.5	14.8 (±0.07)	64.4	27.9
Mauritius	2017	84.0	3012	46.5	14.9 (±0.08)	62.3	24.3
Namibia	2013	89.0	4531	46.9	15.9 (±0.10)	41.4	47.7
Seychelles	2015	82.0	2540	50.4	13.9 (±0.14)	82.0	28.5
Liberia	2017	71.0	2744	51.8	16.5 (±0.13)	24.7	64.6
Mozambique	2015	80.0	1918	52.9	15.4 (±0.24)	50.4	36.4
Tanzania	2014	87.0	3793	49.1	14.0 (±0.20)	81.1	15.5

GSHS, Global School-based Student Health Survey.

were particularly affected by overweight, with more than one in five adolescents being overweight. Mauritius and the Seychelles were also the most affected countries by obesity with around 1 in 10 adolescents.

Among boys, respectively 9.3% (95% CI 3.8% to 16.7%) and 2.5% (95% CI 0.5% to 5.8%) of adolescents had overweight and obesity. These prevalence rates were higher among girls (overweight: 16.2% (95% CI 11.2% to 21.9%) and obesity: 3.8% (95% CI 1.8% to 6.6%)). In all countries excepted Mauritius, boys were less affected by overweight and obesity than girls.

'5-2-1-0' recommendations adherence

Across all countries, more than 4 in 5 adolescents (88.4%) had inadequate fruits and vegetable intake, that is, less than 5 fruits and vegetables per day (table 3). This

proportion varied from 81.4% in Seychelles to 93.9% in Mozambique. Less than 1 in 3 adolescents (31.1%) spent more than 2 hours in front of the screens with considerable variation across countries (from 18.7% in Ghana Junior to 51.0% in Seychelles). Physical inactivity was high in all countries, with 4 out of 5 (82.0%) adolescents having less than 1 hour of physical activity per day. Benin was the country with the lowest prevalence (70.4%) while Ghana ('Junior') had the highest proportion of 'inactive' adolescents (89.9%). Finally, 73.3% of the adolescents had consumed sugar-sweetened beverages during the past 30 days. This prevalence was much lower in Ghana where 58.5% of adolescents in senior institutions consumed sugary drinks and the highest in Seychelles (91.7%).

Table 2 Prevalence of overweight and obesity among adolescents in seven countries of sub-Saharan Africa

	Overweight			Obesity		
	Total	Boys	Girls	Total	Boys	Girls
Total	12.7% (7.5 to 19.0)	9.3% (3.8 to 16.7)	16.2% (11.2 to 21.9)	3.2% (1.1 to 6.1)	2.5% (0.5 to 5.8)	3.8% (1.8 to 6.6)
Benin	8.3% (5.9 to 10.7)	5.3%* (3.0 to 7.6)	16.2% (13.1 to 19.3)	1.2% (0.7 to 1.8)	0.7%* (0.3 to 1.1)	2.6% (1.4 to 3.9)
Ghana Junior	8.4% (5.5 to 11.3)	4.9%* (3.0 to 6.8)	12.2% (7.7 to 16.7)	1.5% (0.5 to 2.5)	0.8%* (0.3 to 1.3)	2.2% (0.6 to 3.8)
Ghana Senior	7.7% (5.9 to 9.5)	3.1%* (2.0 to 4.2)	12.3% (10.1 to 14.5)	1.0% (0.0 to 1.6)	0.6%* (0.3 to 0.9)	1.5% (0.5 to 2.4)
Mauritania	21.7% (16.7 to 26.7)	15.1%* (10.6 to 19.7)	29.2% (22.7 to 35.7)	3.0% (2.4 to 3.7)	1.6%* (0.9 to 2.2)	4.7% (3.1 to 6.4)
Mauritius	24.8% (22.5 to 27.2)	26.7% (24.4 to 29.1)	23.2% (19.9 to 26.4)	9.1% (7.8 to 10.4)	10.7%* (8.6 to 12.8)	7.7% (6.3 to 9.1)
Namibia	6.6% (4.6 to 8.5)	4.1%* (2.2 to 6.1)	8.7% (6.6 to 10.7)	1.7% (1.0 to 2.4)	1.1%* (0.4 to 1.8)	2.2% (1.4 to 3.0)
Seychelles	28.2% (26.3 to 30.1)	26.9% (24.2 to 29.6)	29.5% (26.9 to 32.0)	12.1% (10.7 to 13.5)	11.6% (9.8 to 13.5)	12.5% (10.7 to 14.4)

Notes: Data are prevalence (95% CI).
*p<0.05 for the difference between sexes.

