Children’s physical activity, TV watching and obesity in Cyprus: the CYKIDS study

Chrystalleni Lazarou1, Elpidoforos S. Soteriades2,3

Background: Even though there is a severe obesity problem in Cyprus, information about the contribution of predisposing lifestyle factors is limited. Our aim was to investigate the relationship between physical activity (PA), sedentary behaviour and various obesity indices [i.e. body mass index (BMI), waist circumference (WC), percentage of body fat (BF%) and ‘total & abdominal obesity’ (TAO)].

Methods: A national cross-sectional study of 1140 children (mean age = 10.7 ±0.98 years) selected by multistage sampling in Cyprus was conducted during 2004–05. Children completed a 32-item, semi-quantitative PA questionnaire, which assessed organized and free-time PA and sedentary behaviours. Weight, height and WC were collected from a random sub-sample of 622 children and obesity was defined by IOTF criteria. Body fat percentage was calculated, and TAO status was computed based on obesity status and WC [i.e. (i) both BMI/WC, (ii) either BMI/WC abnormal and (iii) both BMI/WC abnormal]. Linear and logistic regression analyses with obesity indices as dependent variables were applied after adjusting for several potential confounders. Results: Only variables describing sedentary behaviours were retained in the final regression models in both boys and girls. Girls who spent ≥4 h/day on TV and DVD watching were almost three times more likely to be overweight or obese [OR = 2.84 (95% CI 1.08–7.47)], three times more likely to have WC > 75th percentile [OR = 3.25 (95% CI 1.06–9.98)] and 3.5 times more likely to have ≥30% body fat [OR = 3.63 (95% CI 1.01–12.98)], while in boys, even though the same variable was retained in almost all final models, it did not reach statistical significance.

Conclusion: Sedentary behaviours may be more important predictors of children’s various obesity indices than PA behaviours. Interventions targeting sedentary behaviours, such as TV watching, may help in the prevention and treatment of obesity among Cypriot children.

Keywords: BMI, Cyprus, obesity, physical activity, sedentary behaviour, television.

Introduction

Childhood obesity constitutes an ever growing global epidemic, which not only affects children’s current health, but also jeopardizes their future health. It has been reconfirmed by a recent review1 that overweight or obese youth have increased risk to become overweight or obese in adulthood. Also, it has been estimated that about 70% of obese children aged between 10 and 13 years are at risk of remaining obese during their adult life.2 On the other hand, children’s physical activity (PA) levels seem to be decreasing, while the time spent on television viewing, computers and video games has increased.3–6 The problems of childhood obesity and sedentary lifestyle are interrelated leading to a vicious cycle, which is exacerbated by unhealthy dietary behaviours and a built environment that discourages PA.7

Lifestyle recommendations for prevention and management of childhood obesity emphasize maintenance of daily moderate to vigorous PA for at least 60 min8 and highlight exacerbating factors such as television viewing and other screen time, which should be limited to not more than 2 h per day.9 Supporting evidence for the above guidelines, however, is not consistent. In particular, while the evidence on the benefits of obesity prevention and limiting television viewing is convincing, the available evidence on the role of PA in preventing obesity among children appears to have mixed results.9–14 For example, Sallis et al.15 reported in a review article that only 16 out of 31 studies and six out of 21 studies examined in children and adolescents, respectively, have shown a significant association between PA and obesity. Similar findings are reported in a relevant meta-analysis by Marshall et al.16 and in another recently published review regarding PA and inactivity correlates by Van Der Horst et al.3 Van Der Horst et al.17 in particular report that in most studies, no significant association between body mass index (BMI) or skin folds and PA levels in children and adolescents was evident, whereas, evidence regarding the positive association of BMI/skin folds and sedentary behaviours (e.g. TV, DVD watching and time spent on playing electronic media) was more consistent.3

It is noteworthy that most of the research was conducted in the USA with few studies reported from other countries. Hence, there is a need for further investigation of the above relationship and an enhanced understanding of interrelated factors in order to develop targeted preventive programs tailored to regional and local populations.

Even though a severe obesity problem in the Cyprus population has been documented17,18 information about the contribution of predisposing lifestyle factors, such as PA and sedentary patterns, on the association between PA and obesity is limited. In particular, Savva et al.18 reported in a cross-sectional nationwide study among 2457 children, 6–17 years of age from Cyprus, that no significant association between sedentary activities, as assessed via a parental questionnaire and obesity was seen.

