

Metabolic risk and television time in adolescent females

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Abstract

Objectives A sedentary lifestyle is increasingly implicated in a negative metabolic health profile among youth. The present study examined relationships between clustered metabolic risk factors and TV viewing in female adolescents.

Methods The sample comprised 262 girls 14–17 years. Height, weight, fasting glucose, insulin, HDL cholesterol, triglycerides, and blood pressure were measured. Body mass index (BMI) was calculated. TV viewing time and moderate-to-vigorous physical activity (MVPA) were estimated from a 3-day diary. Outcome variables were normalized and expressed as Z scores which were summed into a metabolic risk score. Multiple linear regression analysis was used.

Results TV viewing was independently associated with increased prevalence of clustered metabolic risk in girls after adjustment for several confounders (i.e., chronological age, BMI, MVPA, and parental education). The final model also indicated that lower levels of MVPA, higher BMI, and lower mother education were associated with higher metabolic risk.

Conclusions Increased TV viewing had an adverse effect on metabolic health of adolescent girls. The findings highlight the potential importance of preventive actions to ameliorate metabolic risk in youth which target both sedentary and physically active behaviors.

Keywords Public health · Sedentary behavior · Youth · Overweight · Lifestyle

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Introduction

The prevalence of obesity in young people has increased worldwide during the past decades (Gupta et al. 2013; Lobstein 2010). The etiology of obesity is complex and believed to be linked with a variety of factors associated with diet and the environment. Among the latter, there is concern for reductions in habitual physical activity (PA) and increases in time spent in sedentary behaviors (SB) or physical inactivity. Sedentary behaviors have been and are a fact of life—school, study, leisure reading, sitting and talking, etc., and these are highly valued by society. Technological advances have added to the potential for physically inactive behaviors, and the pace of introducing technology has accelerated over time (Malina 2013).

Time spent viewing television viewing (TV) and more recently using computers and video games are often used as indicators of SB among youth. Moreover, young people are often viewed as particularly vulnerable to the influence of time spent in screen activities (Tremblay et al. 2010a). Systematic reviews (Marshall et al. 2006; Tremblay et al. 2011) have indicated that most young people watch approximately 2–2.5 h of television each day, and of those with access to computers and video games spend an additional 0.5 and 0.75 h, respectively, using these technologies. While some young people are considered “low users” of TV (≤ 2 h/day), 28 % watch >4 h/day, which is double the maximum dose recommended by the American Academy of Pediatrics (American Academy of Pediatrics 2001).

Allowing for the many ways youth can be physically inactive, there is consensus that a sedentary lifestyle is associated with obesity and risk factors for negative health outcomes such as heart disease and diabetes among youth (Ekelund et al. 2006; Hume et al. 2010; Staiano et al. 2013). Extensive television viewing and computer use are consistently associated with overweight and obesity in North American (Mark and Janssen 2008; Staiano et al. 2013), Canadian (Tremblay et al. 2010b), and European (Ekelund et al. 2006; Hume et al. 2010) youth. Moreover, a high level of TV viewing during adolescence is a strong predictor of risk of obesity in adulthood (Boone et al. 2007). Therefore, reducing screen-related sedentary behavior is essential to prevent and treat youth obesity.

Although data on SB among youth worldwide is increasing, there is a need for studies of the health consequences of SB among youth in developing countries many of which are experiencing a nutritional transition. Actually, Brazil is an interesting example of that, and, particularly, regions of the south are more likely to achieve higher levels of overweight than regions from the North (Abrantes et al. 2002). In addition, the majority (58 %) of Brazilian adolescent girls did not achieve 60 min of moderate-to-

vigorous physical activity (MVPA) daily (Machado-Rodrigues et al. 2014b), corroborating several studies which have documented the concerning rates of females who attain the international PA guidelines in a daily basis (Ruiz et al. 2011); indeed, Brazilian girls are more likely to report not participating in MVPA in a daily basis over the last week (Prado et al. 2014) and the low prevalence of PA in Brazilian girls has been associated with higher prevalence of obesity and metabolic risk factors (Machado-Rodrigues et al. 2014b), illustrating the critical need to keep investigation potential factors related to unhealthy behaviors and to develop effective strategies to improve healthy lifestyles in this specific population of female adolescents.

