Influence of federal feeding programs on the anthropometric indicators of nutritional status of adolescents

Influência de programas federais de alimentação sobre os indicadores antropométricos do estado nutricional de adolescentes

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ABSTRACT

Objective

To assess the influence of federal feeding programs on the anthropometric indicators of nutritional status of adolescents from Federal Institutes.

Methods

Temporal analysis of the anthropometric data of students from the capital of *Rio Grande do Norte*, Brazil (n=250), on admission in 2017 (baseline) and after one year, in 2018 (follow-up). Participation in student assistance programs, sociodemographic, anthropometric, dietary, and physical activity aspects were evaluated. The Split Plot ANOVA test was used to analyze height-for-age and body mass index-for-age as continuous variables (mean of z-score; variation in the mean of z-score between baseline and follow-up). Prevalence Ratio was used to analyze categorical variables: improvement in height-for-age (increase in z-score value between baseline and follow-up); improvement in body mass index-for-age (change in z-score towards zero between baseline and follow-up).

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Results

There was a reduction in the height-for-age z-score (-0.173 to -0.350; *p*<0.001; eta=0.195), but this decline was smaller in the participants of both programs (from -0.249 to -0.357) compared to those not assisted by both simultaneously (from -0.149 to -0.345) (*p*=0.041). The improvement in height-for-age was positively associated with longer daily time spent at school and participation in the food program under the National Student Assistance Program. The improvement in body mass index-for-age was negatively associated with sex and positively with the number of people in the household.

Conclusion

The concomitant participation in the National School Feeding Program and in the National Student Assistance Program had a positive influence on the linear growth of students in situations of socioeconomic vulnerability.

Keywords: Adolescent. Health impact assessment. Nutritional status. Public policy. School feeding.

R E S U M O

Objetivo

Avaliar a influência de programas federais de alimentação sobre os índices antropométricos do estado nutricional de adolescentes matriculados em institutos federais.

Métodos

Análise temporal dos dados antropométricos de estudantes da capital do Rio Grande do Norte, Brasil (n=250) na admissão, em 2017 (baseline), e após um ano, em 2018 (follow-up). Foram avaliados a participação nos programas de assistência estudantil, aspectos sociodemográficos, antropométricos, práticas alimentares e de atividade física. O teste Split Plot ANOVA foi utilizado para analisar estatura-para-idade e índice de massa corporal-para-idade como variáveis contínuas (média de escore-z; variação da média de escore-z entre baseline e follow-up). A Razão de Prevalência foi utilizada para analisar as variáveis categóricas: melhora na estatura-para-idade (aumento no valor de escore-z entre baseline e follow-up) e melhora no índice de massa corporal-para-idade (mudança no escore-z em direção ao zero entre baseline e follow-up).

Resultados

Houve redução no escore-z de estatura-para-idade (de -0,173 para -0,350; p<0,001; eta=0,195), porém esse declínio foi menor nos participantes de ambos os programas (de -0,240 para -0,357) comparados àqueles que não foram assistidos simultaneamente por eles (de -0,149 para -0,345) (p=0,041). A melhora na estatura-para-idade associou-se positivamente a um maior tempo diário na escola e à participação no programa de alimentação do Programa Nacional de Assistência Estudantil. A melhora no índice de massa corporal-para-idade associou-se negativamente ao sexo e positivamente ao número de pessoas no domicílio.

Conclusão

A participação concomitante no Programa Nacional de Alimentação Escolar e no Programa Nacional de Assistência Estudantil teve uma influência positiva no crescimento linear dos escolares em situação de vulnerabilidade socioeconômica.

***Palavras-chave**: Adolescente. Avaliação do impacto na saúde. Estado nutricional. Política pública. Alimentação escolar.*

I N T R O D U C T I O N

The provision of healthy food in schools has benefited children and adolescents from various parts of the world as a way to support the development of students through adequate nutrition and the improvement of cognitive skills, in addition to contributing to reducing school dropout [1]. Adolescence is a period of rapid physiological, sexual, neurological, and behavioral changes, besides rapid growth, which can be fully achieved with adequate nutrition [2].

In Brazil, the *Programa Nacional de Alimentação Escolar* (PNAE, National School Feeding Program) stands out for being the oldest, and one of the largest, programs in the world covering school feeding, contemplating the Human Right to Adequate Food and *Segurança Alimentar e Nutricional* (Food and Nutritional Security). Since its creation, in the 1950s, the PNAE went through significant changes, especially after Law n° 11.947/2009, in which important advances in its technical and operational aspects occurred [3].

Among these, the inclusion of the nutritionist as a Responsible Technician, who must elaborate all the menus, and purchase food from family farming [4]. The importance of this program, in terms of coverage and fight against inequality, demands a continuous complex monitoring of its impacts.