We therefore sought to examine the association between PA and sedentary behaviour patterns to total and central obesity among Cypriot children, aged 9–13 years old. The findings of this work might inform the design of interventions for obesity prevention in Cypriot children, while additionally might be useful for other populations as well, who have similar socio-demographic characteristics.

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References

Methods

Participants

A national survey was conducted in 2005, using a multistage stratified sample of 1140 children (533 boys and 607 girls), aged 9–13 years, attending the fourth, fifth and sixth grade of 24 elementary public schools from five districts of Cyprus. A total of 1589 children were identified for potential enrolment; 1140 agreed to participate (72% participation rate), representing 3.7% of the total population of children in Cyprus in the corresponding ages. The study was approved by the Ministry of Education and Culture of Cyprus, and consent forms for children’s participation were obtained from parents and/or legal guardians. Further details have been reported elsewhere.20

Measurements

PA

The children completed a 32-item semi-quantitative, PA questionnaire during regular school hours. Internal reliability tested by Cronbach’s-α was 0.713.21 Test–retest reliability was assessed by giving the same questionnaire in 100 children tested by Cronbach's-α during regular school hours. Internal reliability of the questionnaire was performed against counts of Yamax pedometer (DW-200, Yamax Corporation, Tokyo, Japan) in a sample of 80 children. Specifically, the Spearman ρ correlation coefficient regarding the levels of PA (mean hours per day) as compared with the mean value of counts in all 4 days (three weekdays and one weekend day) that pedometers were worn was 0.305. These values are similar to what others have reported.

Information was collected on the frequency and duration of everyday physical and sedentary activities on weekdays, weekends and on the day prior to the completion of the questionnaire, using an eight-level scale ranging from ‘0’ to ‘>8 h’ per day or week. Time spent on individual PAs was assessed based on a four-level scale ranging from ‘0 times per week’ to ‘>6 times per week’.

Principal component analysis (PCA) (varimax rotation) was employed to extract the main factors out of 21 variables from the above-described questionnaire, assessing children’s frequency and duration of physical activity.21

A physical activity index (PAI) was calculated based on two variables that measured frequency of all running and walking activities per week. We decided to keep the PAI in the regression models, instead of the factors obtained from PCAs, because it is simpler and much easier to be interpreted in the logistic regression models. The PAI has four categories, representing the frequency with which students are committed to the several PAs: (i) 0 times/week, (ii) 1–2 times/week, (iii) 3–5 times/week and (iv) 6–7 times/week. PAI has been validated against pedometer counts (DW-200, Yamax Corporation) in a sample of 80 children. Results show that Spearman’s correlation coefficients range between 0.280 for PA levels during weekdays to 0.352 for PA levels during weekends. For the same reason—simplicity—we used a categorical variable to quantify the hours children were watching TV, video and DVD every day, which was computed on the basis of the variables that constructed the relevant factor from PCA and was categorized in the three following categories: (i) up to 2 h per day, (ii) >2 h and up to 4 h per day and (iii) >4 h per day.

Assessment of other characteristics

Diet

We assessed children’s adherence to the Mediterranean diet by applying the KIDMED index (Mediterranean Diet Quality Index for children and adolescents). The index22 is derived from 16 components that summarize the principles of the Mediterranean diet prototype and provides an arithmetic score that ranges from 0 to 12. It has been positively and significantly correlated with intake of several macro- and micronutrients as they have been estimated by 24 h dietary recalls.23

Socio-demographic variables

Questions regarding socio-demographic characteristics such as age, gender, place of residence and family size were also documented. However, information on other demographic characteristics such as parents’ educational level, income and parents’ occupation were collected via the short questionnaire, which was completed by the parents. Family socio-economic status (SES) was defined by the University of Nicosia (previously known as InterCollege) Research Center, based on parents’ profession and educational level; the highest level of profession, reported by either parent, was used as a proxy of the family’s SES level, along with family income. A similar procedure for defining parental educational level has been used by Veld et al. (in Lazarou et al.20).