In context of the preceding trends, and given that the available information about the relationship of these constructs in Southern Brazilian communities is relatively limited, the aim of the present study is to examine the relationships between metabolic risk factors and TV viewing in a sample of female Brazilian adolescents. Indeed, it achieves greater insight since youth from those Southern regions have one of the highest prevalence of overweight/obesity. It was hypothesized that girls with higher levels of screen time would be more likely to have higher metabolic risk than less sedentary peers.

Methods

Sample

The cross-sectional study is part of a more comprehensive survey of adolescents in Curitiba (Paraná, Brazil) in 2009. The city of Curitiba has a population of 1,678,965 inhabitants with a human development index of 0.763. The sample size consisted of school female youth registered in the education system (approximately 22,000 girls). The following parameters were used to estimate the sample size: an error of 5 %; an estimated metabolic syndrome (MetS) prevalence of 20 %; a design effect of 1.5; a 95 % confidence interval; and an additional 10 % for losses and refusals. A conglomerate sample of 262 girls was evaluated. Curitiba has nine administrative districts with 293 schools. The proportion of students in each of the nine administrative areas was as follows: Santa Felicidade, 6.6 %; Matriz, 12.3 %; Boa Vista, 14.7 %; Cajuru, 12 %; Portão, 10.6 %; Boqueirão, 13.1 %; Bairro Novo, 9.6 %; Pinheirinho, 9.5 %; and Cidade Industrial de Curitiba (CIC), 11.6 %. Nine schools were randomly selected among 293 schools of the nine administrative districts of Curitiba; all students in the respective schools were invited to participate in the project. The sample for this study included 262 female adolescents 14–17 years of age who had complete data for metabolic variables of interest;

furthermore, exclusion criteria were the known presence of diabetes and the use of medications that alters blood pressure, glucose, or lipid metabolism. The project was approved by the Scientific Committee of the Federal University of Paraná which requires anonymity and non-transmissibility of data. All participants returned written informed consent appropriately signed by parents or guardians.

Anthropometry

Stature and body mass were taken by trained research assistants at each school. Participants wore t-shirts and shorts, and shoes were removed. Stature was measured to the nearest 0.1 cm with a portable stadiometer (Ottoboni HM-210D; RJ, Brazil). Body mass was measured to the nearest 0.1 kg with a calibrated beam balance scale (Toledo 2096 PP; SP, Brazil). Body mass index (BMI) was subsequently calculated.

Blood sampling

Blood samples were taken from the antecubital vein by trained nurses between 0800 and 1000 hours with subjects in a fasted state (10 h) and a seated position. Samples were drawn in vacuum tube gel (Sarstedt). After setting at room temperature for about 30 min, samples were centrifuged for 10 min at 3,000 rpm to obtain serum. Samples were subsequently divided into aliquots within 30 min and stored at -80°C until analysis. High density lipoprotein cholesterol (HDL-C), triglycerides (TG), insulin and glucose levels were measured by colorimetric assay on a random access Spectrum CCX analyzer (Abbott Diagnostics, Abbott Park, IL, USA). A single certified laboratory was used for all analyses.

Blood pressure (BP)

Blood pressure was measured according to the method described in The Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents (National High Blood Pressure Education Program 2004). Both systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured in the right arm using a sphygmomanometer. Two measurements were taken by trained technicians before blood samples were drawn and after 5 and 10 min rest in a seated position. The mean of the two measurements was used for analysis. If the two measurements differed by >2 mmHg, a third measure was obtained, and the mean of the two closest measurements was retained for analysis. Within day technical errors of measurement (σ_e) and reliability (R) (Mueller and Martorell 1988) based on replicated measurements of 89

students were as follows: SBP, 2.43 mmHg; DBP, 2.52 mmHg, while reliability coefficients were as follows: SBP, 0.96; DBP, 0.92.

MetS risk score

Definition of the MetS and cutoff points for specific components vary among studies (Cavali et al. 2010), but none apply specifically to children and adolescents. Since the primary objective was to investigate the clustering of risk factors relative to TV viewing, a continuous MetS risk score was used (Eisenmann 2008; Eisenmann et al. 2010). Each of five metabolic indicators (BMI, HDL-C, insulin, TG, blood glucose, BP) was converted to a Z score; Z scores were multiplied by -1 if necessary to indicate higher metabolic risk with increasing value. Z scores of systolic and diastolic BP were averaged and treated as a single indicator. Z scores for the five MetS variables were summed and divided by five to derive an average clustered metabolic risk score as in other epidemiological studies of youth (Brage et al. 2004; Eisenmann 2008; Machado-Rodrigues et al. 2014a).