Table 3 Non-adherence with the '5-2-1-0' recommendations among adolescents in nine countries of sub-Saharan Africa

	<5 fruits and vegetables/day			Screen time >2hours			Physical activity <1hour			Sugar-sweetened beverages ≠ 0		
	Total	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls
Total Countries	88.4% (85.0 to 91.3)	88.4% (84.8 to 91.7)	88.3% (85.0 to 91.2)	31.1% (23.7 to 38.9)	30.3% (23.9 to 37.2)	31.6% (23.1 to 40.7)	82.0% (78.0 to 85.7)	78.7% (73.3 to 85.7)	85.3% (82.2 to 88.0)	73.3% (64.9 to 80.9)	70.9% (61.2 to 79.7)	75.9% (68.4 to 82.7)
Benin	89.2% (86.4 to 92.0)	89.8% (86.8 to 92.7)	87.6% (83.8 to 91.5)	23.2% (19.8 to 26.7)	23.4% (19.5 to 27.3)	22.5% (18.7 to 26.4)	70.4% (65.2 to 75.6)	67.8%* (62.1 to 73.5)	77.5% (72.2 to 82.9)	62.9% (57.1 to 68.6)	59.7%* (53.6 to 65.8)	71.8% (66.7 to 77.0)
Ghana Junior	85.4% (82.6 to 88.1)	86.1% (82.8 to 89.4)	84.4% (80.9 to 87.9)	18.7% (16.0 to 21.3)	18.2% (15.7 to 20.8)	18.9% (15.2 to 22.6)	89.9% (87.6 to 92.2)	89.1% (86.7 to 91.5)	90.4% (87.6 to 93.1)	68.0% (61.2 to 74.7)	64.4%* (55.9 to 72.8)	71.4% (65.1 to 77.6)
Ghana Senior	93.3% (90.9 to 95.7)	94.4% (91.8 to 97.0)	92.3% (89.9 to 94.7)	20.8% (16.9 to 24.6)	23.4% (17.7 to 29.1)	18.2% (14.6 to 21.8)	83.7% (81.6 to 85.7)	82.2% (79.1 to 85.3)	85.1% (81.6 to 88.6)	58.5% (52.1 to 64.8)	53.8%* (46.5 to 61.2)	63.2% (57.1 to 69.2)
Mauritania	86.9% (84.0 to 89.8)	85.8% (82.4 to 89.2)	88.3% (84.7 to 91.2)	37.1% (32.6 to 41.6)	37.1% (31.4 to 42.7)	37.0% (31.5 to 42.6)	87.5% (84.6 to 90.4)	83.4%* (79.0 to 87.9)	92.4% (90.4 to 94.3)	74.6% (72.0 to 77.2)	70.9%* (67.1 to 74.6)	78.5% (75.2 to 81.7)
Mauritius	92.1% (90.8 to 93.4)	91.8% (90.3 to 93.3)	92.4% (90.3 to 94.4)	40.2% (37.2 to 43.2)	38.3% (34.8 to 41.8)	41.6% (37.3 to 45.9)	81.1% (76.8 to 85.3)	73.8%* (68.5 to 79.1)	87.3% (85.3 to 89.4)	81.8% (80.1 to 83.6)	82.8% (81.1 to 84.5)	80.9% (77.8 to 84.0)
Namibia	92.0% (90.7 to 93.3)	91.1%* (89.3 to 92.9)	92.7% (91.4 to 94.0)	36.0% (33.3 to 38.6)	36.2% (33.5 to 38.9)	35.8% (32.2 to 39.4)	85.7% (84.2 to 87.2)	84.7%* (82.8 to 86.6)	86.7% (85.1 to 88.3)	72.3% (68.7 to 76.0)	73.1% (68.7 to 77.5)	71.4% (67.6 to 75.2)
Seychelles	81.4% (79.5 to 83.3)	79.9% (77.0 to 82.8)	82.9% (80.5 to 85.4)	51.0% (48.2 to 53.8)	47.6%* (44.0 to 51.2)	54.4% (51.0 to 57.7)	82.7% (80.9 to 84.5)	79.9%* (76.7 to 83.0)	85.4% (83.1 to 87.7)	91.7% (90.7 to 92.7)	90.7% (89.0 to 92.3)	92.8% (91.4 to 94.1)
Liberia	89.6% (88.1 to 91.0)	90.6% (88.7 to 92.4)	88.7% (87.0 to 90.4)	19.6% (17.7 to 21.6)	18.4% (15.8 to 20.9)	21.3% (18.9 to 23.6)	87.8% (85.5 to 90.2)	84.8%* (81.4 to 88.3)	16.2% (15.2 to 17.2)	68.3% (64.0 to 72.6)	65.4%* (60.1 to 70.7)	71.2% (67.1 to 75.4)
Mozambique	93.9% (92.2 to 95.6)	93.6% (91.0 to 96.2)	94.7% (92.5 to 96.3)	7.5% (3.0 to 11.9)	35.4% (30.4 to 40.4)	36% (34.7 to 44.5)	96.6% (91.6 to 89.6)	80.8%* (75.5 to 86.1)	16.0% (15.0 to 17.0)	38% (38 to 38)	80.9%* (75.1 to 86.6)	87.8% (84.7 to 90.9)
Tanzania	84.9% (81.8 to 88.0)	87.1%* (84.0 to 90.2)	82.6% (78.9 to 86.3)	20.0% (17.6 to 22.4)	19.8% (16.7 to 22.9)	20.3% (17.7 to 22.8)	80.0% (77.1 to 82.9)	77.0%* (72.4 to 81.5)	82.8% (80.2 to 85.4)	61.7% (56.2 to 67.3)	56.9%* (50.4 to 63.5)	66.1% (60.8 to 71.4)