Anthropometry and obesity definition

Anthropometric data (i.e. weight, height and WC) were collected from a sub-sample of 622 children, according to a standard protocol described in Heymsfield et al.24 Obesity was defined based on cut-off criteria from the International Obesity Task Force (IOTF) on age- and sex-specific BMI.25 Percentage of body fat (BF%) was calculated by using the Deurenberg formula, based on BMI for children’s populations.26 Furthermore, based on children’s BMI status and WC level, a new variable called ‘total and abdominal obesity’ (TAO) was computed, comprising the following three levels: (i) obesity status = (normal weight) NW and WC < 75th percentile; (ii) either condition, obesity status = overweight (OW)/obese (OB) or WC ≥ 75th percentile; and (iii) both conditions apply obesity status = OW/OB and WC ≥ 75th percentile.

Data analyses

Descriptive characteristics were stratified by gender. Associations between normally distributed variables were tested by Student’s t-test, and Mann–Whitney U-test was used for non-normally distributed continuous variables. Associations between categorical variables were evaluated by contingency tables and chi-square test without Yate’s continuity in 2 × 2 tables. Normality of variables’ distribution was tested by Shapiro Wilks’ test and by examination of Q–Q plots.

The eight extracted factors of PA and sedentary behaviours were regressed on BMI and WC using multiple linear regression analyses (backward method). Regression analyses were adjusted for age, gender, socio-economic status, place of residence and quality of diet as assessed by the KIDMED score.22 Finally, logistic regression analyses (backward method) were used to compare and complement the results of our linear regression analyses and provided estimates of effects based on odds ratios. A dichotomous BMI variable based on the obesity status (normal weight vs. overweight/obese) and a dichotomous WC variable based on 75th percentile cut-off point
were used as dependent variables. All P-values were based on two-sided tests and compared with a significance level of 0.05. All statistical analyses were performed using SPSS 13.0 software (Statistical Package for Social Sciences, Chicago, IL, USA).

**Results**

**Demographic and lifestyle characteristics of the participants**

In table 1, we present selected descriptive characteristics of the population sample by gender. The mean age was similar in boys and girls (10.68 ± 0.96 vs. 10.67 ± 0.99, P = 0.827), age range 9–13 years old. Boys reported higher levels of PA and more time spent daily on electronic games, while girls reported more time spent in private lessons and studying homework. Obesity levels, as examined by four different indices, showed significant gender-specific differences on WC and obesity status as determined by percentage of body fat, while no significant differences were detected with respect to obesity status as evaluated by BMI and the TAO status. Specifically, a higher percentage of boys were classified as either overweight or obese based on BMI, TAO and WC. However, the difference was statistically significant only by the WC criterion. However,
when the criterion of body fat percentage (BF%) was taken into consideration, the direction of this difference was reversed, i.e. significantly higher percentage of girls was classified as either overweight or obese. Detailed results are presented in table 1.

**Multivariable analyses**

In table 2, we delineate the results of the backward multiple linear regression analysis regarding the most important factors associated with various obesity indices in both boys and girls. 'TV and DVD watching' in girls was positively associated with all obesity indices, while in boys, the above relationship was significantly associated only with abnormal WC. On the other hand, the most consistent factor inversely associated with obesity status in boys was having more afternoon sleep and fewer private lessons.

Results of the backward logistic regression analyses are reported in table 3. We found that children's TV viewing time was, on average, three times more likely to be associated with obesity in four different regression models in both genders [e.g. OR = 2.84 (1.08–7.47) for the association between TV viewing time and BMI in girls]. TV viewing time was the most significant factor that was retained in all final obesity models in both genders.

**Discussion**

We present the results from a national survey among pre-adolescent Cypriot children examining the relationship between selected PAs, sedentary behaviours and various proxy measures of body composition. Our findings provide evidence that television viewing and sedentary activities in a sample of Cypriot pre-adolescent children (~2% of the reference population) are the most important factors examined, that are consistently associated with various obesity indices in both boys and girls. Only one of the PA factors, namely ‘Sports For All’ programs, appeared to be significantly and inversely related with obesity status but only in girls. We also found that obesity was inversely related to having more afternoon sleep.

The observation of a positive association between TV viewing and all four obesity indices was statistically significant only in girls, while in boys, it reached statistical significance only in one of the four obesity indices, that of abnormal WC. The above gender-specific difference has also been reported by others.27,28 Crespo et al.27 have investigated a sample of 4069 children aged between 8 and 16 years in the NHANES (National Health and Nutritional Examination Survey) study showing that increased television watching is associated with a higher prevalence of obesity among girls. Similarly, in a European study among 12,538 children of 11 years old, te Velde et al.29 observed that, in contrast to boys, girls’ sedentary behaviours seemed to be more relevant and inversely related with obesity status only in girls. We also found that obesity was inversely related to having more afternoon sleep.