Daily physical activity (PA) and sedentary behavior (SB)

Each participant completed a diary protocol (Bouchard et al. 1983) for three complete days (Thursday, Friday, and Saturday). The protocol divided each day into 96 periods of 15 min. Participants were required to record all activities and to rate the intensity of the primary activity performed in each 15-minute period using a numeric code ranging from one to nine. Energy expenditure (EE) was estimated from equivalents for each category: (1) sleeping or resting in bed: 0.26 kcal/kg/15 min; (2) sitting: 0.38 kcal/kg/15 min; (3) light activity standing: 0.57 kcal/kg/15 min; (4) slow walking: ≈ 4 km/h: 0.69 kcal/kg/15 min; (5) light manual tasks: 0.84 kcal/kg/15 min; (6) leisure and recreational sports: 1.2 kcal/kg/15 min; (7) manual tasks at a moderate pace: 1.4 kcal/kg/15 min; (8) leisure and sport activities of higher intensity—not competitive: 1.5 kcal/kg/15 min; (9) very intensive activities—competitive sports: 2.0 kcal/kg/15 min. Total daily energy expenditure (TDEE) was estimated for each of the 3 days. Intensity categories 6–9 (4.8–7.8 METs) represented MVPA (Bouchard et al. 1983).

Screen time was the indicator of SB and was based on TV viewing. The amount of time spent viewing TV was determined from the activity diary (Bouchard et al. 1983; Machado-Rodrigues et al. 2012b) and was expressed as min/day.

For inclusion, all (96) 15-min episodes per day had to be completed with a categorical value from 1 to 9 for the

3 days. Records of participants who did not complete the diary for 3 days were excluded. Data processing and inclusion criteria were the same as in European (Machado-Rodrigues et al. 2011, 2012a), Canadian (Katzmarzyk et al. 1998), and Taiwanese (Huang and Malina 2002) youth. Reproducibility of this instrument was $r = 0.91$ in subjects ≥ 10 years of age (Bouchard et al. 1983) and was validated in adolescents against objective measures of PA (Machado-Rodrigues et al. 2012b).

Parental education

Educational background of both parents was used as a proxy for socioeconomic status (SES). Consistent with other studies in Brazil (Rodrigues et al. 2009), parental educational level was grouped into three categories based on the highest level successfully completed by each of the parents: Low, 9 years or less—sub-secondary; Middle, 10–12 years—secondary, and High, higher education.

Statistical procedures

Age-specific descriptive statistics were calculated for height, weight, BMI, MVPA, TV viewing, and all metabolic variables. Prior to analysis, distributions of the clustered metabolic risk factors, TV viewing and MVPA scores were tested for normality and normalized if necessary. Insulin, glucose, triglycerides, and MVPA were logarithmically transformed. Log transformation of the variables improved normality for these variables, and as such, they were used as transformed variables in the analyses. One-way analysis of variance (ANOVA) was used to test the effect of chronological age on all variables. All ANOVAs were followed with Bonferroni-corrected post hoc tests.

Associations between the clustered metabolic risk factors (i.e., the score based on all five metabolic risk factors) and TV viewing, controlling for potentially confounding effects of chronological age and MVPA were estimated using multiple linear regression analysis. In the minimally adjusted model (Model 1), TV viewing was the sole predictor of clustered metabolic risk. Chronological age and BMI were subsequently added as potential confounders (Model 2). In Model 3, MVPA was added as a potential confounder. Finally, educational level of each parent was added as potential confounding factors (Model 4). Significance was set at 5 %. SPSS 17.0 (SPSS Inc., Chicago, IL, USA) was used.

Results

Characteristics of the sample are summarized in Table 1. Height, weight, BMI, triglycerides, HDL cholesterol, insulin levels, DBP, and SBP did not differ among age

groups. Only glucose level differed between 14 year old and 15 and 16 year old groups.

Results of the regression analyses are summarized in Tables 2. TV viewing was independently associated with an increased prevalence of metabolic risk, after adjustment for potential confounders. The final regression model also indicated that girls with lower levels of MVPA were significantly more likely to have higher metabolic risk than their more active peers. A higher BMI ($\beta = 0.23$; 95 % CI, 0.15–0.31) and lower educational level of mothers ($\beta = -0.57$; 95 % CI, -1.12 to -0.02) were also significant predictors of clustered metabolic risk.