Notes: Data are prevalence (95% CI).
*p<0.05 for the difference between sexes.

In addition, a significant difference regarding the insufficient consumption of fruits and vegetables between adolescent boys and girls was found in Namibia and Tanzania (table 3). In Namibia, girls were more concerned by this insufficient consumption while in Tanzania, the reverse was observed. Regarding the excessive screen time, only the Seychelles showed a significant difference between genders, with girls being more concerned. Boys were also more likely to practice sufficient physical activity than girls, which was observed in all countries. Finally, adolescent boys were less likely to consume sugar-sweetened beverages than girls, and this was observed in all countries except Mauritania and Mauritius.

Co-occurrence of non-adherence to the '5-2-1-0' recommendations

Overall, 17.0% (95% CI 11.8% to 23.0%) of the adolescents combined the four risky behaviours among the '5-2-1-0' criteria and thus did not consume enough fruits and vegetables, had a too high screen time, insufficient physical activity and consumed sugar-sweetened beverages. About 43.8% (95% CI 41.9% to 45.8%) of the adolescents engaged in 3 risky behaviours among the 4 criteria, while 28.4% (95% CI 22.4% to 34.8%) engaged in 2 and 4.8% (95% CI 3.1% to 6.9%) engaged in 1 risky behaviour. Only 0.2% (95% CI 0.1% to 0.4%) of the adolescents met the 4 '5-2-1-0' criteria, and therefore, did not engage in any risky behaviour.

Again, girls were less likely to adhere to the recommendations. Indeed, while only 0.1%, 4.0% and 26.2% of the adolescent girls had 0, 1 and 2 risky behaviours accumulated, respectively, these proportions were 0.3%, 5.6% and 30.6% among adolescent boys (table 4). On the contrary, girls were more likely to accumulate 3 or 4 risky behaviours, compared with boys (45.5% and 18.7% among girls vs 42.2% and 15.2% among boys).

