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Prevalence of Thinness and Its Determinants in the School Context in São Tomé and Príncipe: A Cross-Sectional Study with Second Cycle Children

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Abstract

Introduction: Thinness remains a major public health concern among school-aged children in low and middle-income countries, particularly in Sub-Saharan Africa, where undernutrition coexists with the ongoing nutrition transition. Despite increasing evidence of this double burden of malnutrition, limited research has focused on school-aged children and adolescents in São Tomé e Príncipe.

Objective: To assess the prevalence of thinness and identify its main determinants among school-aged children in the Cantagalo District, São Tomé e Príncipe, with a particular focus on dietary intake, household food insecurity and sociodemographic characteristics.

Methods: A cross-sectional study was conducted using data from 546 children enrolled in the 5th and 6th grade. Anthropometric measurements, dietary intake (24h dietary recall), household food insecurity, and sociodemographic and lifestyle data were collected. Nutritional status was classified according to the World Health Organization growth reference, and multivariable logistic regression was used to identify factors independently associated with thinness.

Results: Thinness remained highly prevalent among the study population. Larger households with more school-aged members and purchasing snacks outside the school environment were associated with increased odds of thinness. Conversly, higher birth weight, better linear growth, greater energy intake, and higher intakes of retinol, vitamin B2, folate, and calcium were associated with lower odds of thinness. Although household was highly prevalent, it was not independently associated with thinness after adjustment for potential confounders.

Discussion: The findings indicate that thinness among school-aged children is influenced by a combination of household composition, dietary quality, and food environment. Micronutrient inadequacies and insufficient dietary intake appear to play an important role in undernutrition, highlighting the need to improve both access to and quality of foods available to children, particularly within and around schools.

Conclusion: Thinness continues to represent an important nutritional challenge among school-aged children in São Tomé e Príncipe. Strategies aimed at improving diet quality, promoting healthier school food environments, and strengthening nutrition policies may contribute to reducing undernutrition and supporting healthy growth and development in this population.

Keywords

Thinness; UnderWeight; Dietary Intake; Nutritional status.

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List of Abbreviations, Acronyms and Initials

24-hour Dietary Recall - 24HDR

Body Mass Index – BMI

Confidence interval - CI

Deoxyribonucleic Acid - DNA

Faculty of Nutrition and Food Sciences of the University of Porto – FCNAUP

Food Insecurity – FI

Food and Nutrition Technical Assistance - FANTA

Height-for-age z-score – HAZ

Household Food Insecurity Access Scale - HFIAS

Median - Mdn

Nationally Determined Contribution - NDC

National School Feeding and Health Program – PNASE

Non-communicable chronic diseases – NCDs

Odds Ratio – OR

Ultra-Processed Foods - UPF

United Nations Common Country Analysis - UN CCA

São Tomé and Príncipe –STP

Standard deviation – SD

Small Island Developing State - SIDS

World Food Programme – WFP

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Introduction

The Democratic Republic of São Tomé and Príncipe (STP) is a small island developing state in the Gulf of Guinea, comprising of São Tomé Island and the Autonomous Region of Príncipe, along with several islets. It is one of the Portuguese-speaking African countries and has an estimated population of around 240,000 inhabitants [1].

Classified as a lower-middle-income country by the United Nations and the World Bank, STP had a GDP per capita of approximately USD 3,245 in 2024 [2]. STP is one of the main countries among those of lower-middle income with the highest percentage of childhood overweight/obesity, while simultaneously facing undernutrition and overweight/obesity [3].

According to the Global Nutrition Report (n.d.), 11.7 % of children under five in STP are stunted, and 4.1 % are wasted, figures below the Sub-Saharan African average but still of concern. Meanwhile, 44.2 % of women of reproductive age suffer from anaemia, reflecting persistent nutritional challenges [4].

In Sub-Saharan Africa, the nutritional transition has resulted in two contrasting realities: a steady rise in overweight and obesity on one hand, and persistently high rates of hunger and micronutrient deficiencies on the other [5,6]. In Nigeria, for instance, thinness rates of nearly 96 % have been recorded, particularly among children attending public schools, where food insecurity and limited diet diversity are major contributors [7].

Silva and Catarino (2023) reported that children from rural areas were 4.5 times more likely to experience acute malnutrition than those in urban areas, with significant associations with unsafe water, poor sanitation, and food insecurity

(FI)(8). Anaemia affected 83 % of the sampled children, revealing a severe micronutrient deficiency burden [8].

Particularly in the Cantagalo District, Ferreira et al. (2024) found a thinness prevalence of 34.1 % among school-age children (9–15 years), alongside inadequate micronutrient intake in over 95 % of participants, especially iron, zinc, and vitamin A[9]. Severe FI affected 73.7 % of households, confirming a strong link between that and child nutritional inadequacy [9]. These findings mirror broader African trends where household poverty, maternal education, sanitation, and healthcare access are major predictors of undernutrition [10].

The United Nations Common Country Analysis (UN CCA) (2024) further reports that 10% of STP households experience severe food insecurity, with 42% facing seasonal shortages and 26% enduring chronic deprivation [11]. These structural food access challenges underscore the country's vulnerability to shocks in food supply, climatic fluctuations, and economic instability [11].

Beyond quantity, food quality and safety play a central role in nutrition outcomes. Unsafe food and contamination contribute significantly to child illness and nutrient malabsorption, with the WHO Regional Office for Africa (2024) estimating that 70 % of the 1.5 billion annual diarrhoeal episodes globally stem from foodborne causes [12]. Such health burdens exacerbate thinness and hinder nutrient absorption [12].

The increased availability and consumption of ultra-processed foods (UPF) have further complicated the nutrition landscape. Advances in food processing have expanded accessibility to UPF, foods typically high in energy, sugar, fat, and sodium but poor in micronutrients [13,14]. Using data from this same population, Morais et al. (2024) found that higher UPF consumption among children and

adolescents in Cantagalo was associated with lower intakes of fibre, vitamin B12, and zinc, as well as increased sodium consumption. This reflects a nutrition transition that favours energy-dense but nutritionally poor diets, potentially worsening thinness and other malnutrition indicators [15].

According to the study conducted by M. Rita, based on the same study population, ultra-processed foods accounted for approximately 8.5–9.5% of total daily energy intake [16]. This relatively low consumption is consistent with the fact that São Tomé and Príncipe is a lower-middle-income country. In contrast, the contribution of UPF to total daily energy intake is substantially higher in other countries, reaching approximately 64% in Brazil and ranging from 47% to 68% in the United States, the United Kingdom, and Australia [16].

The increased consumption of these foods can be considered one of the main causes of the obesity epidemic, and their intake is associated with higher rates of overweight, hypertension, metabolic syndrome, and other non-communicable chronic diseases (NCDs) [17,18]. The nutritional poverty associated with these products affects children's performance at school, and it limits better job and overall future opportunities, perpetuating the vicious circle of poverty [17,18].

Thinness is not merely a sign of energy deficit; it has profound developmental and cognitive consequences. Undernutrition during school years can compromise immunity, academic performance, and later adult health [19]. Up to 50 % of adult body weight, 20 % of final height, and 50 % of bone mass are gained during adolescence. Deficiencies at this stage may irreversibly impact growth and health potential [20].

While global nutrition efforts have prioritised children under 5 years, fewer interventions focus on school-age and adolescent groups, despite growing evidence that this period is critical for breaking intergenerational cycles of malnutrition [7]. The Government of STP, through initiatives such as the National School Feeding and Health Programme (PNASE) and partnerships with the World Food Programme (WFP) and FCNAUP, has sought to strengthen nutrition and food security systems.

According to Wrottesley, S. (2021, Cambridge), Africa is one of the regions facing the greatest nutritional challenges among children and adolescents (5–19 years), with high rates of thinness, anaemia and micronutrient deficiencies, but also with a gradual increase in overweight and obesity in certain contexts [21]. The authors found that in public schools, there was a higher risk of thinness, whereas in private schools, the risk was greater for overweight [21]. For example, in Nigeria, a thinness rate of almost 96% was recorded, one of the highest among the regions analysed [7].

In 2025, a demographic survey conducted across 35 African countries revealed an average prevalence of wasting of 7.16% (higher than the 5% threshold set by the WHO) among children aged 0–59 months (approximately 212,715 children) [10]. The main determinants of child thinness included poverty, poor sanitation, low maternal education, inadequate diet, and lack of essential healthcare, reinforcing its multifactorial nature (10). In addition to these factors, rural residence and low birth weight were also identified as causes [10].

The household FI can be measured and monitored with several tools [14,22], such as the Household Food Insecurity Access Scale (HFIAS) [23] under the Food and Nutrition Technical Assistance (FANTA). This instrument classifies households

according to their status of food security or insecurity, focusing exclusively on the access dimension (i.e., physical and economic access to food) [24]. The Household Food Insecurity Access Scale (HFIAS) assesses household food insecurity by evaluating anxiety and concerns related to household food access, as well as the quality and quantity of food consumed. Regarding food quantity, it examines situations in which household members reduce meal size or the number of daily meals or even spend an entire day without eating due to a lack of food or resources. The questionnaire consists of nine items, and the frequency of occurrence is recorded for each situation [25,26].

The Household Food Insecurity Access Scale (HFIAS) assesses household food insecurity by capturing households' experiences related to food access, including anxiety and uncertainty about the household food supply, as well as the quality and quantity of food accessible. Regarding food quantity, it evaluates situations in which households' members reduce meal portions or the number of daily meals or spend an entire day without eating because of insufficient food or lack of resources [25,26].

The HFIAS consists of nine questions, each followed, when applicable, by a frequency of occurrence question. It provides both a continuous food insecurity score and classifies households into four categories: food secure, mildly food insecure, moderately food insecure, and severely food insecure. Overall, the HFIAS provides a measure of the household experience of food access, reflecting the access dimension of food insecurity [25,26]. On a broader scale, armed conflicts, extreme weather and climate events, seasonal fluctuations, and global economic instability are external factors that limit food availability and access, thereby perpetuating poverty and FI [27].

Beyond everything already mentioned, armed conflicts and ongoing conflicts across the African continent also contribute to hunger [27]. Moreover, such events compromise overall food security, ultimately undermining dietary intake and nutritional status [27]. The destruction of local production systems, through attacks, fires, and occupation, such as damage to agricultural land, irrigation infrastructure, and livestock activities, leads to reduced supply, higher local prices, and diminished nutritional availability [27]. Those interruptions in supply and transport chains, which hinder food imports, together with restrictions on humanitarian access, further exacerbate hunger and malnutrition [27].

Smaller countries, such as STP are an island states with a limited domestic market and a high dependency on imported foods, and these foods are more expensive and may not be affordable or accessible to the entire population [27].

Another unmentioned factor that can contribute to hunger, and therefore to child malnutrition, is the unstable climate. STP is highly vulnerable to the impacts of climate change due to the fragility of its ecosystems and its relatively low level of socioeconomic development [28]. As a result, the country is exposed to floods, including those occurring along riverbanks and coastal zones, like storms and droughts [28].

Additionally, rising sea levels contribute to coastal degradation, salinisation, and increased frequency of flash floods, all of which may damage coastal activities essential for local livelihoods [28]. STP's vulnerability is further exacerbated by its classification as a Small Island Developing State (SIDS), characterised by structural fragility, external dependence, unemployment, poverty, income inequality, and limited opportunities for migration [28].