In the country, it is also highlighted the *Programa Nacional de Assistência Estudantil* (PNAES, National Student Assistance Program), which, according to the Decree nº 7.234/2010, aims at expanding the conditions of permanence of young people both in federal public universities and Federal Institutes of Education, Science and Technology (IF), and it considers food as one of the actions to make equal opportunities feasible, improving the academic performance of students in situations of socioeconomic vulnerability [5].

Despite the relevance of both programs for the prevention of grade repetition, dropout situations resulting from insufficient financial conditions and the interruption of generational poverty and income concentration in Brazil, there is still a scarcity of studies evaluating their benefits for the health and nutrition status of adolescents at the IF, particularly comparing the differences in the nutritional status of participants and non-participants of these food programs in the poorest regions of Brazil [6-9].

The evaluation of the impact of public policies in Brazil becomes even more timely and relevant in the current context, in which the country faces a serious economic crisis, combined with political instability, to which the Brazilian government responds with austerity measures that lead to reduced funding for many issues regarding social and food security [10,11].

Thus, this study aimed to assess how the participation in the PNAE, and in a food program under the PNAES, influenced anthropometric indicators of nutritional status of adolescent students from the IF in the capital of *Rio Grande do Norte*, Brazil.

METHODS

This is a temporal analysis study, conducted on the three IF campuses in *Natal*, RN, Brazil. Students of both sexes, who underwent anthropometric assessment in the IF Health Sector on admission, in 2017, and are regularly enrolled in the 2nd grade of High School, during the period of the data collection, were considered eligible. Adolescents who were pregnant or who had physical disabilities that made it impossible to verify anthropometric measures were considered ineligible.

The sampling was simple random probabilistic, with its size being calculated in the Open Epi software (version 3), considering the finite population size of 667 adolescents. The sample size was defined as the highest calculated sample value for the two outcomes investigated in the study (overweight and stunting). Considering the prevalence of 20.5% of overweight for students in the Northeast region, according to the *Pesquisa Nacional de Saúde do Escolar* (PeNSE, National School Health Survey), with 95.0% confidence and 5.0% sampling error, the sample number was of 183 adolescents [12]. Taking into account the prevalence of 2.0% of stunting, also for students in the Northeast region, with 95.0% confidence and 2.0% sampling error, the sample number was of 147 adolescents [13]. Considering the possible losses, the sample size was expanded from 183 to 350 participants.

From these, losses due to missing signature of the legal guardians in the Free and Informed Consent form (n=49), absence from school in the days of data collection (n=25), and refusal to participate in the study (n=24) were observed. Adolescents with incomplete anthropometric information on admission (n=1) and transsexuals on hormone therapy (n=1) were excluded from the study. Thus, 250 adolescents participated at baseline and at follow-up.

The research was approved by the Research Ethics Committee from the Onofre Lopes University Hospital from the Federal University of Rio Grande do Norte (CAAE n° 83027418.7.0000.5292), according to Resolution n° 466/2012 from the National Health Council. The data collection occurred only after the Terms of Free and Informed Acquiescence and Free and Informed Consent were read and signed by the participants and their legal guardians.

Student information collected by the IF staff of health professionals at the time of their admission in 2017 (baseline), was obtained in the Sistema Único de Administração Pública (SUAP, Unified Public Administration System) (secondary data): birth date, sex, family income, number of people in the household, maternal education, participation in student assistance programs, weight, and height.

The follow-up data collection (primary data) took place from June to December 2018, by properly trained staff. In a private location, the anthropometric assessment (weight and height) was conducted individually, according to guidelines from the Ministry of Health; and the stage of sexual maturation was determined according to Tanner's stages, through self-assessment [14]. Then, a self-administered questionnaire with objective questions was developed based on the one used by PeNSE [12].

The IF staff, in which the researcher responsible for this study participated, that evaluated anthropometric measurements at baseline and follow-up, was composed of health professionals who receive periodic training, ensuring the high quality and homogeneity of the data.

Regarding the outcome variables, the anthropometric indexes Height-for-Age (H/A) and Body Mass Index-for-Age (BMI/A) were used both as continuous variables (mean of Z-score (ZS); variation in the mean of ZS between baseline and follow-up), and as categorical (frequency of short height-for-age, thinness, overweight and obesity; improvement in H/A and in BMI/A).

Short stature was considered when H/A <-2 ZS, low weight when BMI/A <-2 ZS, overweight when BMI/A>+1 and <+2 ZS, and obesity when BMI/A>+2 ZS, as established by the Ministry of Health [14].

Improvement in H/A (yes; no) was stated when the value of the ZS between baseline and follow-up increased. The following situations were defined as improvement in BMI/A (yes; no): (a) when a negative ZS value increased, without reaching the overweight range; (b) when a ZS value classified as overweight or obesity decreased between baseline and follow-up, without reaching the thinness range; and (c) when a ZS value, classified as eutrophic, increased or decreased towards the mean of the distribution (that is, they approached the zero value in ZS).