For both girls and boys, the most common combination, affecting more than 1 in 3 adolescents (respectively, 37.7 and 33.3%), was the combination of three risky behaviours: low consumption of fruits and vegetables, and insufficient physical activity, and high consumption of sugar-sweetened beverages.

By looking more precisely at the differences between the observed and expected prevalence rate's in girls and boys, we first notice that the observed number of adolescents respecting all the recommendations (ie, having a score of 0) was lower than expected for either boys or girls. On the contrary, the observed prevalence associated with the highest score (ie, four risky behaviours) were higher than those expected for both girls and boys. The highest observed/expected ratio, respectively, equal to 2.30 for boys and 2.03 for girls, was found for a total score of 2 risky behaviours: high screen time and sugar-sweetened beverages consumption. On the contrary, the lowest observed/expected ratio, equal to respectively 0.45 for boys and 0.47 for girls, was associated with a total score

Table 4 Observed and expected values for combinations of 5210 risky behaviours among adolescents in 9 sub-Saharan African countries

No of risk factors	<5 fruits and vegetables/day	Screen time >2 hours	Physical activity <1 hour	Sugar-sweetened beverages ≠ 0	Boys			Girls		
					O (%)	E (%)	O/E (%)	O (%)	E (%)	O/E (%)
4	+	+	+	+	15.39	14.65	1.05	19.22	18.15	1.06
3	-	+	+	+	2.23	1.72	1.30	2.99	2.37	1.26
3	+	-	+	+	33.31	34.86	0.96	37.72	39.4	0.96
3	+	+	-	+	4.38	3.77	1.16	2.91	2.82	1.03
3	+	+	+	-	4.80	6.41	0.75	4.54	5.99	0.76
2	-	-	+	+	4.29	4.09	1.05	5.15	5.14	1.00
2	+	-	-	+	7.62	8.97	0.85	5.23	6.12	0.85
2	+	+	-	-	1.28	1.65	0.78	0.66	0.93	0.71
2	-	+	-	+	1.01	0.44	2.30	0.75	0.37	2.03
2	-	+	+	-	0.34	0.75	0.45	0.37	0.78	0.47
2	+	-	+	-	18.36	15.26	1.20	15.73	13.01	1.21
1	+	-	-	-	4.35	3.92	1.11	2.44	2.02	1.21
1	-	+	-	-	0.15	0.19	0.79	0.10	0.12	0.83
1	-	-	+	-	0.82	1.79	0.46	0.83	1.70	0.49
1	-	-	-	+	1.32	1.05	1.26	1.19	0.80	1.49
0	-	-	-	-	0.34	0.46	0.74	0.16	0.26	0.62

Notes: The presence of a risky behaviour is shaded grey. E, expected prevalence; O, observed prevalence.

of 2, with the following risky behaviours: high screen time and insufficient physical activity.

DISCUSSION

The main purpose of this study was to assess the prevalence of overweight and obesity, to investigate the adherence to '5-2-1-0' guidelines and to evaluate the co-occurrence of the risky behaviours related to these recommendations among adolescents in Africa. After an initial selection of GSHS data available on the WHO website, nine countries were selected for performing these analyses.

Among the adolescents included in these studies, which were carried out between 2010 and 2017, obesity particularly affected young people in Mauritius and Seychelles where 1 in 10 adolescents had obesity. One in four adolescents had overweight in these two countries.

The high prevalence of obesity in Seychelles in this study is in line with previous findings. Indeed, Seychelles is the country in sub-Saharan Africa that is most affected by overweight and obesity problems.³⁵ Aware of this important public health issue, Seychelles has recently created programmes to fight against the poor eating habits of the population, in part linked to the high consumption of take-out meals.³⁵ Mauritius, another island country in sub-Saharan Africa, was also strongly affected by overweight problems, both among the children and the adults.³⁶ The country has, therefore, developed a national action plan for nutrition³⁷ and other preventive programmes to control the high prevalence of overweight and obesity.³⁸