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Table 2  Results from multiple linear regression (backward method), showing the standard coefficients $b$ and associated $P$-values, that evaluated the association between obesity status (dependent) and factors of physical activity and TV viewing (independent variables)

<table>
<thead>
<tr>
<th>Variables included in the final model</th>
<th>Model for obesity as assessed by BMI$^a$</th>
<th>Model for obesity as assessed by BF percentage$^b$</th>
<th>Model for abnormal waist$^c$</th>
<th>Model for total and abdominal obesity$^d$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Boys</td>
<td>Girls</td>
<td>Boys</td>
<td>Girls</td>
</tr>
<tr>
<td>Physical activity factors (from PCA)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Factor 3: watching TV, video and DVD</td>
<td>NS</td>
<td>0.217**</td>
<td>NS</td>
<td>0.232**</td>
</tr>
<tr>
<td>Factor 7: afternoon sleep, less private lessons</td>
<td>$-0.192^{**}$</td>
<td>NS</td>
<td>$-0.195^{**}$</td>
<td>NS</td>
</tr>
<tr>
<td>Factor 8: sports for all, after school activities (except sports)</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Quality of diet (as assessed by KIDMED score)</td>
<td>NS</td>
<td>0.176**</td>
<td>NS</td>
<td>0.182**</td>
</tr>
<tr>
<td>Place of living (urban/rural)</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Socio-economic level (high, medium and low)</td>
<td>NS</td>
<td>$-0.143^{*}$</td>
<td>NS</td>
<td>$-0.138^{*}$</td>
</tr>
<tr>
<td>Adjusted $R^2$ explained by the variables retained in the final model</td>
<td>0.03</td>
<td>0.09</td>
<td>0.03</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Variables presented in the table are only those retained in the final model (after application of backward multiple linear regression method), showing the standard coefficients $b$ and associated $P$-values, that evaluate the association between four obesity indices and factors of PA and TV viewing (independent variables), by gender.

Variables entered on Step 1: place of residence (categorical), age (per 6 months), socio-economic status (categorical), PA factors (from PCA) [Factor 1: physical activity and sports after school; Factor 2: video, electronic games and computers; Factor 3: watching TV, video and DVD; Factor 4: homework and private lessons; Factor 5: home chores and outside home chores, aerobics, gymnastics, sports; Factor 6: theater cinema, use of mobile phone; Factor 7: afternoon sleep, less private lessons; and Factor 8: sports for all, after school activities (except sports)], quality of diet as assessed by KIDMED score (continuous)

a: dependent variable overweight or obesity vs normal weight status
b: dependent variable BF% $\geq 30$ vs BF% <30
c: dependent variable WC $\geq 75$th vs <75th percentile
d: dependent variable overweight or obese and WC $\geq 75$th percentile vs normal weight and WC <75$th$ percentile, respectively

$^{*}P<0.10; \quad ^{**}P<0.05; \quad ^{***}P<0.001$

NS = non-significant association
<table>
<thead>
<tr>
<th>Variables entered on Step 1:</th>
<th>Model for obesity as assessed by BMI&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Models for obesity as assessed by %BF&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Models for abnormal waist&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Models for total and abdominal obesity&lt;sup&gt;d&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95% CI)</td>
<td>OR (95% CI)</td>
<td>OR (95% CI)</td>
<td>OR (95% CI)</td>
</tr>
<tr>
<td></td>
<td>Boys</td>
<td>Girls</td>
<td>Boys</td>
<td>Girls</td>
</tr>
<tr>
<td>TV viewing time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 2 h/day</td>
<td>–</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2+ up to 4 h/day</td>
<td>–</td>
<td>1.96 (0.85–4.54)</td>
<td>0.34 (0.05–2.12)</td>
<td>1.79 (0.55–5.90)</td>
</tr>
<tr>
<td>&gt;4 h/day</td>
<td>–</td>
<td>2.84 (1.08–7.47)</td>
<td>1.33 (0.25–7.13)</td>
<td>3.63 (1.01–12.98)</td>
</tr>
<tr>
<td>Quality of diet (as assessed by KIDMED score)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor quality diet: score 0–3</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Average quality diet: score 4–7</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Good quality diet: score 8–12</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Age (Per 6 months)</td>
<td>0.46 (0.25–0.85)</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