The socio-demographic variables investigated as exposure variables were: sex (male; female); age group (≤16 years; >16 years); ethnicity (white/yellow; black/mixed); maternal education (no formal education/elementary education; high school; higher education/postgraduate); number of people in the household (≤4 people; >4 people); per capita income (0.00–0.25 minimum wage per capita; 0.25–0.50 minimum wage per capita; 0.50–1.00 minimum wage per capita; >1.00 minimum wage per capita). Per capita income was obtained by the total family wages (considering the minimum wage of R$ 954,00, in force in 2018), divided by the total number of people supported by it.

For the sexual maturation stage, considering the development of breasts and genitals in stages from 1 to 5, for females and males, respectively, adolescents were classified as prepubescent - beginning of the growth spurt (stages 1, 2, and 3 for boys; 1 and 2 for girls), pubescent – at the peak of maximum growth speed (stage 4 for boys and 3 for girls) and in post-pubertal – slowing growth (stage 5 for boys; stages 4 and 5 for girls) [15].

To investigate eating practices, the following variables were used: whether they usually have breakfast, have lunch/dinner with their parents, and exchange lunch/dinner for snacks. These variables were grouped into two categories: no (never, rarely, and 1 to 2 days a week) and yes (3 to 4 days a week; 5 to 6 days a week; every day).

For the practice of physical activity, the Globally Estimated Physical Activity Indicator [16] was used and the adolescents were classified as physically active (practiced ≥300 minutes of physical activity per week) and insufficiently active (practiced <300 minutes of physical activity per week). Daily time spent at school (<8 hours; ≥8 hours) was also investigated.

Regarding access and consumption of meals at school, the participation in the PNAE (small meals offered to all high school students) was reported by the self-completed questionnaire during follow-up. The participation in the IF *Programa de Alimentação Estudantil* (PAIF, Student Food Program), which is linked to PNAES and offers lunch and/or dinner, was verified by the SUAP, where the researcher could identify whether or not the adolescent was registered in this program at baseline. Adolescents were then classified according to their access and/or consumption in both programs: participants in the PNAE (PNAE-P – consumption of meals from PNAE 1-2 days/week, 3-4 days/week and every day) and non-participants in it (PNAE-N – rare or absent consumption of meals from PNAE); participants in the PAIF (PAIF-P – adolescents registered in the program) and non-participants in it (PAIF-N – adolescents not registered in the program).

Considering their participation in the federal feeding programs, students were also classified as assisted exclusively by PNAE (PNAE-PE –consumption of meals from PNAE at least once a week, and not registered in PAIF); assisted exclusively by PAIF (PAIF-PE – adolescents registered in PAIF, and with rare or absent consumption of meals from PNAE); assisted by both (BOTH – consumption of meals from PNAE 1-2 days/week, 3-4 days/week and every day, and registered in the program); and not assisted any of them (NONE – rare or absent consumption of meals from PNAE, and not registered in PAIF).

For the statistical analysis, the software IBM®SPSS® (version 20.0) for Windows (IBM Corp., Armonk, USA) was used, in all tests $p < 0.05$ was considered statistically significant.

To assess the evolution of the anthropometric indicators of nutritional status of the group as a whole, between baseline and follow-up, the McNemar's test was used for categorical variables (frequency of nutritional deviations).

To compare it between participants and non-participants of PNAE and PAIF over time, the Split Plot ANOVA test was performed with a 95% confidence level for continuous variables (mean z-score of the indices H/A and BMI/A). The evaluation of the effect size was obtained by interpreting the partial eta square coefficient, in which values of 0.01–0.06 represent a small effect; 0.07–0.12 moderate effect; and a value greater than 0.13 a great effect of the time or participation in programs on the variation of the average of H/A and BMI/A of the adolescents [17].

The strength of the association between height-for-age and BMI-for-age with sociodemographic characteristics, sexual maturation, daily time spent at school, eating habits, physical activity, and participation in programs was verified through the bivariate Poisson regression, estimating the crude Prevalence Ratios (PR) and respective 95% confidence intervals (95%CI). Variables that were significant at the 20% level in this bivariate analysis were tested in multiple analysis with robust variance. With this, the adjusted PR and respective 95%CI were calculated to compose the final model, keeping the variables that remained associated with the outcomes (improvement of the height-for-age and BMI-for-age indicators), with a significance level of 5.0%

RESULTS

The participants were mostly female (57.6%), aged up to 16 years (84.4%), black or mixed-race (67.9%), and had per capita income up to half minimum wage (59.6%) (Table 1). Almost 70% of students who earn up to 0.5 minimum wage spend 8 hours or more at school (p=0.059).