Discussion

Systematic evaluation of the independent contributions of SB to clustered metabolic risk in Brazilian youth is lacking. This cross-sectional analysis indicated a positive relationship between the clustering of metabolic risk factors and TV viewing in a cross-sectional sample of Brazilian girls 14–17 years. That association was not altered after adjustment for several potential confounding factors and was consistent with other studies showing that higher time spent in sedentary activities (i.e., TV viewing) was associated with a worse metabolic profile in youth (Hsu et al. 2011; Tremblay et al. 2011).

The epidemic of “diseases of Western civilization” in many parts of the world has been attributed to contemporary lifestyles (Staiano et al. 2013; Tremblay et al. 2011). Young children and adolescents are specifically viewed as vulnerable to the influence of electronic media. From the perspective of clinical and educational intervention designs, screen time assessment is an attractive target for several reasons. Increased screen time is associated with excessive adiposity in young people (Ekelund et al. 2006; Hume et al. 2010) so that reducing that SB may help address the issue of youth overweight and obesity. On the other hand, TV viewing and computer use are relatively accessible among children and adolescents, and also relatively easy to quantify. It is estimated that 70 and 69 % of 13 year old boys and girls, respectively, watched TV 2 or more hours per day; estimates were similar among 15 year olds, 69 and 67 % among boys and girls, respectively (WHO 2005). In the present study, Brazilian female adolescents spent, on average, about 4 h viewing TV daily. Time viewing TV did not differ among the age groups of girls between 14 and 17 years. This estimate was two times more than the current guideline for North American youth (Canadian Pediatric Society, American Academy of Pediatrics) which recommends that screen-based SB such as watching TV and playing PC/video games should be limited to <2 h per day among children and adolescents.

Table 1 Descriptive characteristics of Brazilian adolescents by age group and for the total sample [behavioral risk & MetS study (Brazil), 2009–2012]

Variable	14 years old (n = 74)	15 years old (n = 91)	16 years old (n = 56)	17 years old (n = 41)	Total sample (n = 262)	ANOVA
Chronological age (years)	14.0 ± 0.3	14.8 ± 0.3	15.9 ± 0.3	16.9 ± 0.2	15.1 ± 1.0	a,b,c,d,e,f,g
Weight (kg)	52.6 ± 11.1	54.6 ± 11.0	55.2 ± 9.6	55.7 ± 8.2	54.3 ± 10.3	
Height (m)	158.1 ± 5.5	159.8 ± 6.1	160.5 ± 6.0	160.8 ± 6.9	159.6 ± 6.1	
BMI (kg/m ²)	20.96 ± 3.89	21.31 ± 3.71	21.38 ± 2.92	21.51 ± 2.66	21.25 ± 3.45	
Insulin ^a (mmol/l)	6.93 ± 2.62	7.01 ± 3.55	6.21 ± 1.68	7.30 ± 2.62	6.86 ± 2.84	
Glucose ^a (mmol/l)	90.55 ± 12.73	100.02 ± 18.94	98.48 ± 8.65	96.51 ± 12.89	96.47 ± 15.02	b,c
Triglycerides ^a (mmol/l)	90.39 ± 30.57	86.26 ± 31.71	80.85 ± 23.97	85.60 ± 39.78	86.16 ± 31.35	
HDL cholesterol (mmol/l)	43.58 ± 9.05	46.37 ± 11.57	45.71 ± 13.20	45.17 ± 11.29	45.25 ± 11.25	
Systolic BP (mmHg)	102.07 ± 11.67	102.89 ± 12.26	99.16 ± 11.84	101.95 ± 9.88	101.71 ± 11.67	
Diastolic BP (mmHg)	69.23 ± 9.44	68.38 ± 8.49	68.02 ± 10.04	68.41 ± 9.83	68.55 ± 9.28	
Metabolic risk (Z score)	0.22 ± 2.26	0.63 ± 2.81	0.01 ± 2.11	0.47 ± 2.25	0.09 ± 2.90	
TV viewing (min)	237.4 ± 99.1	232.9 ± 126.4	285.1 ± 198.2	195.0 ± 106.3	239.4 ± 138.0	
MVPA ^h (min)	51.4 ± 64.7	53.0 ± 67.9	46.2 ± 65.5	43.8 ± 67.4	49.6 ± 66.1	

BMI body mass index, BP blood pressure, MVPA moderate-to-vigorous physical activity

^a Data are shown as mean (SD) unless otherwise stated

^b Statistical differences between 14 and 15 years old age groups ($p < 0.01$)