In Mauritania, which is less affected by obesity, a high prevalence of overweight was found among young girls, with around 3 in 10 adolescent girls being overweight. As a direct consequence of the country's Leblouh tradition, young girls are sometimes force-fed to meet cultural criteria and take on the roles of wife and mother as quickly as possible.³⁹ In the other countries studied (Benin, Ghana and Namibia), the prevalence of obesity was quite low, but overweight nevertheless affected between 6.6% and 8.4% of adolescents. In all of the countries studied, girls were significantly more affected by overweight or obesity than boys, which is consistent with results from other African countries.⁴⁰ Hypothesis mentioned by the authors were differences in physiology, lifestyle habits such as physical activity,⁴¹ or different sex chromosomes.⁴² It is, therefore, essential to take these differences into account in health interventions aiming at fighting obesity.

Looking at adherence to the '5-2-1-0' recommendations, more than four in five adolescents did not consume at least five fruits and vegetables per day, which is consistent with various studies targeting adolescents from other African countries^{43 44} but other regions in the world as well.^{22 45} Some countries, such as Mozambique, the Seychelles and Mauritius, were also particularly affected by high consumption of sugar-sweetened beverages among adolescents, with more than four in five adolescents regularly consuming a sugary drink. This high consumption

has also been observed in other studies.^{22 46} In order to combat this scourge, some countries such as South Africa have recently implemented a tax on sugary drinks leading to a drop in consumption, especially among individuals with lower incomes.⁴⁷

Screen time was the only criterion in the '5-2-1-0' recommendations that was fairly well respected, with approximately less than one in two adolescents having too much screen time. These criteria are also respected in some regions of the world, such as China, for example,⁴⁸ but on the contrary is worrying in other countries such as the USA, where adolescents spend on average more than 7 hours a day in front of the screens.⁴⁹ Finally, lack of physical activity among adolescents was found in all countries studied with a significant difference between girls and boys, in favour of boys. Four in five adolescent girls were active less than 1 hour per day, which was deemed insufficient. Since this gender difference was also shown in other studies,⁵⁰ adolescent girls are an important target for promoting physical activity. In our study, this gender difference was also found for the three other criteria, and therefore, needs to be taken into consideration.

By analysing the co-occurrence of these risky behaviours, only 0.2% of adolescents met the '5-2-1-0' criteria at the same time, that is, a good consumption of fruits and vegetables, sufficient physical activity, limited screen time and a good consumption of sugar-sweetened beverages. On the contrary, three in five adolescents accumulated three or four risky behaviours. The most observed combination of these risky behaviours was: low consumption of fruits and vegetables, insufficient physical activity and high consumption of sugar-sweetened beverages, and affected more than one in three adolescents. This study then showed that few adolescents respected the '5-2-1-0' recommendations, suggesting that more intensive efforts in terms of nutrition, screen time and physical activity are needed.

These efforts are not only to be made on behaviours but also on the environment. Indeed, these risky behaviours are obviously dependent on the environment in which the adolescent grows up. It is then necessary to make the necessary modifications in order to change the behavioural habits of this population. These actions are notably the subject of the 'Taking Action on Childhood Obesity' campaign led by the WHO, suggesting, for example: to improve the environments in which children live, play and learn, to implement policies to support healthy food environments, for mothers, infants and children, to increase policy priority to ensure safe and accessible environments for physical activity and to strengthen the measurement of food and physical activity environments and policy implementation.⁵¹

Results should be interpreted in light of some limitations. First, the main limitation is the cross-sectional design of the study, which hampers the possibility to establish causal links. Second, our study relies on self-reported measures, which may be susceptible to various error biases, such as desirability or memory bias. Moreover,

some variables were not directly available. For example, the screen time question included ‘other sitting activities’ and is, therefore, not restricted to screen time only. The answer given by the adolescents to the screen time question also needs careful interpretation since access to a smartphone or a computer device may vary across participants. In addition, physical activity was measured over the last 7 days, and therefore, does not allow more general monitoring of the situation. The same limitation also applies to the measurement of sugar-sweetened beverage consumption, for which adolescents who rarely consume this type of drink may have hesitated between ‘less than one time per day’ and ‘I did not drink carbonated soft drinks during the past 30 days’ propositions. Finally, caution is needed in extrapolating these results to national levels since the data were only collected among schooled adolescents.