<sup>a</sup> dependent variable overweight or obesity vs normal-weight status. Total cases: 622 (2% of the reference population)

<sup>b</sup> dependent variable BF% ≥ 30 vs. BF% < 30. Total cases: 622 (2% of the reference population)

<sup>c</sup> dependent variable WC ≥ 75th vs < 75th percentile. Total cases: 622 (2% of the reference population)

<sup>d</sup> dependent variable overweight or obese and WC ≥ 75th percentile vs normal weight and WC < 75th percentile, respectively. Total cases: 622 (2% of the reference population)

*Variables entered on Step 1: place of residence (categorical), age (per 6 months), socio-economic status (categorical), PA index (categorical), TV viewing time (categorical), quality of diet as assessed by KIDMED score (categorical)
sedentary or PA pursuits. In the study of Hager,\textsuperscript{40} it has been shown that increased TV viewing after school correlated with decreased PA. Therefore, further investigation of the relationship between specific day time periods associated with sedentary behaviour and PA patterns may provide further helpful insights into the understanding of such behaviours, which might in turn inform public health programs.

Additionally, there is a need to explore novel ways of encouraging children, who prefer screen entertainment, to be active while they watch TV. For example, a recently published study suggested a novel walking media station, which enables normally seated screen activities, in children, to be conducted whilst walking.\textsuperscript{41} Parallel efforts should also target the promotion of PA and improvement of children’s healthy dietary habits, since clustering of unhealthy lifestyle behaviours could further exacerbate the obesity problem.\textsuperscript{35}

Our study findings also suggest that girls may need to be particularly targeted with special intervention programs. Therefore, research should also address factors that may be associated with gender-specific differences regarding PA and sedentary activity patterns as well as obesity.

Strengths of our study include the fact that this is a novel study in Cyprus examining the relationship of obesity indices, PA and sedentary behaviours, and thus adds to the growing body of literature on child sedentary behaviours and obesity. The sample was nation-wide and thus provided information applicable in public health programs on a nation-wide level, and in countries with similar demographic profile, such as other Mediterranean countries. Furthermore, we report associations between TV viewing time and various obesity indices, besides BMI, which is the only index that is usually reported and thus additional useful insights are given on the type, magnitude and consistency of the reported relationship.

We would also like to acknowledge the limitations of our study, which should be taken into account when interpreting and generalizing the results. First, this was a cross-sectional study and therefore causation should be examined with caution. Secondly, PA and dietary data were based on self-reports. Although we made every effort to obtain accurate data, there is a possibility of misreporting which has occurred, which might have influenced our findings. Even though this is a cross-sectional study and observed associations may be bi-directional, we believe that our findings are suggestive of causal relationships based on plausible biological associations. Further more, current BMI cut-offs have lower sensitivity and therefore may lead to potential misclassification.\textsuperscript{24} Even though we also estimated body fat percentage, the estimation was not from direct measurement, but was based on anthropometry (BMI). Two main disadvantages of prediction formulas are that their validity is only proven in the population in which they were developed and they often underestimate BF\% especially in individual level. However, it is generally acknowledged that prediction formulas give generally good estimates of BF\% on a group level. Furthermore, the use of four obesity indices in this study could help overcome any misclassification problems of each obesity index and offer valid results with respect to group-level associations.

**Conclusion**

In summary, our findings show that TV viewing time is an important correlate consistently associated with obesity status in Cypriot children, particularly among girls. Our results call for the implementation of public health programs to prioritize on actions that will motivate children to reduce sedentary habits, such as television watching or other screen time. Future research should also address factors that may be associated with gender-specific differences regarding physical activity and sedentary activity patterns and obesity.

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**Conflicts of interest**: None declared.

**Key points**

- An inverse association between more afternoon sleep and fewer private lessons and obesity status was observed.
- Television watching and sedentary activities are the most important of the factors that are consistently associated with four obesity indices in both boys and girls.
- Public health professionals, educators and parents should prioritize on actions that will motivate children to reduce sedentary habits, such as television watching or other screen time.

**References**


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