Given that much of STP's agriculture is subsistence-based, any climatic disturbance, such as flooding that destroys cropland or disrupts the transport of agricultural products on rural roads (reduces agricultural productivity, diminishes household income, and constrains the ability to purchase additional foods) [2]. The country's Nationally Determined Contribution (NDC) explicitly highlights these vulnerabilities [2].

According to this context, the present dissertation aims to deepen the understanding of the prevalence of thinness and its main determinants among school-aged children and adolescents in the Cantagalo District of STP, focusing on food insecurity and socio-demographic factors. By identifying modifiable risk factors, this study seeks to inform targeted nutrition policies and strengthen ongoing efforts to improve child health, educational performance, and long-term human development in the country.

Aims

The primary objectives of this study are to assess the prevalence of thinness and identify its main correlates among children and adolescents in the Cantagalo District of STP, focusing on FI, the degree of food processing, and sociodemographic factors of both the children/adolescents and their households.

Methods

Study design, participants and ethics

This will be an analytical cross-sectional study based on data that has been collected within the framework of the "MeNutRic Mais: Improving the Nutritional Status of Children in São Tomé and Príncipe" project.

To engage the entire school community, oral and written invitations have been used as the communication strategy. The inclusion criterion was enrolment as a 5th- or 6th-grade student at one of the eight public basic education schools. Exclusion criteria included absence on the day of the interview and/or missing essential research data, particularly regarding dietary intake.

The data to be analysed in this study were gathered by a multidisciplinary team from Helpo NGOD between November 2022 and February 2023 in the Cantagalo District. Data collection has occurred on multiple days throughout this period across the participating schools; however, each student was assessed only once.

Of 1,187 students screened for eligibility, 573 participated in the interviews. Lastly, 546 students were included, as they fulfilled all inclusion criteria.

Both the "MeNutRic Mais" project and the present study were approved by the Health Ethics Committee for Scientific Research of the Ministry of Health of the Democratic Republic of STP. Informed consent, either written or oral (for those who were illiterate), was obtained from the parent or legal guardian of each child or adolescent who agreed to participate in the study.

To ensure data confidentiality and maintain the anonymity of each participant, a numerical code was assigned to every child.

Data Collection

The questionnaire has been divided into three parts (A, B, and C). Part A was self-administered by the teachers. Parts B and C were directed to parents/guardians and children/adolescents, respectively [29]. Only parts B and C have been considered for the purposes of this study [29].

Part B addresses the sociodemographic and clinical factors of the families. The questions address the relationship of the guardian to the child/adolescent, sex, age, marital status, educational qualifications, employment status in the last 12 months, smoking habits, the number and ages of the family, who is responsible for cooking, monthly family income and the average daily amount spent on food [29]. Part C approaches the sociodemographic profile of the children and adolescents. The data was collected on variables such as sex, age, school grade, number of siblings, age of the members of the family, mother's age at the time of birth, breastfeeding history (whether breastfed or not), and age at weaning (in months) [29]. The questions explore the main source of food consumed, whether the participant ate breakfast before school, brought snacks from home, purchased food in the school or around and consumed the hot meals provided at school, as well as the frequency of these meals throughout the week [29].

In addition to the above, information was also collected on water consumption during the school day and on the journeys to and from school (means of transportation and duration), as well as on sleep patterns and physical activity [29].

Anthropometric assessment

The anthropometric assessment of the study population was conducted by a trained team, including nutritionists from the HELPO NGO, following standardized anthropometric procedures.

Body weight was measured in kilograms (kg) using a calibrated SECA® 877 digital scale, with a precision of 0.1 kg. Children and adolescents were weighed wearing light clothing and no shoes. Height was measured in metres (m) using a portable SECA® 213 stadiometer, with a precision of 1 mm. During height measurement, participants stood barefoot with their head positioned in the Frankfort plane. Height-for-age z-scores (HAZ) and body mass index-for-age z-scores (BAZ) were calculated using the WHO AnthroPlus® software (version 1.0.4). Both indices were calculated and classified according to the 2007 World Health Organization (WHO) Growth Reference for children and adolescents aged 5-19 years.

Height-for-age z-score (HAZ) was used to assess linear growth according to the WHO Child Growth Standards/WHO Growth Reference. Stunting was defined as HAZ < −2 SD, while severe stunting was defined as HAZ < −3 SD.

Sociodemographic Characterization and Lifestyle

The characterization of the sample was carried out using variables from the questionnaire related to the child's guardians, such as sex, degree of kinship, educational level, marital status, employment status in the last 12 months and smoking habits. Regarding the household, information was collected on the number of members, monthly family income, and the monthly amount allocated to food. Regarding the child, information was obtained on age, sex, type and origin of water consumed, dietary intake, and daily physical activity data. Additionally,

they were also asked whether they ate breakfast before going to school, whether they had their meals at school, whether they bought other types of food near the school (usually ultra-processed products), and how much they spent on those products.

Dietary intake assessment

The dietary intake assessment was performed using a single 24-hour Dietary Recall (24HDR) questionnaire, which was administered indirectly by trained interviewers following standardized procedures. This approach collected information on all foods and beverages that were consumed during the preceding day, including the timing and location of meals, portion sizes, product brands, and methods of preparation.

These questionnaires were analysed, and portion sizes were then estimated using food composition tables (from Portugal and West Africa) [32,33], portion and weight manuals [34].

Finally, using Food Processor® software (ESHA Research, USA), the dietary data were converted into nutritional information to enable subsequent analysis of the children's and adolescents' UPF intake. The degree of processing was analysed according to the NOVA classification [13,35]. Considering the dietary data collected, the quantity and frequency of consumption of these foods were assessed.

The nutritional analysis focused on macronutrients (carbohydrates, protein, and fat) and the following micronutrients: vitamins A, B12, C, and D, folate, calcium, iron, magnesium, sodium, and zinc. These vitamins and minerals were selected due to their recognized importance in growth and their role as indicators of nutritional status in children and women of reproductive age, as they reflect

changes in diet and nutritional condition [36]. As an additional quality control procedure, the Goldberg method was applied to identify potential misreporting of dietary energy intake [37].

Methods

For categorical variables, descriptive statistics consisted of calculating absolute (n) and relative (%) frequencies. For continuous variables with a normal distribution, the mean (M) and standard deviation (SD) were calculated, whereas for discrete variables and/or continuous variables with a non-normal distribution, the median (Mdn) and the 25th and 75th percentiles (P25–P75) were determined. Histograms were used to visually assess the normality of the distributions of the continuous variables.

The p-value was calculated considering two groups (combining the moderate/severe undernutrition and mild undernutrition groups, and the normal weight and overweight/obesity groups). This approach was used because the number of cases in some variables was very small, making it impossible to perform Fisher's exact test. Therefore, this grouping was necessary, as the chi-square test was insufficient due to contingency table cells presenting expected frequencies lower than 5.

To analyse differences between groups, the independent samples Student's t-test was used when the continuous variable presented a normal distribution, and the Mann–Whitney U test was used when the continuous variable was discrete and/or presented a non-normal distribution. Pearson's chi-square test (x^2) or Fisher's exact test (in cases where the assumptions of the x^2 test were not met) was used for categorical variables.

Statistical significance was assumed for a p-value < 0.05 and a 95% confidence interval (CI). All statistical analyses were performed using IBM SPSS® Statistics software.

A logistic regression analysis was conducted using as independent variables those that showed a statistically significant association ($p < 0.05$).

As the sample size (n) of at least one group was small, the variables Daily amount in food and Place of purchase had to be recorded. The first variable was reduced from 5 categories (less than 50, 50–100, 100–200, 200–300, and more than 300) to 3 categories (less than 100, 100-200 and more than 200). The second variable was reduced from 4 categories (inside the school, outside the school, both, and other) to 3 categories (inside the school, outside the school, and both + other).

Results

Table 1 presents the sociodemographic characteristics of households according to the nutritional status of the children. In most cases, the mother was the primary caregiver of the children (87.6%) and the head of the household (73.1%). The mean age (± SD) of the household head was 37.97 (9.76) years. A large proportion of household heads were cohabiting with a partner (73.1%), and the majority were non-smokers (99.6%). Most household heads had completed primary education (Grades 1–4), whereas those with no formal education (2.5%) and those holding a university degree (1.2%) were the least represented.

During the previous 12 months, most household heads were employed (48.5%), while only a small proportion were studying (2.4%). In most households (85.3%), the mother was responsible for food preparation and cooking. Slightly more than 13% of households reported having a home garden.

The median number (P25–P75) of household members living together was 6 (5–7), including 1 (0–1) child younger than 5 years, 3 (2–3) members aged between 5 and 18 years, and 2 (2–3) members older than 18 years.

According to Table 1, differences were observed in the distribution of household food expenditure between the two groups, with a higher proportion of households in the thinness group reporting food expenditure below 100 (35.8%). Furthermore, the majority of households were exposed to food insecurity (73.4%).

When comparing household characteristics according to the nutritional status of the children (Table 1), statistically significant differences were identified for the following variables: the number of household members aged 5–18 years and the amount of money spent on food.

The proportion of children with thinness was higher among households reporting food expenditure between 100 and 200 (50.3%). Regarding the number of household members aged 5–18 years, the only difference observed corresponded to the 75th percentile, which was 4 in the thinness group and 3 in the non-thinness group.

Table 1. Families' sociodemographic characteristics

	Total	Thinness	Non-Thinness	p value
Relationship of guardian (respondent) to the child/adolescent, n(%)				0.611
Mother	394 (73.1)	128 (69.6)	266 (74.9)	
Father	49 (9.1)	20 (10.9)	29 (8.2)	
Grandparents	29 (5.4)	11 (6.0)	18 (5.1)	
Aunt/Uncle	33 (6.1)	14 (7.6)	19 (5.4)	
Others	34 (6.3)	11 (6.0)	23 (6.5)	

Head of the household, sex (n%)				0.256
Male	67 (12.4)	27 (14.7)	40 (11.3)	
Female	472 (87.6)	157 (85.3)	315 (88.7)	
Relationship to the child/adolescent, n(%)				0.341
Mother	387 (71.9)	123 (66.8)	264 (74.6)	
Father	44 (8.2)	16 (8.7)	28 (7.9)	
Grandparents	27 (5.0)	11 (6.0)	16 (4.5)	
Aunt/Uncle	39 (7.2)	18 (9.8)	21 (5.9)	
Others	41 (7.6)	16 (8.7)	25 (7.1)	
Age in years, Mean±SD	37.9 ± 9,7	37.9 ± 10.5	37.9 ± 9.3	0.984*1
Child caregiver ,n(%)				0.404
Yes	491 (91.1)	165 (89.7)	326 (91.8)	
No	48 (8.9)	19 (10.3)	29 (8.2)	
Cohabiting with a partner, n (%)				0.122
Yes	375 (73.1)	122 (68.9)	253 (75.3)	
No	138 (26.9)	55 (31.1)	83 (24.7)	
Smoker, n (%)				0.116*2
Yes	2 (0.4)	2 (1.1)	0	
No	535 (99.6)	181 (98.9)	354 (100)	
Highest level of education, n (%)				0.620*2
No education	13 (2.5)	2 (1.1)	11 (3.2)	
1st to 4th grade	203 (38.8)	73 (41.5)	130 (37.5)	
5th to 6th grade	112 (21.4)	37 (21.0)	75 (21.6)	
7th to 9th grade	125 (23.9)	42 (23.9)	83 (23.9)	
10th to 12th grade	64 (12.2)	19 (10.8)	45 (13.0)	
Higher education	6 (1.2)	3 (1.7)	3 (0.9)	