Despite these limitations, our study is the first to focus on adherence to the ‘5-2-1-0’ recommendations in nine countries of sub-Saharan Africa. By studying the prevalence of each of these criteria as well as obesity and overweight, our study provides new insights into the health condition of adolescents in these countries. Additionally, the study was conducted on a large sample with high response rates.

CONCLUSION

This study was the first to assess the prevalence rates of overweight and obesity among adolescents simultaneously in nine countries of sub-Saharan Africa. In addition to the high prevalence of obesity and overweight, this study showed that the adherence to the ‘5-2-1-0’ recommendations was insufficient, especially among adolescent girls, and provided new insights in the co-occurrence of several risky behaviours. These results emphasise the need to strengthen health interventions and programmes, such as the ‘5-2-1-0’ recommendations, to promote healthy behaviours and prevent obesity and overweight among African adolescents.

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REFERENCES

- 1 Dietz WH, Baur LA, Hall K, *et al*. Management of obesity: improvement of health-care training and systems for prevention and care. *Lancet* 2015;385:2521–33.
- 2 Debeila S, Modjadji P, Madiba S. High prevalence of overall overweight/obesity and abdominal obesity amongst adolescents: an emerging nutritional problem in rural high schools in limpopo province, South Africa. *Afr J Prim Health Care Fam Med* 2021;13:e1–9.
- 3 WHO. Obesity and overweight. 2021. Available: <https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight> [Accessed 28 Jul 2021].
- 4 Wehrauch-Blüher S, Schwarz P, Klusmann JH. Childhood obesity: increased risk for cardiometabolic disease and cancer in adulthood. *Metabolism* 2019;92:147–52.
- 5 Guh DP, Zhang W, Bansback N, *et al*. The incidence of co-morbidities related to obesity and overweight: a systematic review and meta-analysis. *BMC Public Health* 2009;9:88.
- 6 Wehrauch-Blüher S, Kromeyer-Hauschild K, Graf C, *et al*. Current guidelines for obesity prevention in childhood and adolescence. *Obes Facts* 2018;11:263–76.
- 7 Apovian CM. Obesity: definition, comorbidities, causes, and burden. *Am J Manag Care* 2016;22:s176–85.
- 8 Crespo CJ, Smit E, Troiano RP, *et al*. Television watching, energy intake, and obesity in US children: results from the third National health and nutrition examination survey, 1988–1994. *Arch Pediatr Adolesc Med* 2001;155:360–5.
- 9 Vartanian LR, Schwartz MB, Brownell KD. Effects of soft drink consumption on nutrition and health: a systematic review and meta-analysis. *Am J Public Health* 2007;97:667–75.
- 10 Forshee RA, Anderson PA, Storey ML. Sugar-sweetened beverages and body mass index in children and adolescents: a meta-analysis. *Am J Clin Nutr* 2008;87:1662–71.
- 11 Dabas A, Seth A. Prevention and management of childhood obesity. *Indian J Pediatr* 2018;85:546–53.
- 12 Rogers VW, Motyka E. 5-2-1-0 goes to school: a pilot project testing the feasibility of schools adopting and delivering healthy messages during the school day. *Pediatrics* 2009;123 Suppl 5:S272–6.