^c Statistical differences between 14 and 16 years old age groups ($p < 0.01$)

^d Statistical differences between 14 and 17 years old age groups ($p < 0.01$)

^e Statistical differences between 15 and 16 years old age groups ($p < 0.01$)

^f Statistical differences between 15 and 17 years old age groups ($p < 0.01$)

^g Statistical differences between 16 and 17 years old age groups ($p < 0.01$)

^h Log-transformed values were used in the analysis

Excessive screen time is generally accepted as an independent risk factor for negative health indicators in youth (Staiano et al. 2013; Tremblay et al. 2011). The association between increased time viewing TV and elevated clustered metabolic risk in Brazilian adolescent girls (Table 2) was generally consistent with other studies addressing metabolic risk or specific risk factors in youth. For example, screen time was associated with an increased likelihood of the MetS in a dose-dependent manner independent of PA in adolescents monitored in the U.S. National Health and Nutrition Examination Surveys (Mark and Janssen 2008). TV viewing time was independently correlated with body weight and level of fatness in the European Youth Heart Study (Andersen et al. 2006). Moreover, an increase in daily time viewing TV was systematically associated with obesity among Chinese urban children and adolescents <1 h (10.9 %), 1–2 h (11.8 %), 2–3 h (13.2 %) and >3 h (15.1 %) (Ma et al. 2002).

The relatively limited impact of MVPA on the relationship between screen time and clustered metabolic risk in Brazilian adolescent girls was also consistent with other studies in youth (Ekelund et al. 2006; Mark and Janssen

2008). TV viewing time was correlated to components of the MetS after adjustment for PA in the European Youth Heart Study (Ekelund et al. 2006). Intuitively, a potential explanation for the negative health effects of SB (i.e., TV viewing) is that time spent in sedentary activities displaces time available for physical activities (Iannotti et al. 2009; Rey-Lopez et al. 2008). Indeed, the literature has consistently shown that PA decreases across age, and SB increases across age during adolescence (Malina et al. 2004). However, findings from recent studies (Machado-Rodrigues et al. 2012a) have suggested that adolescents are not replacing PA with sedentary activities (neither screen activities nor objectively measured SB). This observation is corroborated by Iannotti and co-workers (Iannotti et al. 2009); in fact, even with PA in the same equation of SB, this latter behavior had significant negative associations with several health variables such as adiposity (Katzmarzyk et al. 2012), and metabolic and cardiovascular markers (Ekelund et al. 2009). Of note, despite of PA generally had a positive association with positive health markers and negative associations with negative health markers, the pattern of associations for SB seems to be not similar and regression

Table 2 Prediction of the clustered metabolic risk score in Brazilian females 14–17 years [behavioral risk & MetS study (Brazil), 2009–2012]

Model	R^2 (%)	Adjusted R^2 (%)	Predictor	Clustered metabolic risk score				Standardized β coefficient	
				Unstandardized coefficients		95 % CI for β			
				β	Std. error	Lower	Upper		
1	$F_{(1,260)} = 3.181$ (n.s.)	1.2	1.0	TV viewing	0.002	0.001	0.000	0.005	0.11
2	$F_{(2,258)} = 15.912$ ($p < 0.01$)	12.1	11.0	BMI	0.234	0.041	0.152	0.315	0.33
3	$F_{(1,257)} = 5.982$ ($p < 0.05$)	14.1	12.7	BMI	0.225	0.041	0.144	0.306	0.32
				MVPA	-0.005	0.002	-0.009	-0.001	-0.14
4	$F_{(2,255)} = 2.521$ ($p < 0.05$)	15.7	13.7	TV viewing	0.003	0.001	0.001	0.005	0.12
				BMI	0.232	0.041	0.151	0.313	0.33
				MVPA	-0.005	0.002	-0.009	-0.001	-0.14
				Mother education	-0.568	0.281	-1.121	-0.015	-0.14

Model 1 = unadjusted; Model 2 = adjusted for chronological age, and BMI; Model 3 = model 2 + adjusted for moderate-to-vigorous physical activity (MVPA); Model 4 = model 3 + adjusted for mother and father education. (Only significant predictors of metabolic risk were included in the statistically controlled models)

coefficients have been still significant when both PA and SB are included in the analytical approaches (Iannotti et al. 2009), suggesting these constructs are independent behaviors, each with significant health correlates and, in turn, should be individually investigated.