Occupational status in the last 12 months, n (%)				0.657
Student	13 (2.4)	5 (2.7)	8 (2.3)	
Housewife/househusband	186 (34.7)	66 (35.9)	120 (34.1)	
Employed/self-employed	260 (48.5)	83 (45.1)	177 (50.3)	
Unemployed or retired	77 (14.4)	30 (16.3)	47 (13.4)	
Home garden, n (%)				0.498
Yes	72 (13.4)	22 (12.0)	50 (14.1)	
No	465 (86.6)	161 (88.0)	304 (85.9)	
Person responsible for preparing/cooking meals at home, n (%)				0.633*2
Mother	453 (84.5)	151 (82.1)	302 (85.8)	
Father	5 (1.0)	3 (1.6)	2 (0.6)	
Grandparents	34 (6.3)	13 (7.1)	21 (6.0)	
Children	9 (1.7)	3 (1.6)	6 (1.7)	
Others	35 (6.5)	14 (7.6)	21 (6.0)	
Household members, Mdn (P25–P75)				
Number of members living together (n= 544)	6.0 (5.0 – 7.0)	6.0 (5.0 – 7.0)	6.0 (5.0 – 7.0)	0.448*3
Number of members aged <5 years old (n= 539)	1.0 (0.0 – 1.0)	1.0 (0.0 – 1.0)	1.0 (0.0 – 1.0)	0.526
Number of members aged between 5 and 18 years old	3.0 (2.0-3.0)	3.0 (2.0 – 4.0)	3.0 (2.0 – 3.0)	0.023
Number members aged >18 years old	2.0 (2.0-3.0)	2.0 (2.0-3.0)	2.0 (2.0-3.0)	0. 174
Household income in STN, n (%)				0.700
Inf 500	33 (7.9)	13 (9.2)	20 (7.2)	
500-1000	42 (10.0)	16 (11.3)	26 (9.3)	
1000-2000	111 (26.4)	32 (22.7)	79 (28.3)	
2000-3000	133 (31.7)	44 (31.2)	89 (31.9)	

Sup 3000	101 (24.0)	36 (25.5)	65 (23.3)	
Daily amount of food expenses in STN, n (%)				«0.001
Inf 100	158 (31.2)	62(35.8)	96 (28.7)	
100-200	279 (55.0)	87 (50.3)	192 (57.5)	
Sup 200	70 (13.8)	24 (13.9)	46 (13.8)	
Food Insecurity, n (%)				0.935
Yes	353 (73.4)	120 (73.6)	233 (73.3)	
No	128 (26.6)	43 (26.4)	85 (26.7)	

Notes: 1 corresponds to the independent samples t-test; 2 corresponds to Fisher's exact test; 3 corresponds to the Mann-Whitney U test.

Table 2 presents the characteristics of the children and adolescents according to their nutritional status. Slightly more than 50% of the children and adolescents were male, and the mean age (± SD) was 10.8 (± 1.2) years. Most participants were attending the 5th grade (56.2%). The median number (P25–P75) of siblings was 3 (2–4), corresponding to 3 (2–4) among children and adolescents with malnutrition (severe, moderate, and mild) and 3 (2–3) among those with normal weight and overweight/obesity. Most participants were first-born children (29.4%), with the percentage decreasing progressively from the first-born to the last-born child. At the child's birth, the median maternal age (P25–P75) was 25.0 (21.0–31.0) years.

The mean birth weight (± SD) was 3.22 (± 0.6) kg, and the majority of participants had a normal birth weight (83.7%). Almost all children and adolescents had been breastfed (98.5%), with a median breastfeeding duration (P25–P75) of 18 (15–20) months. The mean (± SD) HAZ and BMI-for-age z-scores were −0.50 (± 1.1) and −0.7 (± 0.04), respectively.

Over 50% of the target population had taken at least one oral nutritional supplement. The main source of food for approximately 90% of children and adolescents was household food provision, although a small proportion still depended on agriculture and self-production (6.5%) or donations (3.2%).

More than 90% of children and adolescents ate breakfast before leaving home and had lunch at school. Regarding school lunches, more than 60% consumed school meals five times per week, whereas only a minority (5.2%) consumed them once weekly. Nearly 90% of children and adolescents did not bring snacks from home to school, which resulted in 38.5% purchasing snacks either inside the school (38.2%) or outside the school (54.1%), most commonly one to two times per week.

Approximately 90% of children and adolescents drank water, most commonly from public fountains or wells (44.7%), whereas only a small proportion consumed bottled water (4.9%). More than 50% did not have access to treated water.

During the week, most children and adolescents walked to school (96.8%) and returned home on foot (98.1%). Regarding lifestyle habits, the median daily duration (P25–P75) of physical activity was 120 (60–180) minutes, and the median sleep duration was 11 (11–12) hours per day.

When analysing the characteristics of children and adolescents according to nutritional status (Table 2), statistically significant differences were identified for the following variables: birth weight (g), breastfeeding, height-for-age z-score, BMI-for-age z-score, place of snack purchase, and sleep duration.

Children and adolescents with normal weight or overweight/obesity (non-thinness group) had a higher mean birth weight (3.26 ± 0.61 kg). The not-thinness group had a higher proportion of individuals who had been breastfed (99.4%).

Children and adolescents with normal weight or overweight were more likely to purchase snacks inside the school (42.3%), whereas those with thinness tended to purchase them outside the school premises (64.4%).

For both HAZ and BMI-for-age z-scores, the thinness group presented lower values compared with the normal-weight and overweight group.

Regarding daily sleep duration, both groups presented identical values at the 25th and 50th percentiles. However, differences were observed at the 75th percentile, with the thinness group presenting a longer sleep duration (12 hours) compared with the non-thinness group.

Table 2. Children's/adolescents' sociodemographic characteristics

	Total	Thinness	Not Thinness	p value
Sex, n(%)				0.749
Female	260 (48.2)	87 (47.3)	183 (48.7)	
Male	279 (51.8)	97 (52.7)	182 (51.3)	
Age in years, Mean±SD	10.82 ± 1.167	10.87 ± 1.166	10.80 ± 1.169	0.495*1
School grade, n (%)				0.639
5th grade	303 (56.2)	106 (57.6)	197 (55.5)	
6th grade	236 (43.8)	78 (42.4)	158 (44.5)	
Number of siblings, Mdn (P25–P75), n=535	3.0 (2.0-4.0)	3.0 (2.0-4.0)	3.0 (2.0-4.0)	0.791*3
Birth order, n (%)				0.452
First-born	140 (29.7)	53 (33.1)	87 (27.9)	
Second-born	114 (24.2)	34 (21.3)	80 (25.6)	
Third-born	93 (19.7)	35 (21.9)	58 (18.6)	

Fourth-born	58 (12.3)	16 (10.0)	42 (13.5)	
Fifth-born	34 (7.2)	9 (5.6)	25 (8.0)	
Sixth-born or other	33 (6.9)	13 (8.1)	20 (6.4)	
Maternal age at birth in years, Mdn (P25–P75), n = 490	25.0 (21.0-31.0)	25.0 (20.0-31.0)	25.0 (21.0-31.0)	0.514
Birth weight in grams (n=443), Mean±SD	3.2 ± 0.6	3.1 ± 0.6	3.3 ± 0.6	0.032
WHO weight status classification				0.144*2
Very low birth weight, n (%)	2 (0.5)	2 (1.4)	0	
Low birth weight, n (%)	37 (8.4)	15 (10.4)	22 (7.4)	
Normal for gestational age, n (%)	369 (83.7)	118 (81.9)	251 (84.5)	
Macrosomic, n (%)	33 (7.5)	9 (6.3)	24 (8.1)	
Gestational age in weeks (n=478), Mean±SD	39.5 ± 1.7	39.3 ± 1.9	39.6 ± 1.6	0.060*1
Gestational age in weeks				0.076
Preterm, n(%)	44 (9.3)	18 (11.3)	26 (8.3)	
Term, n(%)	412 (86.9)	140 (87.5)	272 (86.6)	
Post term, n(%)	18 (3.8)	2 (1.3)	16 (5.1)	
Breastfeeding, n(%)				0.021*2
Yes	523 (98.5)	178 (96.7)	348 (99.4)	
No	8 (1.5)	6 (3.3)	2 (0.6)	
Breastfeeding duration in months (n=487), Mdn (P25–P75)	18.0 (15.0-20.0)	18.0 (15.0-20.0)	18.0 (15.0-20.0)	0.317
Height-for-agez-score,at the interview (n=539), Mean±SD	-0.50 ± 1.08	-0.76± 1.09	-0.36 ± 1.01	«0.001
BMI-for-agez-score,at the interview (n=), Mean±SD	-0.66 ± 0.042	-1.65 ± 0.051	-0.15 ± 0.035	«0.001
Dietary oral supplement in the previous 12 months, n(%)				0.052
Yes	239 (54.9)	92 (61.3)	145 (51.6)	
No	196 (45.1)	58 (38.7)	138 (48.4)	
Main source of child/adolescent nutrition, n(%)				0.685*2
Own production, farming, hunting or fishing	35 (6.5)	12 (6.5)	23 (6.5)	

Purchases	487 (90.4)	164 (89.1)	323 (91.0)	
Exchanges, donations	17 (3.2)	8 (4.3)	9 (2.5)	
Eating breakfast before going to school? n (%)				0.746
Yes	492 (91.8)	171 (92.9)	321 (91.2)	
No	22 (4.1)	6 (3.3)	16 (4.5)	
Sometimes	22 (4.1)	7 (3.8)	15 (4.3)	
Eating a hot meal for lunch at school, n (%)				0.277
Yes	504 (93.5)	175 (95.1)	329 (92.7)	
No	35 (6.5)	9 (4.9)	26 (7.3)	
Frequency of hot school meals consumption? n (%)				0.318
One time/week	26 (5.2)	9 (5.2)	17 (5.2)	
Two times/week	33 (6.6)	17 (9.8)	16 (4.9)	
Three times/week	70 (14.1)	24 (13.9)	46 (14.2)	
Four times/week	60 (12.1)	22 (12.7)	38 (11.7)	
Daily	308 (62.0)	101 (58.4)	207 (63.9)	
Bringing snacks from home to school? n (%)				0.656
Yes	206 (38.5)	74 (40.2)	132 (37.6)	
No	265 (49.5)	91 (49.5)	174 (49.6)	
Sometimes	64 (12.0)	19 (10.3)	45 (12.8)	
Buying foods at school and/or near it? n (%)				0.765
Yes	471 (87.5)	160 (87.0)	311(87.9)	
No	67 (12.5)	24 (13.0)	43 (12.1)	
Place of purchases, n (%)				0.013*2
Inside the school	169 (38.2)	45 (30.2)	124 (42.3)	
Outside the school (up to 100m)	239 (54.1)	96 (64.4)	143 (48.8)	
Both or other places	34 (7.7)	8 (5.4)	26 (8.9)	
Frequency of those food purchases? n (%)				0.798
Less than one time/week	82 (16.0)	28 (16.4)	54 (15.9)	
One to two times/week	183 (35.8)	62 (36.3)	121 (35.6)	