Table 1 - Sociodemographic characteristics, eating practices, and participation in federal adolescent feeding programs (n=250). *Natal* (RN), Brazil, 2017-2018.

Variables	n	%
Sex (n=250)		
Male	106	42.2
Female	144	57.6
Age group (n=250)		
≤16 years	211	84.4
>16 years	39	15.6
Sexual maturation (n=250)		
Prepubescent	12	4.8
Pubescent	121	48.4
Post-puberal	117	46.8
Ethnicity (n=246)		
White/Yellow	79	32.1
Black/Pardo (Mixed)	167	67.9
Maternal education (n=250)		
No study/elementary school	53	21.2
High school	130	52.0
Higher education / post-graduate	67	28.8
Per capita income (n=250)		
0.00 – 0.25 minimum wage	84	33.6
0.25 – 0.50 minimum wage	65	26.0
0.50 – 1.00 minimum wage	47	18.8
>1.00 minimum wage	54	21.6
Presents food insecurity (n=250)	34	13.6
Has breakfast (n=249)	66	26.5
Has lunch/dinner with the parents (n=245)	131	53.5
Exchanges lunch/dinner for snacks (n=248)	30	12.1
Participation in PNAE (n=249)		
No	40	16.1
Yes	209	83.9
Participation exclusively in PNAE (n=249)		
No	98	39.4
Yes	151	60.6
Participation in PNAES (n=250)		
No	153	61.2
Yes	97	38.8
Participation in PAIF (n=97)		
No	32	33.0
Yes	65	67.0
Participation exclusively in PAIF (n=250)		
No	226	90.4
Yes	24	9.6

Nota: PAIF: Student Food Program of the Federal Institutes of Education, Science and Technology of Rio Grande do Norte, linked to the PNAES; PNAE: National School Food Program; PNAES: National Student Assistance Program.

The practice of not having breakfast (73.5%) was predominant. Most students were PNAE-P (83.9%), of which 60.6% consumed only the meals offered by this program. Among the students assisted by PNAES, 67% were PAIF-P (Table 1).

When investigating the anthropometric indicators of nutritional status, a prevalence of 4.0% short stature, 48.0% overweight, and 4.4% obesity was identified. Between baseline and follow-up, there was a slight increase in the prevalence of short stature in the whole group (from 4.0% to 5.8%; p=0.063) and a reduction in the mean H/A z-score (p<0.001). This reduction over time had a large effect (19.5%; eta = 0.195). The mean BMI/A did not change significantly over time (p=0.356; eta=0.004) (Table 2).

Table 2 - Nutritional status and anthropometric indexes (z-score) of adolescent students Rio Grande do Norte. *Natal* (RN), Brazil, 2017-2018.

Variables	Baseline		Follow-up		p-value
	n	%	n	%	
Height for Age(n=250)	250		243		
Short stature	10	4.0	14	5.8	0.063
Adequate stature	240	96.0	229	94.2	
Body Mass Index for Age (n=250)	250		250		
Thinness	8	3.2	5	2.0	0.375
Eutrophy	183	73.2	192	76.8	0.151
Overweight	48	19.2	46	18.4	0.850
Obesity	11	4.4	7	2.8	0.219
Variables	Mean z-score	SD	Mean z-score	SD	p-value
Height for Age (n=243)	-0.173	0.935	-0.350	0.974	<0.001*
Body Mass Index for Age (n=243)	0.150	1.111	0.200	0.981	0.356**

Nota: *Spanova Partial Eta squared = 0.195; ** Spanova Partial Eta squared = 0.004.

When comparing PNAE-P and PNAE-N students, the z-score values in the baseline did not differ for H/A and BMI/A (p=0.117 and 0.819, respectively), as well as the evolution of these indicators (Figures 1A and 2A).

When comparing PAIF-P and PAIF-N students, the z-score values in the baseline also did not differ for H/A and BMI/A (p=0.194 and 0.755, respectively). But when assessing their evolution, PAIF-P adolescents presented a lower reduction in H/A (from -0.299ZS to -0.414ZS; Δ of -0.115ZS) than PAIF-N (from -0.130ZS to -0.328ZS; Δ of -0.198 ZS) (p=0.046). The effect between the groups was considered small (1.6%; eta = 0.016) (Figure 1C).

No difference was observed in the evolution of H/A and BMI/A between adolescents assisted exclusively by PNAE or PAIF, when compared to those who were not assisted by any of them (Figures 1B and 2B). In contrast, students assisted by both programs presented a lower reduction in H/A (from -0.249ZS to -0.357ZS; Δ of -0.108ZS) compared to those not simultaneously assisted by both (from -0.149ZS to -0.345ZS; Δ of -0.196 ZS) (p=0.041) (Figure 1E).