The interaction of social and educational factors play an important role on leisure activity choices, and it has been responsible of perpetuating specific stereotypes among children and adolescents (Ramirez et al. 2011). In addition, technological changes in Brazil (Silva et al. 2014) have also led to an increase of opportunities to undertake convenient and attractive sedentary behaviors as part of a contemporary lifestyle which is assumed to be influenced by the socioeconomic position of families (Leech et al. 2014). Previous studies have reported a significant association between socioeconomic position of females and healthy lifestyle (Pitel et al. 2013); individuals with lower SES had increased risk of obesity, dyslipidemia, hypertension, insulin resistance, and MetS (Scuteri et al. 2008; Vernay et al. 2013). Findings of the present study are in line with the above-mentioned research by revealing that a lower educational level of mothers was also significant predictors of clustered metabolic risk of female Brazilian adolescents. In fact, it has been suggested that mothers with higher levels of education are more likely to engage in health promoting behaviors and thus present an influential role model for youth (Desai and Alva 1998). Further possible explanations have been proposed, including differences in lifestyle (diet, PA, and smoking), sensitivity to psychological stress, body image and access to medical care. Actually, reduced leisure time PA (Mota et al. 2009) and high consumption of low-cost energy-dense foods composed of refined grains, added sugars, and fat (Leech et al. 2014) have been observed in lower socioeconomic categories, partly due to limited financial resources.

Furthermore, limited access to medical care among women with less favorable SES (Scuteri et al. 2008) might lead to the absence of prevention and management of MetS. On the other hand, differences between measures usually used to assess the metabolic risk, SES, and especially SB are pointed out as an additional source of variation. Therefore, future research needs to move beyond that relationship and focus on other modes of sedentarism (e.g., objective measures of the time, type, and context of sedentary pursuits) which will be needed in combination with robust and standardized measures of health indicators.

The present study was limited to TV viewing. Note, however, TV viewing and computer use are not the only form of SB in adolescents who also spend substantial amounts of time with a variety of media in addition to time sitting in school classes, riding in cars, eating, socializing, reading, and studying (Malina 2013). Non-screen sedentary time (NSST) has been relatively understudied (Biddle et al. 2009). After adjusting for multi-tasking, in 2009 American youth 8–18 years devoted 7.6 h daily to media: TV, music/audio, computer, video games, print and movies (Rideout et al. 2010). Overall, boys spent more time with media than girls; time spent with video games accounted for most of the sex difference. The estimate of media time in 2009 was increased relative to 1999 and 2004, 6.3 h per day in both years. Consistent with other observations, media use was not associated with PA: heavy users 2 h, moderate users 1.7 h, and light users 1.7 h (Rideout et al. 2010). A recent survey noted that Australian adolescents spent, on average, 5.75 h in NSST, which comprised 60 % of total sedentary time (Olds et al. 2010). NSST included school activities (42 %), socializing (19 %), self-care, mainly eating (16 %), and passive transport (15 %). More recently, it was estimated that European adolescents in the HELENA study (Ruiz et al. 2011) spent most of registered accelerometry

time in sedentary behaviors (9 h/day, or 71 % of the registered time); sedentary time was also higher in older than younger female adolescents. The preceding highlights the need for further study of time used by youth, perhaps focusing on the development of more objective measures of time, types, and contexts of sedentary activities.

Important strengths of the present study are that we used standardized procedures for the analyses of the metabolic risk, and the information of adolescent's lifestyle was collected using validated tools in an understudied population. However, the present study has several limitations. First, SB was limited to self-reported time viewing TV which is only one dimension of a complex construct previously discussed. Second, results are based on a relatively small sample of Brazilian adolescent girls 14–17 years living in the urban center of the Paraná region; relations among sedentary behavior and metabolic markers may vary with age, culture, or SES. Therefore, results generalization for other populations of adolescents is somewhat limited and results should be viewed with caution. Third, causal relationships between SB and increased clustered metabolic risk cannot be inferred from the cross-sectional design. Finally, parental education was used as a proxy for socio-economic status. Future research should also assess other parent-related variables such as income, type of employment, leisure activities, among others, which may have a different impact on standardized measures of health indicators.

Conclusion

In conclusion, increased time viewing TV had an adverse influence on metabolic risk in Brazilian adolescent girls. MVPA had a significant, but relatively limited impact on the relationship between screen time and clustered metabolic risk. The findings highlight the potential importance of preventive actions to ameliorate metabolic risk in youth which need to target both sedentary and physically active behaviors.

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