Three to four times/week	152 (29.7)	54 (31.6)	98 (28.8)	
Daily	80 (15.7)	24 (18.9)	56 (8.3)	
More than once a day	14 (2.7)	3 (1.8)	11 (3.2)	
Money spent on those purchases in STN (n=476), Mdn (P25-P75)	5.0 (2.0-6.0)	5.0 (2.0-5.0)	5.0 (2.0-7.0)	0.207*3
Drinking water while at school, n (%)				0.099
Yes	484 (89.9)	171 (92.9)	313 (88.2)	
No	55 (10.2)	13 (7.1)	42 (11.8)	
Source of that water, n (%)				0.994
Tap	108 (35.0)	39 (35.8)	69 (34.5)	
Bottled	15 (4.9)	5 (4.6)	10 (5.0)	
Fountain or well	138 (44.7)	48 (44.0)	90 (45.0)	
River or stream	38 (12.3)	14 (12.8)	24 (12.0)	
Other (rain, tank...)	10 (3.2)	3 (2.8)	7 (3.5)	
Treated water, n (%)				0.897
Yes	118 (45.4)	42 (44.7)	76 (45.8)	
No	142 (54.6)	52 (55.3)	90 (54.2)	
From home to school, n (%)				0.605
By foot	521 (96.8)	177 (96.2)	344 (97.2)	
Transport (van, school bus or motorcycle)	17 (3.2)	7 (3.8)	10 (2.8)	
Duration in minutes (n=) Mdn(P25–P75)	20.0 (10.0-40.0)	20.0 (10.0-40.0)	20.0 (10.0-40.0)	0.750*3
From school to home, n (%)				0.741*2
By foot	529 (98.1)	180 (97.8)	349 (98.3)	
Transport (van, school bus or motorcycle)	10 (1.9)	4 (2.2)	6 (1.7)	
Duration in minutes (n=), Mdn(P25–P75)	20.0 (10.0-40.0)	20.0 (10.0-40.0)	20.0 (10.0-40.0)	0.863*3
Daily time of physical activity and/or sport and/or active play in minutes (n=546), Mdn(P25–P75)	120.0 (60.0 – 180.0)	105.0 (60.0 - 180.0)	120.0 (60.0 - 180.0)	0.693*3
Daily sleep duration in hours and minutes (n=546), Mdn(P25–P75)	11.0 (11.0-12.0)	11.0 (10.0-12.0)	11.0 (10.0-11.0)	0.024*3

Notes: 1 corresponds to the independent samples t-test; 2 corresponds to Fisher's exact test; 3 corresponds to the Mann-Whitney U test.

Table 3 presents the nutritional intake characteristics of children and adolescents according to BMI.

The mean daily total energy intake (± SD) was 1482.3 kcal (± 574.6), with higher energy intake observed among the participants in the not-thinness group (1518.5 ± 601.2 kcal). Mean daily total protein intake (± SD) was 44.1 g (± 16.4). Protein intake was lower among the children and adolescents with thinness.

When analysing nutritional intake according to BMI status (Table 3), statistically significant differences were identified for the following variables: total energy intake, saturated fat, total protein, retinol, vitamin B2, folate, and calcium.

Saturated fat intake was significantly higher among the participants with normal and overweight; however, when considering its contribution to total energy intake, this difference was no longer observed. The intake of all the micronutrients mentioned above (retinol, vitamin B2, folate, and calcium) was higher among participants with normal and overweight.

Table 3. Nutritional intake of children and adolescents according to the BMI

	Total	Thinness Mdn(P25-75)	Not Thinness Mdn(P25-75)	p value
Total energy (kcal/day), Mean±SD	1482. 35 ± 574. 62	1412.60 ± 513.87	1518.49 ± 601.21	0.033
Total fat (g/day)	45.10 (31.34 - 62.32)	42.05 (30.46 - 57.65)	46.82 (31.54 - 64.49)	0.078

Total fat (%TEV)	28.73 (23.41 – 35.53)	28.17 (22.59 – 35.23)	29.24 (23.51 – 35.52)	0.523
Saturated fat (g/day)	8.21 (5.90 – 11.94)	7.53 (5.37 – 11.76)	8.40 (6.20 – 12.00)	0.040
Saturated fat (%TEV)	5.32 (3.99 – 6.97)	5.26 (3.77 – 6.82)	5.38 (4.06 – 7.06)	0.286
Monounsaturated fat (g/day)	10.02 (6.16 – 14.77)	9.13 (5.48 – 14.10)	10.36 (6.40 – 14.92)	0.092
Monounsaturated fat (%TEV)	6.35 (4.45 – 8.62)	6.25 (4.32 – 8.36)	6.42 (4.50 – 8.80)	0.429
Polyunsaturated fat (g/day)	13.68 (7.80 – 22.49)	13.06 (6.38 – 21.79)	14.12 (7.98 – 22.62)	0.144
Polyunsaturated fat (%TEV)	8.78 (5.90 – 12.73)	8.12 (5.49 – 12.89)	8.98 (6.08 – 12.60)	0.307
Carbohydrates (g/day), Mean±SD	205.67 ± 84.12	196.84 ± 73.23	210.24 ± 89.00	0.062
Carbohydrates (%TEV), Mean±SD	55.94 ± 9.89	55.38 ± 9.91	55.72 ± 9.88	0.463
Total sugars (g/day)	37.67 (13.85 – 68.51)	38.23 (13.93 – 67.97)	37.83 (13.83 – 68.52)	0.609
Total sugars (%TEV)	10.62 (4.28 – 19.15)	10.92 (4.12 – 20.54)	10.49 (4.28 – 15.25)	0.773
Total fiber (g/day)	12.15 (7.46 – 18.01)	12.44 (7.38 – 16.98)	11.97 (7.57 – 18.93)	0.571
Soluble fiber (g/day)	0.20 (0.02 – 24.38)	0.01 (0.00- 15.33)	0.03 (0.00- 24.38)	0.110

Protein (g/day), Mean±SD	44.06 ± 16.43	41.40 ± 16.53	45.43 ± 17.75	0.011
Protein (g/kg/day), Mean±SD	1.36 ± 0.59	1.44 ± 0.63	1.32 ± 0.56	0.022
Protein (%TEV), Mean±SD	12.16 ± 2.94	11.86 ± 2.74	12.31 ± 3.04	0.089
Cholesterol (mg/day)	48.14 (28.18 – 83.95)	44.74 (22.76 – 77.59)	52.11 (30.40 – 86.93)	0.061
Vitamin A (µgRE/day)	118.21 (53.27 – 199.7)	120.04 (52.19 – 199.44)	114.66 (53.43 – 199.28)	0.851
Retinol (µg/day)	99.56 (50.72 – 213.93)	88.41 (40.79 – 187.82)	105.55 (56.22 – 225.95)	0.024
Beta-carotene (µg/day)	1405.9 (620.8 – 2543.4)	1352.96 (582.43 – 2505.10)	1458.72 (651.45 – 2546.51)	0.490
VitaminB-1 (mg/day)	0.49 (0.34 – 0.69)	0.47 (0.33 – 0.60)	0.50 (0.35 – 0.72)	0.053
VitaminB-2 (mg/day)	0.42 (0.25 – 0.63)	0.35 (0.22 – 0.56)	0.45 (0.26 – 0.64)	0.008
VitaminB-3 (mgNE/day)	9.4 (6.11 – 13.4)	9.29 (5.68 – 12.20)	9.51 (6.18 – 13.90)	0.121
VitaminB-6 (mg/day)	0.74 (0.52 – 1.04)	0.72 (0.46 – 0.99)	0.77 (0.54 – 1.07)	0.051
VitaminB-12 (mg/day)	3.12 (1.32 – 5.93)	3.00 (1.32 – 5.75)	3.27 (1.32 – 6.05)	0.319
Vitamin C (mg/day)	49.17 (27.67 – 79.33)	44.59 (28.90 – 72.55)	54.88 (27.60 – 83.64)	0.101

Vitamin D (mg/day)	6.77 (2.70 - 11.70)	6.72 (2.80 - 11.11)	6.95 (2.53 - 11.89)	0.524
Vitamin E α-tocopherol (mg/day)	7.05 (3.56 - 12.59)	6.48 (3.25 - 11.42)	7.30 (3.76 - 12.62)	0.266
Folate DFE (µg/day)	82.18 (58.41 - 121.58)	75.73 (57.02 - 101.81)	86.82 (59.43 - 128.76)	0.008
Vitamin K (µg/day)	2.81 (0.54 - 5.52)	2.61 (0.64 - 4.99)	3.10 (0.50 - 6.20)	0.516
Iron (mg/day)	4.13 (3.12 - 5.32)	4.02 (2.91 - 5.17)	4.28 (3.20 - 5.34)	0.065
Magnesium (mg/day)	141.71 (107.89 - 188.43)	141.93 (103.73 - 176.63)	141.80 (111.40 - 192.75)	0.242
Calcium (mg/day)	161.59 (100.94 - 289.50)	140.71 (93.60 - 243.10)	173.72 (104.41 - 300.49)	0.022
Zinc (mg/day)	3.22 (2.29 - 4.39)	3.14 (2.08 - 4.02)	3.29 (2.32 - 4.62)	0.061
Copper (mg/day)	0.14 (0.04 - 0.32)	0.16 (0.043 - 0.33)	0.13 (0.040 - 0.32)	0.736
Phosphorus (mg/day)	455.32 (317.31 - 599.18)	424.30 (292.80 - 562.67)	461.82 (327.99 - 619.99)	0.030
Potassium (mg/day)	1321.16 (862.01 - 1892.49)	1375.18 (842.91 - 1840.00)	1306.27 (857.33 - 1958.59)	0.574

Selenium (µg/day)	20.32 (7.63 – 40.28)	20.32 (9.72 – 36.56)	20.32 (6.95 – 40.64)	0.415
Sodium (mg/day)	1141.92 (779.16 – 1700.48)	1116.51 (727.13 – 1636.71)	1145.69 (794.89 – 1719.66)	0.271

Table 4 presents the results of the logistic regression analysis. The findings showed that the number of household members aged between 5 and 18 years was positively associated with higher odds of thinness (OR = 1.170; 95% CI: 1.030–1.345; p = 0.017).

Likewise, compared with children who purchased snacks inside the school (reference category), those who purchased snacks outside the school had significantly higher odds of thinness (OR = 1.850; 95% CI: 1.206–2.838; p = 0.005). Purchasing snacks both inside and outside the school was not significantly associated with thinness.

The height-for-age z-score demonstrated a significant inverse association with malnutrition (OR = 0.700; 95% CI: 0.587–0.834; p < 0.001), indicating that better linear growth was associated with a lower odds of thinness. Birth weight also showed a statistically significant inverse association.