When investigating the associated factors with the improvement of the anthropometric indicators of nutritional status between baseline and follow-up, H/A improvement was almost 50% lower in adolescents who spent more time at school (PR=0.46 CI 95% 0.29-0.72) and PAIF-N (PR=0.52 CI% 0.32-0.84), regardless of age and gender.

The improvement in BMI/A was about 30% greater in adolescents who lived with a larger number of people (>4 people) (PR=1.27 95% CI 1.02-1.60), and less expressive in women (PR = 0.65 95% CI 0.51-0.82) (Table 3).
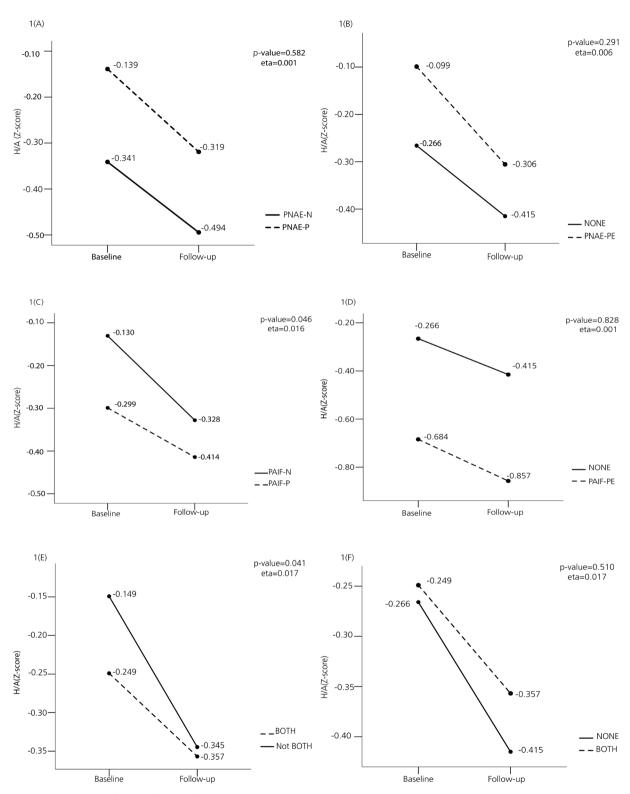
Figure 1 - Evolution of Height for Age of adolescents according to participation in the National School Food Program – PNAE and in the Student Food Program of the Federal Institutes of Education, Science and Technology of Rio Grande do Norte, linked to the National Student Assistance Program. *Natal* (RN), Brazil, 2017-2018.

Nota: H/A: Height for Age; PNAE-N: Non-Participants in PNAE; PNAE-P: Participants In PNAE; PNAE-PE: Assisted Exclusively by PNAE; PAIF-N: Non-Participants in PAIF; PAIF-P: Participants in PAIF; PAIF-PE: Assisted Exclusively by PAIF; BOTH: Assisted Both by PNAE and PAIF; NONE: Not Assisted by PNAE or PAIF.
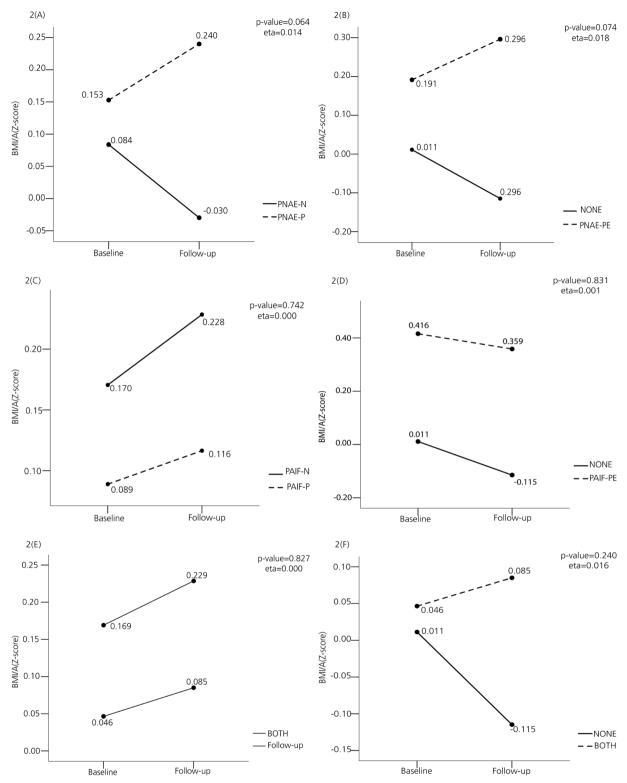
Figure 2 - Evolution of Body Mass Index for Age of adolescents according to participation in the National School Food Program – PNAE and in the Student Food Program of the Federal Institutes of Education, Science and Technology of Rio Grande do Norte, linked to the National Student Assistance Program. *Natal* (RN), Brazil, 2017-2018.