- 13 FloridaHealth. 5210 let's go! 2018. Available: <http://www.5210letsgo.com/brief-overview.html> [Accessed 22 Jul 2021].
- 14 WHO. Seventy-second World Health Assembly. Follow-up to the high-level meetings of the United Nations general assembly on health-related issues. Prevention and control of noncommunicable diseases-report by the director-general. 2019. Available: https://apps.who.int/gb/ebwha/pdf_files/WHA72/A72_19-en.pdf [Accessed 11 Aug 2021].
- 15 Isakson E. A sporting chance: physical activity as part of everyday life. *Lancet* 2021.
- 16 World Health Organization. Report of the commission on ending childhood obesity; 2016.
- 17 Vancampfort D, Stubbs B, Firth J, *et al*. Sedentary behavior and depressive symptoms among 67,077 adolescents aged 12-15 years from 30 low- and middle-income countries. *Int J Behav Nutr Phys Act* 2018;15:73.
- 18 Arundell L, Fletcher E, Salmon J, *et al*. A systematic review of the prevalence of sedentary behavior during the after-school period among children aged 5-18 years. *Int J Behav Nutr Phys Act* 2016;13:93.
- 19 Mellendick K, Shanahan L, Wideman L, *et al*. Diets rich in fruits and vegetables are associated with lower cardiovascular disease risk in adolescents. *Nutrients* 2018;10:136.
- 20 Gopinath B, Hardy LL, Baur LA, *et al*. Physical activity and sedentary behaviors and health-related quality of life in adolescents. *Pediatrics* 2012;130:e167-74.
- 21 Sambira J. Afrique renouveau-La mobilité des jeunes à l'origine Du changement. 2013. Available: <https://www.un.org/africarenewal/fr/magazine/mai-2013/la-mobilité-des-jeunes-à-l'origine-du-changement> [Accessed 23 Jul 2021].
- 22 Beal T, Morris SS, Tumilowicz A. Global patterns of adolescent fruit, vegetable, carbonated soft drink, and fast-food consumption: a meta-analysis of global school-based student health surveys. *Food Nutr Bull* 2019;40:444-59.
- 23 Cockx L, Colen L, De Weerd J, *et al*. Urbanization as a driver of changing food demand in Africa: evidence from rural-urban migration in Tanzania. Publications Office of the European Union, 2019.
- 24 Yang-Huang J, van Grieken A, Wang L, *et al*. Clustering of sedentary behaviours, physical activity, and energy-dense food intake in six-year-old children: associations with family socioeconomic status. *Nutrients* 2020;12:1722.
- 25 López-Gil JF, Brazo-Sayavera J, García-Hermoso A, *et al*. Clustering patterns of physical fitness, physical activity, sedentary, and dietary behavior among school children. *Child Obes* 2020;16:564-70.
- 26 Moitra P, Madan J, Verma P. Independent and combined influences of physical activity, screen time, and sleep quality on adiposity indicators in Indian adolescents. *BMC Public Health* 2021;21:2093.
- 27 Keino S, Plasqui G, Etyang G, *et al*. Determinants of stunting and overweight among young children and adolescents in Sub-Saharan Africa. *Food Nutr Bull* 2014;35:167-78.
- 28 Muthuri SK, Francis CE, Wachira L-JM, *et al*. Evidence of an overweight/obesity transition among school-aged children and youth in Sub-Saharan Africa: a systematic review. *PLoS One* 2014;9:e92846.
- 29 CDC. Centers for disease control and prevention, Global school-based student health survey (GSHS). 2018. Available: <https://www.cdc.gov/GSHS/> [Accessed 22 Jul 2021].
- 30 World Health Organization, Global School-based Student Health Survey (GSHS). 2021. Available: <https://www.who.int/teams/noncommunicable-diseases/surveillance/systems-tools/global-school-based-student-health-survey> [Accessed 22 Jul 2021].
- 31 Almansour AM, Siziya S. Suicidal ideation and associated factors among school going adolescents in Swaziland. *Afr Health Sci* 2017;17:1172-7.
- 32 Sharma SR, Matheson A, Lambrick D, *et al*. The role of tobacco and alcohol use in the interaction of social determinants of non-communicable diseases in Nepal: a systems perspective. *BMC Public Health* 2020;20.
- 33 Hoogstoel F, Samadoulougou S, Lorant V, *et al*. A latent class analysis of health lifestyles in relation to suicidality among adolescents in Mauritius. *Int J Environ Res Public Health* 2021;18:6934.