Regarding dietary intake, both total energy intake (OR = 0.999; 95% CI: 0.999–1.000; p = 0.044) and saturated fat intake (OR = 0.966; 95% CI: 0.934–0.999; p = 0.044) were inversely associated with thinness . Higher intake of vitamin B2 (OR = 0.442; 95% CI: 0.227–0.860; p = 0.016), folate (OR = 0.994; 95% CI: 0.990–0.998; p = 0.001), retinol (OR = 0.998; 95% CI: 0.997–1.000; p = 0.020), and calcium (OR = 0.999; 95% CI: 0.998–1.000; p = 0.047) were also independently associated with lower odds of thinness.

Conversely, protein intake showed a positive association with thinness (OR = 1.418; 95% CI: 1.050–1.914; p = 0.023).

Daily sleep duration was also statistically significant (p = 0.046); however, as the OR was rounded to 1.000, this suggests a negligible magnitude of the association. No statistically significant associations were observed for BMI-for-age and daily food expenses.

Overall, the findings suggest that family, behavioural, and nutritional factors play an important role in the occurrence of thinness, particularly household size, place of food purchase, and micronutrient intake.

Table 4. Multivariable logistic regression analysis of factors associated with nutritional status, with thinness as the reference category.

	Odds Ratio (OR)	Confidence Interval (CI)	P value
Number of members aged between 5 and 18 years old	1.170	1.030 – 1.345	0.017
Daily amount of food expenses in STN, n(%)	REF		
100-200	0.702	0.467 – 1.055	0.088
Sup a 200	0.808	0.449 – 1.454	0.477
Birth weight in grams (n=443), Mean±SD	0.999	0.999 – 1.000	0.033
BMI-for-agez-score,at the interview, Mean±SD	0.000	0.00	0.816
Height-for-age-z score,at the interview, Mean±SD	0.700	0.587 – 0.834	«0.001
Place of purchases, n(%)	REF		
Outside school	1.850	1.206 – 2.838	0.005
Both outside and at school	0.848	0.358 – 2.009	0.708
Daily sleep duration in hours and minutes, Mdn(P25–P75)	1.000	1.000 – 1.000	0.046
Total energy (kcal/day), Mean±SD	0.999	0.999 – 1.000	0.044
Saturated fat (g/day)	0.966	0.934 – 0.999	0.044

Protein (g/kg/day), Mean±SD	1.418	1.050 – 1.914	0.023
Retinol (µg/day)	0.998	0.997 – 1.000	0.020
VitaminB-2 (mg/day)	0.442	0.227 – 0.860	0.016
Folate DFE (µg/day)	0.994	0.990 – 0.998	0.001
Calcium (mg/day)	0.999	0.998 – 1.000	0.047

Note: The variables "BMI-for-age z-score at the interview" and "Daily sleep duration (hours and minutes)" have odds ratio (OR) and confidence interval (CI) values of 0.000 and 1.000, respectively, due to rounding to three decimal places.

Discussion

The present study aimed to assess the prevalence of thinness and identify its main determinants among school-aged children and adolescents in the district of Cantagalo, São Tomé and Príncipe (STP), with a particular focus on food insecurity, dietary intake, and sociodemographic characteristics. The findings highlight the persistence of undernutrition and nutritional inadequacies, particularly micronutrient deficiencies, within this population, despite the ongoing nutrition transition observed across several African countries.

The results demonstrated that thinness remains highly prevalent among children and adolescents in Cantagalo, confirming that undernutrition continues to represent a major public health concern in STP. According to Ferreira et al. (2024), the prevalence of thinness reaches 34% among children aged 10–11 years living in the same district. Beyond STP, several countries in Sub-Saharan Africa display similar patterns, where thinness, stunting, micronutrient deficiencies, and food insecurity remain common among school-aged populations [6,21].

Although global nutrition initiatives have traditionally focused on children under five years of age, there is growing evidence that school-aged children and adolescents constitute a nutritionally vulnerable group, particularly in low- and middle-income African countries [38]. This stage of life is characterised by rapid

physical growth, increased nutritional requirements, and substantial cognitive development. Consequently, adequate dietary intake is essential for healthy growth and for achieving favourable long-term health and educational outcomes [39].

This study found a significant association between the number of household members aged 5–18 years and the odds of undernutrition. Children living in households with a greater number of school-aged members were more likely to experience thinness. This finding may reflect increased competition for food and financial resources within the household, particularly in contexts of poverty and food insecurity. Similar associations have been reported in several African studies, in which larger household size was associated with poorer dietary adequacy, lower dietary diversity, and increased vulnerability to undernutrition [7,10]. In resource-constrained settings such as STP, families with multiple children may face greater difficulties in ensuring regular access to nutritionally adequate foods, particularly animal-source foods and foods rich in vitamins and minerals [40].

Most households included in this study experienced FI, highlighting the vulnerability of the population. Although FI was not significantly associated with nutritional status, its high prevalence reflects the challenging socioeconomic conditions experienced by many families in the Cantagalo district. In a previous study based on the same sample of children and adolescents from Cantagalo, Ferreira et al. (2024) similarly reported severe food insecurity in more than 70% of households [9].

Another important finding was the association between purchasing snacks outside the school environment and a higher likelihood of undernutrition. Children and adolescents who purchased food outside school premises were more likely to

be thin than those who purchased food within the school environment. This finding may reflect differences in the nutritional quality of foods sold outside schools compared with those available within them. In many African countries, the rapid expansion of food environments surrounding schools has increased children's access to low-cost ultra-processed foods that are energy-dense but poor in essential micronutrients [5].

In a previous analysis of the same study population, Morais et al. (2024) demonstrated that higher consumption of ultra-processed foods in Cantagalo was associated with lower intakes of dietary fibre and several micronutrients, including zinc and vitamin B12 [15]. Although these products may contribute to total energy intake, they frequently have poor nutritional quality, thereby contributing to significant micronutrient deficiencies.

The nutritional analysis conducted in the present study revealed widespread inadequacies in several nutrients essential for growth and development. Statistically significant protective associations were observed for total energy intake, retinol, vitamin B2, folate, and calcium intake. These findings suggest that better dietary quality and higher total energy intake may contribute to reducing the odds of thinness among school-aged children and adolescents. [41]. Chronic insufficient energy intake compromises growth, immune function, and body weight maintenance, particularly during late childhood and adolescence, periods characterised by increased nutritional requirements [41].

Micronutrients also appeared to play an important role in nutritional status. Retinol intake demonstrated a protective association against undernutrition. Vitamin A deficiency remains highly prevalent in Sub-Saharan Africa and has been associated with impaired immune function, increased susceptibility to infections,

and reduced academic performance [42]. Low vitamin A intake may reflect limited access to animal-source foods, fruits, and vegetables, which are often less available in food-insecure households [43].

Similarly, vitamin B2 (riboflavin) intake was inversely associated with undernutrition. Riboflavin plays a central role in energy metabolism, including carbohydrate metabolism, lipid metabolism, and energy homeostasis, as well as in growth and cellular development [44]. Low intake of this vitamin may indicate limited dietary diversity and low consumption of milk, eggs, and animal-source foods, which are often economically inaccessible in vulnerable settings [45].

Folate intake also demonstrated a significant protective effect. Folate is essential for DNA synthesis, cell division, and tissue growth, making adequate intake particularly important during periods of rapid growth such as adolescence. Low folate intake has frequently been associated with poor dietary diversity and insufficient consumption of vegetables, legumes, and fortified foods [45].

Calcium intake was likewise associated with a lower likelihood of undernutrition. Calcium is essential for bone mineralisation and skeletal growth during childhood and adolescence [44]. The low calcium intake observed in this population may reflect limited consumption of dairy products and other calcium-rich foods, potentially related to economic constraints and reduced food availability [45].

The present study also identified a significant inverse association between birth weight and thinness. Children with higher birth weights were less likely to experience undernutrition later in life. This finding reinforces the existing evidence regarding the impact of early-life nutritional conditions on subsequent growth and development. Low birth weight is frequently associated with

intrauterine growth restriction, maternal undernutrition (including nutritional deficiencies such as anaemia), infections, and inadequate prenatal care, all of which contribute to an increased risk of childhood undernutrition [45-47].

Height-for-age z-score (HAZ) also demonstrated a strong protective association with nutritional status. Children with better linear growth were less likely to experience thinness, suggesting the coexistence of chronic and acute forms of undernutrition within the same population. Similar findings have been reported in several Sub-Saharan African countries, where stunting and thinness frequently coexist and reflect prolonged nutritional deprivation, recurrent infections, and socioeconomic vulnerability [48].

An unexpected finding of the present study was the positive association between protein intake (g/kg/day) and undernutrition.

One possible explanation for this finding is that children with thinness have a lower body weight. Consequently, although their absolute protein intake (g/day) may be lower, expressing protein intake relative to body weight (g/kg/day) can result in higher values. In addition, dietary intake was assessed using a single 24-hour recall, which may not accurately reflect participants' usual protein intake due to day-to-day variation. Furthermore, the cross-sectional design of this study does not allow the temporal relationship between dietary intake and thinness to be established. Therefore, it cannot be determined whether higher protein intake per kilogram of body weight preceded the development of thinness or reflects dietary changes following the onset of undernutrition.

Sleep duration was also found to be statistically significant, although the observed odds ratio does not suggest a clinically meaningful association.

Nevertheless, sleep patterns may indirectly influence nutritional status through their effects on metabolism, appetite regulation, and overall health status [49].

The findings of this study should be interpreted in light of several limitations. First, due to the cross-sectional design, causal relationships between the identified factors and undernutrition/thinness cannot be established. Second, dietary intake was assessed using a single 24-hour dietary recall, which may not adequately represent habitual intake or capture seasonal variations in dietary patterns. Furthermore, dietary data relied on the memory and reporting abilities of both children and caregivers, potentially introducing recall bias. Finally, although BMI-for-age is widely used in epidemiological studies, it does not directly assess body composition and may therefore fail to fully capture differences between fat mass and lean mass.

Despite these limitations, the study has several important strengths. To the best of our knowledge, this is one of the first studies to specifically investigate thinness and its determinants among school-aged children and adolescents in STP. Furthermore, the detailed nutritional analysis enabled the identification of important micronutrient inadequacies associated with undernutrition. The adaptation of the Food Processor® database to include local foods and recipes also contributed to improving the accuracy of dietary assessment.

Conclusion

This study demonstrated that thinness remains highly prevalent among school-aged children and adolescents in the Cantagalo district of São Tomé and

Príncipe, confirming that undernutrition continues to represent an important nutritional challenge in this population.

The findings identified several factors associated with thinness. A greater number of household members aged 5–18 years and purchasing snacks outside the school environment were associated with a higher likelihood of thinness. Conversely, higher birth weight, better linear growth (higher HAZ), greater total energy intake, and higher intakes of retinol, vitamin B2, folate, and calcium were associated with a lower likelihood of thinness. Although protein intake showed a positive association with undernutrition, this result should be interpreted with caution, given the cross-sectional design and the possibility of reverse causality.

Overall, these findings suggest that both household characteristics and dietary quality contribute to the nutritional status of school-aged children and adolescents in Cantagalo. The observed associations emphasise the importance of improving access to nutritionally adequate diets, particularly micronutrient-rich foods, while strengthening the nutritional quality of foods available in and around schools. Future longitudinal studies are needed to clarify the causal relationships between these factors and thinness and to support the development of targeted nutrition interventions in this population.