Note: BMI/A: Body Mass Index for Age; PNAE-N: Non-Participants in PNAE; PNAE-P: Participants in PNAE; PNAE-PE: Assisted Exclusively by PNAE; PAIF-N: Non-Participants in PAIF; PAIF-P: Participants in PAIF; PAIF-PE: Assisted Exclusively by PAIF; NONE: Not Assisted by PNAE or PAIF.

Table 3 - Prevalence Ratio for improving nutritional status according to sociodemographic characteristics, daily time spent at school, eating practices, physical activity, and participation in federal feeding programs for adolescents. *Natal* (RN), Brazil, 2017-2018.

Variables	Improvement in height for age				Improvement in BMI for age			
	n	%	PR (95% CI) Crude	PR (95% CI) Adjusted[a]	n	%	PR (95% CI) Crude	PR (95% CI) Adjusted[b]
Age group (N=243)								
≤16 years (n=211)	45	21.3	1.00	1.00	112	53.1	1.00	1.00
>16 years (n=32)	12	37.5	1.76 (1.05–2.95)	1.58 (0.92–2.72)	16	50.0	0.94 (0.65–1.36)	0.90 (0.62–1.31)
Sex (N=243)								
Male (n=100)	18	18.0	1.00	1.00	67	67.0	1.00	1.00
Female (n=143)	39	27.3	1.52 (0.92–2.49)	1.52 (0.94–2.47)	61	42.7	0.64 (0.50–0.81)	0.65 (0.51–0.82)
Sexual maturation (N=243)								
Prepubescent / pubescent (n=128)	30	23.4	1.00		75	58,6	1.00	
Post-puberal (n=115)	27	23.5	1.00 (0.64–1.58)		53	46.1	0.79 (0.62–1.01)	
Number of people in the household N=243)								
≤4 people (n=165)	38	23.0	1.00		79	47.9	1.00	1.00
>4 people (n=78)	19	24.4	1.06 (0.65–1.71)		49	62.8	1.31 (1.04–1.66)	1.27 (1.02–1.60)
Per capita income (N=243)								
>0.50 minimum wage (n=99)	20	20.2	1.00		50	50.5	1.00	
≤0.50 minimum wage (n=144)	37	25.7	1.27 (0.79–2.06)		78	54.2	1.07 (0.84–1.37)	
Daily time spent at school (N=242)								
<8 hours (n=84)	27	32.1	1.00	1.00	42	50.0	1.00	
≥8 hours (n=158)	30	19.0	0.59 (0.38–0.92)	0.46 (0.29–0.72)	86	54.4	1.09 (0.84–1.41)	
Has breakfast (N=242)								
Yes (n=179)	43	24.0	1.00		92	51.4	1.00	
No (n=63)	14	22.2	0.93 (0.54–1.57)		35	55.6	1.08 (0.83–1.41)	
Has lunch/dinner with the parents (N=238)								
Yes (n=111)	22	19.8	1.00		60	54.1	1.00	
No (n=127)	34	26.8	1.35 (0.84–2.17)		65	51.2	0.95 (0.74–1.21)	
Exchanges lunch/dinner food for snacks (N=241)								
No (n=213)	49	23.0	1.00		116	54.5	1.00	
Yes (n=28)	8	28.6	1.24 (0.66–2.34)		11	39.3	0.72 (0.45–1.16)	
Practice of physical activity (N=243)								
Physically active (≥ 300 min/week) (n=47)	13	27.7	1.00		27	57.4	1.00	
Insufficiently active (<300 min/week) (n=196)	44	22.4	0.81 (0.48–1.38)		101	51.5	0.90 (0.68–1.19)	
Participation in PNAE (N=242)								
Yes (n=203)	47	23.2	1.00		109	53.7	1.00	
No (n=39)	10	25.6	1.11 (0.61–2.00)		18	46.2	0.86 (0.60–1.24)	
Participation in PAIF (N=243)								
Yes (n=61)	21	34.4	1.00	1.00	31	50.8	1.00	
No (n=182)	36	19.8	0.58 (0.37–0.90)	0.52 (0.32–0.84)	97	53.3	1.05 (0.79–1.39)	

Note: [a]Adjusted model considering the improvement in height-for-age as a dependent variable, and age group, sex, daily time spent in school and participation in the PAIF as independent variables; Goodness of fit deviance = 0.635 / Omnibus Test p=0.006; [b]Adjusted model considering the improvement in BMI-for-age as a dependent variable; and age group, sex and number of people in the household as independent variables; Goodness of fit deviance = 0.652 / Omnibus Test p=0.040. BMI: Body Mass Index; CI: Confidence Interval; PAIF: Student Food Program of the Federal Institutes of Education, Science and Technology of Rio Grande do Norte, linked to the National Student Assistance Program; PNAE: National School Food Program; PR: Prevalence Ratio.