- 34 WHO. WHO anthropoPlus for personal computers manual-software for assessing growth of the world's children and adolescent. 2019. Available: https://www.who.int/growthref/tools/who_anthroplus_manual.pdf [Accessed 09 Feb 2022].
- 35 Meriton-Jean S, Amia H. Seychelles is the fattest country in Sub-Saharan Africa, according to WHO report. Seychelles News Agency; 2015. Available: <http://www.seychellesnewsagency.com/articles/2244/Seychelles+is+the+fattest+country+in+sub-Saharan+Africa%2C+according+to+WHO+report> [Accessed 24 Aug 2021].
- 36 Caleyachetty R, Rudnicka AR, Echouffo-Tcheugui JB, *et al*. Prevalence of overweight, obesity and thinness in 9-10 year old children in Mauritius. *Global Health* 2012;8:28.
- 37 Mauritius. Republic of Mauritius, Ministry of health and quality of life, National plan of action for nutrition. 2016. Available: [https://extranet.who.int/ncdccc/Data/MUS_B14_NPAN%202016-2020\[1\].pdf](https://extranet.who.int/ncdccc/Data/MUS_B14_NPAN%202016-2020[1].pdf)
- 38 Assumpcao LV. A health policy with atomic precision in Mauritius international atomic energy agency. 2018. Available: <https://www.iaea.org/newscenter/news/a-health-policy-with-atomic-precision-in-mauritius> [Accessed 24 Aug 2021].
- 39 Mallasasime B. The culture where girls are force-fed into obesity (to be sexy): history of yesterday. 2021. Available: <https://historyofyesterday.com/the-culture-where-girls-are-force-fed-into-obesity-to-be-sexy-80215035eaba> [Accessed 24 Aug 2021].
- 40 Choukem S-P, Tochie JN, Sibetcheu AT, *et al*. Overweight/obesity and associated cardiovascular risk factors in Sub-Saharan African children and adolescents: a scoping review. *Int J Pediatr Endocrinol* 2020;2020:6.
- 41 Nyawornota VK, Aryeetey R, Bosomprah S, *et al*. An exploratory study of physical activity and over-weight in two senior high schools in the accra Metropolis. *Ghana Med J* 2013;47:197-203.
- 42 Zore T, Palafox M, Reue K. Sex differences in obesity, lipid metabolism, and inflammation-a role for the sex chromosomes? *Mol Metab* 2018;15:35-44.
- 43 Seyoum Y, Humblot C, Nicolas G, *et al*. Iron deficiency and anemia in adolescent girls consuming predominantly plant-based diets in rural Ethiopia. *Sci Rep* 2019;9:17244.
- 44 Isabirye N, Bukonya JN, Nakafeero M, *et al*. Dietary diversity and associated factors among adolescents in eastern Uganda: a cross-sectional study. *BMC Public Health* 2020;20:534.
- 45 Frank SM, Webster J, McKenzie B, *et al*. Consumption of fruits and vegetables among individuals 15 years and older in 28 low- and middle-income countries. *J Nutr* 2019;149:1252-9.
- 46 Pengpid S, Peltzer K. Prevalence and socio-behavioral factors associated with sugar-sweetened beverages consumption among 15 years and older persons in South Africa. *Diabetes Metab Syndr Obes* 2019;12:937-45.
- 47 Wrottesley SV, Stacey N, Mukoma G, *et al*. Assessing sugar-sweetened beverage intakes, added sugar intakes and BMI before and after the implementation of a sugar-sweetened beverage tax in South Africa. *Public Health Nutr* 2021;24:2900-10.
- 48 Zhu Z, Tang Y, Zhuang J, *et al*. Physical activity, screen viewing time, and overweight/obesity among Chinese children and adolescents: an update from the 2017 physical activity and fitness in china—the youth study. *BMC Public Health* 2019;19.
- 49 Rideout RMB, Robb MB. The common sense census: media use by tweens and teens. 2019. Available: <https://www.common sense media.org/sites/default/files/uploads/research/2019-census-8-to-18-full-report-updated.pdf> [Accessed 17 Feb 2022].
- 50 Marques A, Henriques-Neto D, Peralta M, *et al*. Prevalence of physical activity among adolescents from 105 low, middle, and high-income countries. *Int J Environ Res Public Health* 2020;17:3145.
- 51 World Obesity Federation, WHO. Taking action on childhood obesity. 2018. Available: <https://apps.who.int/iris/bitstream/handle/10665/274792/WHO-NMH-PND-ECHO-18.1-eng.pdf> [Accessed 30 Mar 2023].