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Annexes and Appendices

Annex A – Ethical approval from the Health Ethics Committee for Scientific Research from the Ministry of Health of the Democratic Republic of São Tomé and Príncipe

Appendix A - Table 1. Families'sociodemographic characteristics

Appendix B - Table 2. Children's/adolescents'sociodemographic characteristics

Appendix C - Table 3. Nutritional intake of children and adolescents according to the BMI

Annex A

REPÚBLICA DEMOCRÁTICA DE SÃO TOMÉ E PRÍNCIPE
(Unidade – Disciplina – Trabalho)
Ministério da Saúde
Direção dos Cuidados de Saúde
Comissão de Ética na Saúde para a Investigação Científica

PARECER COMISSÃO DE ÉTICA NA SAÚDE PARA A INVESTIGAÇÃO CIENTÍFICA

COMPONENTE I: AVALIAÇÃO GERAL

I.1) Dados Gerais

Título do Estudo: Estudo de avaliação do estado nutricional das crianças e dos hábitos alimentares das famílias do Distrito de Cantagalo.

Referência Protocolo: 019/2022
Data de submissão: 25/03/2022
Investigador Principal: ***Daniel Elsilay Barros Cravid***
Promotor(a) da investigação: Camões IP, ONG Helpo, Programa Alimentar Mundial (PAM)
Local de investigação: Distrito de Cantagalo (São Tomé)
Primeiro Parecer: ----------//----------
Data de nova submissão: ----------//---------
Parecer final: ***Favorável***
Data de validação do parecer em plenária CESIC: 26/10/2022

I.2) Interesse do estudo

2.1) O estudo tem interesse para ser realizado no território nacional? *(assinale com X)*
Sim X Não _____

2.2) Justificação *(preencher em qualquer das opções)*:

O estudo irá permitir ao país obter informações que irão contribuir para a implementação de uma estratégia nacional de alimentação escolar que visa a melhoria da saúde e do estado nutricional das crianças de São Tomé e Príncipe.

REPÚBLICA DEMOCRÁTICA DE SÃO TOMÉ E PRÍNCIPE
(Unidade – Disciplina – Trabalho)
Ministério da Saúde
Direção dos Cuidados de Saúde
Comissão de Ética na Saúde para a Investigação Científica

Profissão	**Médico Clínica Geral**
Assinou declaração de confidencialidade?	**Sim**
Apresenta conflitos de interesses?	**Não**

III.3) Assinaturas

Avaliado por,

(Amadeu Maia)

CESIC
Comissão de Ética na Saúde
Para Investigação Científica
São Tomé e Príncipe

Validação certificada por,

Adionilde Aguiar
Presidente da Comissão de Ética na Saúde para a Investigação Científica do Ministério da Saúde

Data: São Tomé e Príncipe, 02 de Novembro de 2022

Appendice A

Table 1. Families'sociodemographic characteristics

	Total	Severe/ Moderate Thiness	Mild Thinness	Normal Weight	Overweight/ Obesity	p value
Relationship of guardian (respondent) to the child/adolescent, n(%)						0.611
Mother	394 (73.1)	22 (59.5)	106 (72.1)	250 (75.5)	16 (66.7)	
Father	49 (9.1)	4 (10.8)	16 (10.9)	28 (8.5)	1 (4.2)	
Grandparents	29 (5.4)	3 (8.1)	8 (5.4)	18 (5.4)	0	
Aunt/Uncle	33 (6.1)	6 (16.2)	8 (5.4)	17 (5.1)	2 (8.3)	
Others	34 (6.3)	2 (5.4)	9 (6.1)	18 (5.4)	5 (20.8)	
Head of the household, sex (n%)						0.256
Male	67 (12.4)	4 (10.8)	23 (15.6)	37 (11.2)	3 (12.5)	
Female	472 (87.6)	33 (89.2)	124 (84.4)	294 (88.8)	21 (87.5)	
Relationship to the child/adolescent, n(%)						0.341
Mother	387 (71.9)	20 (54.1)	103 (70.1)	249 (75.5)	15 (62.5)	
Father	44 (8.2)	3 (8.1)	13 (8.8)	27 (8.2)	1 (4.2)	
Grandparents	27 (5.1)	3 (8.1)	8 (5.4)	16 (4.8)	0	
Aunt/Uncle	39 (7.2)	7 (18.9)	11 (7.5)	18 (5.5)	3 (12.5)	
Others	41 (7.6)	4 (10.8)	12 (8.2)	20 (6.1)	5 (20.8)	
Age in years, Mean±SD	37.97 ± 9,76	38.3 ± 11.27	37.86 ± 10.40	38.2 ± 9.3	34.8 ± 9.43	Teste T ind 0.984
Child caregiver ,n(%)						0.404
Yes	491 (91.1)	34 (91.9)	131 (89.1)	306 (92.4)	20 (83.3)	
No	48 (8.9)	3 (8.1)	16 (10.9)	25 (7.6)	4 (16.7)	
Cohabiting with a partner, n(%)						0.122
Yes	375 (73.1)	22 (66.7)	100 (69.4)	235 (75.1)	18 (18.3)	
No	138 (26.9)	11 (33.3)	44 (30.6)	78 (24.9)	5 (21.7)	
Smoker, n(%)						0.116 (fisher)
Yes	2 (0.4)	1 (2.7)	1 (0.7)	0	0	
No	535 (99.6)	36 (97.3)	145 (99.3)	330 (100)	24 (100)	
Highest level of education, n(%)						Fisher 0.620
No education	13 (2.5)	0	2 (1.4)	11 (3.4)	0	

1st to 4th grade	203 (38.8)	14 (41.2)	59 (41.5)	124 (38.4)	6 (25.0)	
5th to 6th grade	112 (21.4)	5 (14.7)	32 (22.5)	71 (22.0)	4 (16.7)	
7th to 9th grade	125 (23.9)	10 (29.4)	32 (22.5)	76 (23.5)	7 (29.4)	
10th to 12th grade	64 (12.2)	4 (11.8)	15 (10.6)	41 (12.7)	4 (16.7)	
Higher education	6 (1.2)	1 (2.9)	2 (1.4)	0	3 (12.5)	
Occupational status in the last 12 months, n(%)						0.657
Student	13 (2.4)	1 (2.7)	4 (2.7)	7 (2.1)	1 (4.2)	
Housewife/househusband	186 (34.7)	16 (43.2)	50 (34.0)	114 (34.8)	6 (25.0)	
Employed/self-employed	260 (48.5)	14 (37.8)	69 (46.9)	163 (49.7)	14 (58.3)	
Unemployed or retired	77 (14.4)	6 (16.2)	24 (13.4)	44 (13.4)	3 (12.5)	
Home garden, n(%)						0.498
Yes	72 (13.4)	5 (13.5)	17 (11.6)	43 (13.0)	7 (29.2)	
No	465 (86.6)	32 (86.5)	129 (88.4)	287 (87.0)	17 (70.8)	
Person responsible for preparing/cooking meals at home, n (%)						0.633 (fisher)
Mother	453 (84.5)	28 (75.7)	123 (83.7)	281 (85.7)	21 (87.5)	
Father	5 (1.0)	1 (2.7)	2 (1.4)	2 (0.6)	0	
Grandparents	34 (6.3)	3 (8.1)	10 (6.8)	21 (6.4)	0	
Children	9 (1.7)	0	3 (2.0)	5 (1.5)	1 (4.2)	
Others	35 (6.5)	5 (13.5)	9 (6.1)	19 (5.8)	2 (8.3)	
Household members, Mdn (P25–P75)						
Number of members living together (n= 544)	6.00 (5.00 - 7.00)	5.50 (5.00 - 7.00)	6.00 (5.00 - 7.00)	6.00 (5.00 - 7.00)	6.00 (5.00 - 6.75)	Man whitney 0.448
Number of members aged <5 years old (n= 539)	1.00 (0.00 - 1.00)	1.00 (0.00 - 1.00)	1.00 (0.00 - 1.00)	1.00 (0.00 - 1.00)	1.00 (0.00 - 1.00)	0.526
Number of members aged between 5 and 18 years old (n=539)	3.00 (2.00-3.00)	3.00 (2.00 - 4.00)	3.00 (2.00 - 4.00)	3.00 (2.00 - 3.00)	2.50 (2.00 - 3.00)	0.023
Number members aged >18 years old	2.00 (2.00-3.00)	2.00 (2.00-3.00)	2.00 (2.00-3.00)	2.00 (2.00-3.00)	2.00 (2.00-3.00)	0. 174
Household income in STN, n(%)						0.700
Inf 500	33 (7.9)	1 (3.7)	12 (10.5)	20 (7.7)	0	
500-1000	42 (10.0)	1 (3.7)	15 (13.2)	23 (8.8)	3 (15.8)	
1000-2000	111 (26.4)	6 (22.2)	26 (22.8)	76 (29.2)	3 (15.8)	
2000-3000	133 (31.7)	9 (33.3)	35 (30.7)	83 (31.9)	6 (31.6)	
Sup 3000	101 (24.0)	10 (37.0)	26 (22.8)	58 (22.3)	7 (36.8)	
Daily amount of food expenses in STN, n(%)						«0.001
Inf 50	22 (4.3)	0	6 (4.3)	16 (5.1)	0	

50-100	136 (26.8)	6 (18.8)	50 (35.5)	77 (24.6)	3 (14.3)	
100-200	279 (55.0)	18 (56.3)	69 (48.9)	179 (57.2)	13 (61.9)	
200-300	56 (11.0)	5 (15.6)	8 (5.7)	39 (12.5)	4 (19.0)	
Sup 300	14 (2.8)	3 (9.4)	8 (5.7)	2 (0.6)	1 (4.8)	
Food Insecurity, n(%)						0.935
Yes	353 (73.4)	25 (75.8)	95 (73.1)	220 (74.1)	13 (61.9)	
No	128 (26.6)	8 (24.2)	35 (26.9)	77 (25.9)	8 (38,1)	

Note: The total in the first column corresponds to the characterization of all the children and adolescents' families, which differs from the total for the BMI categories variable.. Mdn: median; P25-P75: 25th and 75th percentiles;

The analysis of the normality of the variables was conducted using IBM SPSS Statistics, with only the variable *Household members* found to be non-normally distributed. Therefore, the p-value was obtained using the Mann Whitney test. The remaining variables were considered normally distributed. For those with two groups, the p-value was calculated using the Chi-square test. For the others (with more than two groups), the independent samples t-test was applied.

The Levene's test for equality of variances was not statistically significant ($p > 0.05$) for the variable age in years, indicating that the assumption of homogeneity of variances was met. Therefore, equal variances were assumed, and the two-tailed significance value of the t-test corresponding to this row was interpreted.