DISCUSSION

This temporal analysis study revealed that participation in federal feeding programs had a positive influence on the anthropometric indicators of nutritional status of students in situations of socioeconomic vulnerability.

A low prevalence of thinness and a high prevalence of overweight was observed in adolescents, corroborating with studies conducted with this population in Latin America and Brazil, and with IF students [8,12,18,19]. Both at baseline and follow-up, the prevalence of thinness and overweight were close to national averages (3.1% and 23.7%, respectively) and the averages of the Northeast region (3.7% and 20.5%, respectively) [12].

The prevalence of stunting exceeded what was expected, both on baseline and follow-up, evidencing the ongoing nutritional transition process in the Brazilian population, marked by the double burden of malnutrition [20]. Although typical diets of the nutritional transition are energy-dense, and therefore provide adequate or excessive calories, they lack the micronutrients necessary for linear growth [21-23]. Unhealthy eating practices reported in this study, such as not having breakfast, reduce the consumption of traditional foods, which are important sources of vitamins, minerals, and fiber [24]. These practices may be associated with the characteristic eating behavior of this stage of life [23,24]. On the other hand, many adolescents live in a situation of food insecurity, and their main meals are provided in the school environment, and thus, skipping breakfast may reflect the poor economic condition of their families [25]. Stunting is an indicator of chronic malnutrition and is associated with poor living conditions, as observed in this study, in which the majority of the mothers of adolescents had low education levels, and low *per capita* income [14,26]. Also, nutritional needs during puberty can be greater than at any other stage of life, and inadequacies can lead to delayed linear growth and impaired organ remodeling [2].

The worsening of H/A was significantly smaller for those receiving PAIF, suggesting that the lunch and/or dinner offered by this program, particularly when concomitant with the consumption of PNAE meals, may have contributed as an energy and nutrient supply, and had a positive influence on the linear growth of these adolescents in socioeconomic vulnerability.

However, the influence on the evolution of H/A of students assisted exclusively by only one of the programs did not differ from the observed in non-participants, probably because of the lower supply of energy, macro, and micronutrients offered by only one of them may not be sufficient to promote linear growth. A greater number of school meals per day may better meet nutritional needs. In this direction, Bento *et al*. [27] have demonstrated that the daily consumption of two or three school meals was associated with greater participation of fresh and minimally processed foods, and lower intake of ultra-processed foods by the students. This effect, however, was not observed among those who consume only one school meal per day.

Although the absence of a positive influence of the PNAE alone on the nutritional status of adolescents, its multidisciplinary and intersectoral character expands the possibilities of social returns, including the demand for local purchase of food, which maintains resources within the region, enhancing local income; the incentive for local production, strengthening short production circuits and reducing the need for large displacements of food between regions, thus bringing benefits to the environment; and the prioritization of healthy eating, contributing to improving health and acquiring skills, as well as developing healthy eating habits. This public policy advocates that the provision of healthy school feeding should be associated with initiatives for sustainable purchasing, linked to the strengthening of family farming and to the *Segurança Alimentar e Nutricional* (Food and Nutritional Security) of students [28].

According to the current legislation on PNAE, priority is given to fresh and minimally processed foods, in alignment with the Dietary Guidelines for the Brazilian Population. Thirty percent of all the resources destined to the PNAE must be used in the purchase of products from family-based farms and the school menu must meet the nutritional needs of students; offering two portions of fruits and three of vegetables per week (280g/student/week). Instead, ultra-processed products; such as canned foods, sausages, beverages with low nutritional value, and sweets; are prohibited or restricted [29].

Despite the recognized importance of the role of the nutritionists in the technical responsibility for planning the menu based on the nutritional aspects and guidelines from the PNAE, the insufficient number of these professionals in the institution may result in inadequate planning or preparation and may have contributed to the weak association observed in the present study. Although not evaluated here, the low financial resources allocated to the program by the federal government, and complemented by the institutions are a reality across the country that must be highlighted due to its potential to minimize the effects of the PNAE [30]. Equally important as increasing the budget, is the need for educational actions focused on food and nutrition as a strategy that involves the handlers. There is evidence that the irregularity in the offer of programs meals and the problems related to the menu may incite students to consume foods with low nutritional content brought from home or sold in cafeterias, which may also be a factor that contributed to the absence of association observed in the present study [4].