Appendix B

Table 2. Children's/adolescents' sociodemographic characteristics

	Total	Severe /Moderate Thinness	Mild Thinness	Normal Weight	Overweight/Obesity	p value
Sex, n(%)						0.749
Female	260 (48.2)	19 (51.4)	68 (46.3)	156 (47.1)	17 (70.8)	
Male	279 (51.8)	18 (48.6)	79 (53.7)	175 (59.2)	7 (29.2)	
Age in years, Mean±SD	10.82 ± 1.17	10.7 ± 1.20	10.9 ± 1.60	10.82 ± 1.90	10.5 ± 0.78	Teste T ind 0.495
School grade, n(%)						0.639
5th grade	303 (56.2)	24 (64.9)	82 (55.8)	187 (56.5)	10 (41.7)	
6th grade	236 (43.8)	13 (35.1)	65 (44.2)	144 (43.5)	14 (58.3)	
Number of siblings, Mdn (P25–P75), n=535	3.00 (2.00-4.00)	3.00 (2.00-5.00)	3.00 (2.00-4.00)	3.00 (2.00-4.00)	3.00 (2.00-4.00)	Man whitney 0.791
Birthorder, n(%)						0.452
First-born	140 (29.7)	6 (17.6)	47 (37.3)	83 (28.5)	4 (19.0)	
Second-born	114 (24.2)	8 (23.5)	26 (20.6)	74 (25.4)	6 (28.6)	
Third-born	93 (19.7)	8 (23.5)	27 (21.4)	54 (18.6)	4 (19.0)	

Fourth-born	58 (12.3)	7 (20.6)	9 (7.1)	37 (12.7)	5 (23.8)	
Fifth-born	34 (7.2)	1 (2.9)	8 (6.3)	23 (7.9)	2 (9.5)	
Sixth-born or other	33 (6.9)	4 (11.8)	9 (7.1)	20 (6.9)	0	
Maternal age at birth in years,Mdn (P25–P75), n = 490	25.0 (21.00-31.00)	25.5 (23.00-31.75)	24.00 (20.00-31.00)	25.00 (21.00-31.00)	24.00 (20.00-27.00)	0.514
Birth weight in grams (n=443), Mean±SD	3.22 ± 620.05	3.06 ± 621.15	3.14 ± 642.19	3.26 ± 608.92	3.28 ± 607.24	0.032
WHO weight status classification						Fisher 0.144
Very low birth weight, n(%)	2 (0.4)	1 (4.0)	1 (0.8)	0	0	
Low birth weight, n(%)	37 (8.4)	3 (12.0)	12 (10.1)	20 (7.2)	2 (9.5)	
Normal for gestational age,n(%)	369 (83.7)	19 (76.0)	99 (83.2)	233 (84.4)	18 (85.7)	
Macrosomic, n(%)	33 (7.5)	2 (8.0)	7 (5.9)	23 (8.3)	1 (4.8)	
Gestational age in weeks (n=478), Mean±SD	39.5 ± 1.69	39.4 ± 2.53	39.3 ± 1.75	39.6 ± 1.59	39.5 ± 1.25	Teste T ind 0.060
Gestational age in weeks						0.076
Preterm,n(%)	44 (9.3)	1 (3.4)	17 (13.0)	24 (8.2)	2 (9.5)	
Term, n(%)	412 (86.9)	27 (93.1)	113 (86.3)	253 (86.3)	19 (90.5)	
Postterm, n(%)	18 (3.8)	1 (3.4)	1 (0.8)	16 (5.5)	0	
Breastfeeding, n(%)						Fisher 0.021
Yes	523 (98.5)	34 (94.4)	141 (97.2)	324 (99.4)	24 (100.0)	
No	8 (1.5)	2 (5.6)	4 (2.8)	2 (0.6)	0	
Breastfeeding duration in months (n=487), Mdn (P25–P75)	18.00 (15.00-20.00)	18.00 (18.00-20.00)	18.00 (15.00-20.00)	18.00 (18.00-20.00)	18.00 (18.00-22.00)	0.317
Height-for-agez-score,at the interview (n=539), Mean±SD	-0.50 ± 1.08	-0.765 ± 0.98	-0.761 ± 1.08	-0.41 ± 1.08	0.25 ± 1.01	«0.001
BMI-for-agez-score,at the interview (n=), Mean±SD	3.63 ± 0.73	1.86 ± 0.347	3.00 ± 0.00	4.00 ± 0.00	5.21 ± 0.415	«0.001
Dietary oral supplement in the previous 12 months, n(%)						0.052
Yes	239 (54.9)	21 (80.8)	71 (57.3)	135 (51.1)	11 (57.9)	
No	196 (45.1)	5 (19.2)	53 (42.7)	130 (48.9)	8 (42.1)	
Main source of child/adolescente nutrition, n(%)						Fisher 0.685

Own production,farming,hunting,or fishing	35 (6.5)	0	12 (8.2)	22 (6.6)	1 (4.2)	
Purchases	487 (90.4)	37 (100.0)	127 (86.4)	300 (90.6)	23 (95.8)	
Exchanges, donations	17 (3.2)	0	8 (5.4)	9 (2.7)	0	
Eating breakfast before going to school? n(%)						0.746
Yes	492 (91.8)	36 (97.3)	135 (91.8)	300 (91.2)	21 (91.3)	
No	22 (4.1)	1 (2.7)	5 (3.4)	16 (4.9)	0	
Sometimes	22 (4.1)	0	7 (4.8)	13 (4.0)	2 (8.7)	
Eating a hot meal for lunch at school, n(%)						0.277
Yes	504 (93.5)	37 (100.0)	138 (93.8)	309 (93.4)	20 (83.3)	
No	35 (6.5)	0	9 (6.1)	22 (6.6)	4 (16.7)	
Frequency of hot school meals consumption? n(%)						0.318
One time/week	26 (5.2)	2 (5.6)	7 (5.1)	16 (5.3)	1 (4.8)	
Two times/week	33 (6.6)	2 (5.6)	15 (10.9)	16 (5.3)	0	
Three times/week	70 (14.1)	1 (2.8)	23 (16.8)	44 (14.5)	2 (9.5)	
Four times/week	60 (12.1)	8 (22.2)	14 (10.2)	35 (11.6)	3 (14.3)	
Daily	308 (62.0)	23 (63.9)	78 (56.9)	192 (63.4)	15 (71.4)	
Bringing snacks from home to school? n(%)						0.656
Yes	206 (38.5)	15 (40.5)	59 (40.1)	126 (38.4)	6 (26.1)	
No	265 (49.5)	17 (45.9)	74 (50.3)	162 (49.4)	12 (52.2)	
Sometimes	64 (12.0)	5 (13.5)	14 (9.5)	40 (12.2)	5 (21.7)	
Buying foods at school and/or near it? n(%)						0.765
Yes	67 (12.5)	33 (89.2)	127 (86.4)	289 (87.6)	22 (91.7)	
No	471 (87.5)	4 (10.8)	20 (13.6)	41 (12.4)	2 (8.3)	
Place of purchases, n(%)						Fisher 0.013
Inside the school	169 (38.2)	8 (25.8)	37 (31.4)	116 (42.3)	8 (42.1)	
Outside the school (up to 100m)	239 (54.1)	20 (64.5)	76 (64.4)	134 (48.9)	9 (47.4)	
Both or other places	34 (7.7)	3 (9.7)	5 (4.2)	24 (8.7)	2 (10.5)	
Frequency of those food purchases? n(%)						0.798

Less than one time/week	82 (16.0)	5 (13.5)	23 (17.2)	51 (16.1)	3 (12.5)	
One to two times/week	183 (35.8)	14 (37.8)	48 (35.8)	116 (36.7)	5 (20.8)	
Three to four times/week	152 (29.7)	11 (29.7)	43 (32.1)	86 (27.2)	12 (50.0)	
Daily	80 (15.7)	7 (18.9)	17 (12.7)	54 (17.1)	2 (8.3)	
More than once a day	14 (2.7)	0	3 (2.2)	9 (2.8)	2 (8.3)	
Money spent on those purchases in STN (n=476), Mdn (P25-P75)		5.00 (2.00-6.00)	5.00 (2.00-5.00)	5.00 (2.00-6.00)	5.00 (2.00-7.75)	MW 0.207
Drinking water while at school, n(%)						0.099
Yes	484 (89.9)	36 (97.3)	135 (91.8)	289 (87.3)	24 (100.0)	
No	55 (10.2)	1 (2.7)	12 (8.2)	42 (12.7)	0	
Source of that water, n(%)						0.994
Tap	108 (35.0)	8 (36.4)	31 (35.6)	64 (32.2)	5 (38.5)	
Bottled	15 (4.9)	1 (4.5)	4 (4.6)	9 (4.8)	1 (7.7)	
Fountain or well	138 (44.7)	8 (36.4)	40 (46.0)	86 (46.0)	4 (30.8)	
River or stream	38 (12.3)	5 (22.7)	9 (10.3)	22 (11.8)	2 (15.4)	
Other (rain,tank...)	10 (3.2)	0	3 (3.4)	6 (3.2)	1 (7.7)	
Treated water, n(%)						0.897
Yes	118 (45.4)	10 (43.5)	32 (45.1)	71 (45.2)	5 (55.6)	
No	142 (54.6)	13 (56.5)	39 (54.9)	86 (54.8)	4 (44.4)	
From home to school, n(%)						0.605
By foot	521 (96.8)	36 (97.3)	141 (95.9)	322 (97.6)	22 (91.7)	
Transport (van,school bus,or motorcycle)	17 (3.2)	1 (2.7)	6 (4.1)	8 (2.4)	2 (8.3)	
Duration in minutes (n=) Mdn(P25–P75)	20.00 (10.00-40.00)	12.50 (5.00-31.00)	20,00 (10.00-45.00)	20.00 (10.00-40.00)	25.00 (10.00-30.00)	MW 0.750
From school to home, n(%)						Fisher 0.741
By foot	529 (98.1)	36 (97.3)	144 (98.0)	326 (98.5)	23 (95.8)	
Transport (van,school bus,or motorcycle)	10 (1.9)	1 (2.7)	3 (2.0)	5 (1.5)	1 (4.2)	
Duration in minutes (n=), Mdn(P25–P75)	20.00 (10.00-40.00)	10.00 (5.00-30.00)	20,00 (10.00-45.00)	20.00 (10.00-40.00)	30.00 (10.00-45.00	MW 0.863
Daily time of physical activity and/or sport and/or active play in minutes (n=546),Mdn(P25–P75)	120.00 (60.00 - 180.00)	90.00 (60.00-165.00)	120.00 (60.00-180.00)	120.00 (60.00-180.00)	60.00 (60.00-112.50)	MW 0.693

Daily sleep duration in hours and minutes (n=546), Mdn(P25–P75)	11.00 (11.00-12.00)	11.00 (10.00-12.00)	11.00 (10.00-11.30)	10.50 (10.00-11.00)	11.00 (10.00-11.00)	MW 0.024

Note:The total in the first column corresponds to the characterization of the children and adolescents for different BMI categories. BMI: body mass índex; Mdn: median; P25–P75: 25th and 75th percentiles;

The analysis of the normality of the variables was conducted using IBM SPSS Statistics, with some variables found to be non-normally distributed and therefore described using the median. Consequently, the p-value was obtained using the Mann Whitney test.The remaining variables were considered normally distributed and the description was performed using the mean For those with two groups, the p-value was calculated using the Chi-square test. For the others (with more than two groups), the independent samples t-test was applied.

The Levene's test for equality of variances was not statistically significant ($p > 0.05$) for the variables age in years and gestational age in weeks, indicating that the assumption of homogeneity of variances was met. Therefore, equal variances were assumed, and the two-tailed significance value of the t-test corresponding to this row was interpreted.

Appendix C

Table 3. Nutritional intake of children and adolescents according to the BMI

	Total	Severe/Moderate Thinness Mdn(P25-75)	Mild Thinness	Normal Weight Mdn(P25-75)	Overweight / Obesity Mdn(P25-75)	p value
Total energy (kcal/day), Mean±SD	1482. 35 ± 574. 62	1488.46 ± 485.79	1393.51 ± 520.55	1515 ± 604.34	1566.67 ± 566.17	0.033
Total fat (g/day)	45.10 (31.34 – 62.32)	42.91 (32.34 – 62.13)	42.00 (30.1 – 56.48)	46.48 (31.4 – 64.49)	52.45 (32.75 – 73.75)	0.078
Total fat (%TEV)	28.73 (23.41 – 35.53)	27.49 (23.22 – 33.56)	28.50 (22.31 – 35.99)	28.86 (23.27 – 35.71)	30.64 (25.54 – 35.44)	0.523
Saturated fat (g/day)	8.21 (5.90 – 11.94)	9.55 (5.96 – 13.95)	7.06 (5.18 – 11.36)	8.29 (6.08 – 11.62)	12.87 (7.72 – 16.12)	0.040
Saturated fat (%TEV)	5.32 (3.99 – 6.97)	5.85 (4.43 – 7.42)	5.12 (3.69 – 6.67)	5.24 (3.99 – 6.93)	7.01 (5.77 – 9.1)	0.286
Monounsaturated fat (g/day)	10.02 (6.16 – 14.77)	8.40 (6.03 – 15.43)	9.15 (5.34 – 13.61)	10.14 (6.26 – 14.73)	11.44 (6.76 – 18.45)	0.092
Monounsaturated fat (%TEV)	6.35 (4.45 – 8.62)	5.59 (4.09 – 7.05)	6.43 (4.31 – 8.55)	6.40 (4.48 – 8.68)	6.76 (4.82 – 9.34)	0.429
Polyunsaturated fat (g/day)	13.68 (7.80 – 22.49)	15.03 (5.36 – 23.96)	12.96 (6.62 – 21.47)	13.79 (7.91 – 22.44)	14.86 (8.77 – 22.58)	0.144

Polyunsaturated fat (%TEV)	8.78 (5.90 - 12.73)	8.38 (13.1 - 4.62)	8.07 (5.76 - 12.49)	8.84 (6.08 - 12.72)	9.80 (6.90 - 12.19)	0.307
Carbohydrates (g/day), Mean±SD	205.67 ± 84.12	212.59 ± 71.16	192.88 ± 73.42	210.30 ± 89.84	209.48 ± 78.11	0.062
Carbohydrates (%TEV), Mean±SD	55.94 ± 9.89	57.84 ± 9.02	56.01 ± 10.23	55.88 ± 10.00	53.51 ± 7.90	0.463
Total sugars (g/day)	37.67 (13.85 - 68.51)	40.05 (21.09 - 81.5)	37.25 (13.28 - 64.32)	37.35 (13.83 - 68.51)	48.75 (11.26 - 70.98)	0.609
Total sugars (%TEV)	10.62 (4.28 - 19.15)	10.68 (5.89 - 22.82)	11.02 (3.44 - 19.68)	10.59 (4.26 - 19.03)	10.03 (4.79 - 15.25)	0.773
Total fiber (g/day)	12.15 (7.46 - 18.01)	14.89 (7.4 - 15.66)	12.22 (7.37 - 16.68)	11.93 (7.47 - 18.38)	15.24 (8.2 - 21.36)	0.571
Soluble fiber (g/day)	0.20 (0.02 - 24.38)	0.02 (0.00- 22.38)	0.01 (0.00 - 14.8)	0.05 (0.00 - 24.38)	0.00 (0.00- 35.96)	0.110
Protein (g/day), Mean±SD	44.06 ± 16.43	41.93 ± 14.98	41.27 ± 16.94	45.02 ± 17.40	51.07 ± 21.64	0.011
Protein (g/kg/day), Mean±SD	1.36 ± 0.59	1.59 ± 0.62	1.41 ± 0.64	1.33 ± 0.56	1.12 ± 0.46	0.022
Protein (%TEV), Mean±SD	12.16 ± 2.94	11.36 ± 2.28	11.98 ± 2.84	12.24 ± 2.97	13.38 ± 3.71	0.089
Cholesterol (mg/day)	48.14 (28.18 - 83.95)	53.06 (28.01 - 91.71)	44.29 (22.04 - 74.48)	51.35 (30.4 - 83.95)	75.7 (28.53 - 153.89)	0.061
VitaminA (µgRE/day)	118.21 (53.27 - 199.7)	152.26 (58.74 - 225.70)	116.98 (51.1 - 195.94)	108.03 (52.11 - 195.71)	165.21 (118.39 - 295.49)	0.851
Retinol (µg/day)	99.56 (50.72 - 213.93)	100.62 (64.45 - 205.1)	85.03 (36.00 - 195.82)	103.27 (56.22 - 224.80)	143.93 (59.34 - 253.52)	0.024
Beta-carotene (µg/day)	1405.9 (620.8 - 2543.4)	1424.82 (587.17 - 2493.21)	1345.94 (504.75 - 2512.49)	1404.1 (625.88 - 2568.05)	1553.39 (845.13 - 2274.12)	0.490
VitaminB-1 (mg/day)	0.49 (0.34 - 0.69)	0.47 (0.32 - 0.56)	0.46 (0.33 - 0.60)	0.49 (0.35 - 0.71)	0.53 (0.33 - 0.83)	0.053
VitaminB-2 (mg/day)	0.42 (0.25 - 0.63)	0.41 (0.22 - 0.58)	0.33 (0.21 - 0.56)	0.44 (0.26 - 0.63)	0.60(0.33 - 0.84)	0.008

VitaminB-3 (mgNE/day)	9.4 (6.11 - 13.4)	8.70 (5.20 - 13.77)	9.33 (6.00 - 12.15)	9.40 (6.18 - 13.80)	12.07 (6.30 - 14.61)	0.121
VitaminB-6 (mg/day)	0.74 (0.52 - 1.04)	0.68 (0.48 - 1.06)	0.72 (0.46 - 0.99)	0.76 (0.54 - 1.06)	0.88 (0.71 - 1.14)	0.051
VitaminB-12 (mg/day)	3.12 (1.32 - 5.93)	2.62 (1.12 - 5.36)	3.03 (1.32 - 5.75)	3.15 (1.24 - 5.85)	5.56 (1.37 - 7.26)	0.319
Vitamin C (mg/day)	49.17 (27.67 - 79.33)	47.37 (30.53 - 69.06)	43.77 (26.99 - 73.56)	54.43 (27.26 - 84.27)	58.28 (30.88 - 82.92)	0.101
Vitamin D (mg/day)	6.77 (2.70 - 11.70)	5.37 (3.54 - 10.44)	6.72 (2.65 - 11.33)	6.86 (2.42 - 11.69)	10.41 (3.46 - 14.13)	0.524
Vitamin E α-tocopherol (mg/day)	7.05 (3.56 - 12.59)	7.58 (4.10 - 14.04)	6.35 (3.10 - 11.25)	7.02 (3.62 - 12.60)	10.71 (4.62 - 14.58)	0.266
Folate DFE (µg/day)	82.18 (58.41 - 121.58)	88.31 (62.31 - 107.45)	74.89 (55.54 - 100.60)	86.82 (59.45 - 126.62)	89.26 (50.94 - 146.44)	0.008
VitaminK (µg/day)	2.81 (0.54 - 5.52)	1.39 (0.54 - 3.77)	2.81 (0.67 - 4.99)	2.89 (0.48 - 5.94)	5.46 (1.47 - 6.98)	0.516
Iron (mg/day)	4.13 (3.12 - 5.32)	4.28 (2.91 - 6.70)	3.94 (2.91- 4.91)	4.24 (3.17 - 5.31)	4.77 (3.53 - 6.75)	0.065
Magnesium (mg/day)	141.71 (107.89 - 188.43)	149.61 (101.13 - 180.75)	141.41 (103.66 - 176.12)	140.00 (111.39 - 191.40)	163.03 (117.88 - 245.09)	0.242
Calcium (mg/day)	161.59 (100.94 - 289.50)	147.95 (106.34 - 247.73)	140.17 (93.19 - 243.40)	165.98 (103.30 - 281.79)	314.73 (172.01 - 416.83)	0.022
Zinc (mg/day)	3.22 (2.29 - 4.39)	3.24 (2.32 - 4.24)	3.07 (2.07 - 3.92)	3.24 (2.31 - 4.53)	4.10 (2.48 - 5.90)	0.061
Copper (mg/day)	0.14 (0.04 - 0.32)	0.16 (0.040 - 0.30)	0.16 (0.050 - 0.34)	0.12 (0.040 - 0.32)	0.28 (0.103 - 0.52)	0.736
Phosphorus (mg/day)	455.32 (317.31	426.78 (314.20 - 605-70)	424. 05 (289.40 - 561.61)	458.38 (327.81 - 609.68)	550.65 (376.30 - 757.72)	0.030

	- 599.18)					
Potassium (mg/day)	1321.16 (862.01 - 1892.49)	1437.97 (856.49 - 1801.23)	1368.03 (817.35 - 1846.22)	1285.17 (847.82 - 1927.09)	1618.64 (1150.81 - 2458.55)	0.574
Selenium (µg/day)	20.32 (7.63 - 40.28)	16.24 (7.04 - 29.62)	20.32 (9.75 - 36.57)	20.32 (6.61 - 40.64)	30.48 (10.38 - 42.10)	0.415
Sodium (mg/day)	1141.92 (779.16 - 1700.48)	1190.86 (829.50 - 1662.40)	1103.69 (711.88 - 1636.78)	1143.02 (804.11 - 1714.59)	1238.32 (722.51 - 2068.77)	0.271

Note: The total in the first column corresponds to the nutritional intake of all children and adolescents for different BMI categories. M:mean;Mdn:median;NE:niacinequivalents; P25–P75:25th and 75th percentiles; RE: retinol equivalents; SD: standard deviation; TEV: total energy value;

The analysis of the normality of the variables was conducted using IBM SPSS Statistics, with some variables found to be non-normally distributed and therefore described using the median. Consequently, the p-value was obtained using the Mann Whitney test. The remaining variables were considered normally distributed and the description was performed using the mean For the normally distributed, the p-value was obtained using the independent samples t-test.

The Levene's test for equality of variances was not statistically significant ($p > 0.05$) for the variable's carbohydrates (% of total energy intake), protein (g/day), protein (g/kg/day), and protein (% of total energy intake), indicating that the assumption of homogeneity of variances was met. Therefore, equal variances were assumed, and the two-tailed significance value of the corresponding row of the t-test was interpreted. For the variables total energy intake and carbohydrates (g/day), the Levene's test for equality of variances was statistically significant ($p < 0.05$). Therefore, equal variances were not assumed, and the two-tailed significance value from the corresponding row was interpreted.

Prevalence of Thinness and Its Determinants in the School Context in São Tomé and Príncipe: A Cross-Sectional Study with Second Cycle Children

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