When investigating the factors associated with the improvement of the anthropometric indicators of nutritional status of adolescents, it was observed that, in females, the improvement of BMI/A was about 30% lower. This may be related to the higher-calorie expenditure activities performed by males (*e.g.*, running, jumping, ball games), favoring weight control. Among adolescent females, there also appears to be an early sexual maturation when compared to the chronological age of males, which contributes to being overweight [31]. The onset of puberty in females is associated with an increase in the amount of fat mass, as a consequence of increased blood concentration of estradiol. Thus, it is plausible that the early onset of puberty in females is associated with a higher amount of adipose tissue, which may lead to a higher prevalence of overweight [32].

On the other hand, a larger number of people in the household was associated with improved BMI/A. In Brazil, large families usually have only one financial provider, so the more members the family has, the less pocket money each one has to spend. In contrast, studies have shown that youngsters with pocket money generally increase their autonomy to pay for a variety of goods, including food, and this practice appears to have a positive correlation with visits to fast-food restaurants and unhealthy eating, which may contribute to weight gain [33,34].

Improvement in H/A was lower among adolescents with greater daily time spent at school. Although this finding may seem contradictory, as the student could potentially benefit from more meals offered by federal feeding programs, the reason the students do this is often to practice sports, resulting in a higher energy spending, during the swing shifts, and in the increase of nutritional needs. Students with greater daily time spent at school are also those with lower income, and possibly less availability of good nutritional food at home, which may have also interfered with the improvement in H/A. Also, the school may be an obesogenic environment, characterized by the offer of tasty and low-cost food in cafeterias or nearby establishments, even though this food is caloric, rich in sugars and fats, it presents small amounts of vitamins and minerals [24].

Thus, the need to intensify investigations on the role of the school food environment in determining the eating habits of adolescents is clear, as noted by Vale et al. [35]. According to the authors, the presence of a cafeteria at school was a determinant in the model of low adherence to school meals. Having these spaces that sell competitive foods in the school environment leads to irregular consumption of PNAE meals, which is a program that aims the universal coverage of students to promote healthy eating habits.

The improvement of H/A was lower in PAIF-N students, demonstrating that besides the positive effects on health and dropout rate, this federal feeding program may cooperate with the reduction of chronic malnutrition in low-income settings, such as the public education system of Brazil. Almost all PAIF-P students also consumed PNAE meals, and even though the participation in PNAE alone was not associated with an improvement in H/A or BMI/A in this study, their positive effect has been demonstrated, and undoubtedly must have contributed to better learning conditions and the permanence of students in school [25].

Limitations inherent to the present study deserve attention, such as the time interval between the two observations. The one-year period may not have been enough to improve the anthropometric nutritional status of adolescents. In addition, data on weight and height at baseline were secondary, and although they were collected by highly trained health professionals, errors are still possible.

However, this is a pioneer research on the influence of federal food programs on the nutritional status of adolescents of the IF. Its originality in the national scenario reinforces the importance of monitoring the nutritional status of adolescents in high school and assessing whether food programs in this environment have an impact on the health and nutrition of their beneficiaries. It also contributes to a more assertive performance by health professionals, so that governments and administrators strengthen and improve public policies aimed at food and nutritional security. Lastly, shows that it is essential to coordinate actions that enable the incorporation of food, health and nutrition themes in the curricula and pedagogical projects of schools, to empower the food programs and contribute to the autonomy of students in their food choices.

CONCLUSION

The adolescents had a high prevalence of overweight and stunting, evidencing the presence of the double burden of malnutrition. Participants in the Student Feeding Program linked to the National Student Assistance Program, including those who also consumed meals from the National School Feeding Program, presented lower reduction of the average H/A in z-score over time, and higher prevalence of improvement in H/A when compared to non-participants, demonstrating the positive influence of the programs on the linear growth of students in socioeconomic vulnerability.

This study reinforces the need to maintain, improve and monitor these programs, adopting instruments and methodologies of health indicators for the evaluation of the beneficiaries, and providing training for professionals who work in their implementation. Thus, this possible progress around the evaluation conducts would provide to the managers more consistent information for the decision making and evaluation of impacts from such programs.

If, on the one hand, the relevance of federal food programs for the permanence and success of students is indisputable, on the other it is still necessary to improve their execution in the Federal Institutes, in order to increase their influence on the nutritional status of their beneficiaries. Greater impacts of the programs could be measured according to the level of maturity of implementation and management of this policy. Relevant variables, such as direct or outsourced administration of meal production and policy monitoring, can result in differences in their outcomes for the target audience, suggesting the need for further studies.

CONTRIBUTORS

MEC ANDRADE participated in the design and planning of the study, literature review, data collection and analysis, interpretation of the results, writing of the manuscript. CO LYRA collaborated on data analysis, interpretation of results, writing of the manuscript, approval of the final version. FR ARAÚJO acted in the interpretation of results, writing of the manuscript, approval of the final version. UV BAGNI collaborated in all stages of the study, including writing of the manuscript and approval of the final version.

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