

ORIGINAL ARTICLE

Watching television is associated with childhood obesity: but is it clinically important?

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Objective: To assess the impact of television viewing during childhood and adolescence on body mass index (BMI) in children up to the age of 15 years.

Design: Unselected birth cohort, assessed at birth and every 2 years from age 3 to 15 years.

Subjects: In all, 1037 individuals were assessed at age 3 years. At age 15 years, 976 (95% of living cohort) continued to participate.

Measurements: Parental estimates of weekday television viewing between age 5 and 11 years. Self-reports of television viewing at age 13 and 15 years. Weight and height were measured at each age to calculate BMI.

Results: BMI and prevalence of overweight at all ages were significantly associated with mean hours of television viewing reported in the assessments up to that age. These associations were stronger in girls than boys. The associations remained significant after adjusting for parental body mass indices and socio-economic status.

Conclusion: Time spent watching television is a significant predictor of BMI and overweight in childhood. Although the effect size appears small, it is larger than the effect sizes commonly reported for nutritional intake and physical activity. Television viewing should be regarded as an important contributing factor to childhood obesity.

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Keywords: television; childhood; body mass index; birth cohort

Introduction

Childhood obesity is now a global epidemic.¹ How this epidemic should be managed is not yet clear, but a priority is to identify the lifestyle and environmental factors that have led to the problem. An obvious candidate is television viewing – an activity popular with children throughout the world and a biologically plausible cause of increased body weight. However, the extent to which television viewing contributes to childhood obesity is controversial. A recent meta-analysis of the evidence found that time spent television viewing was consistently linked with overweight, but that the association was weak and unlikely to be clinically relevant.² However, the majority of studies reviewed were cross-sectional, did not control for confounding factors and therefore unable to establish a cause-and-effect

sequence. Reported associations between television viewing and physical activity were also weak. The authors concluded that television viewing was unlikely to be an important cause of childhood obesity.

We recently reported findings from a birth cohort linking childhood television viewing with a number of adverse health outcomes, including overweight in adulthood.³ This data set also allows us to examine the association with childhood overweight and to address many of the shortcomings of previous studies. We now report on the longitudinal associations between childhood television viewing and body mass index (BMI) at age 5, 7, 9, 11, 13 and 15 years in this cohort.

Methods

The study has previously been described in detail.^{3,4} In brief, Study members were born in Dunedin, New Zealand, between April 1972 and March 1973. All children still living in the province of Otago were invited to participate in the first follow-up assessment at an age of 3 years. In total, 1037 (91% of eligible births, 52% male) children attended, constituting the base sample for the remainder of the study.

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Follow-ups included in this report were carried out at age 5 ($n=991$), 7 ($n=954$), 9 ($n=955$), 11 ($n=925$), 13 ($n=850$) and 15 years ($n=976$). Cohort families represent the full range of socio-economic status in the South Island of New Zealand and are mostly of New Zealand European ethnicity. Written informed consent was obtained for each assessment. The study was approved by the Otago Ethics Committee.

Between age 5 and 11 years, parents were asked how much time the Study members watched television on weekdays. At age 13 and 15 years Study members themselves were asked how long they usually watched television on weekdays and at weekends. At each age height without shoes and weight in light clothing were measured to calculate BMI in kg/m^2 .

Covariate measures for this analysis were obtained at several ages. The socio-economic status of the Study members' families was measured at each age according to the highest parental occupation on a six-point scale, based on the educational level and income associated with that occupation in the New Zealand census (6 = unskilled labourer, 1 = professional).⁵ Childhood socio-economic status was taken as the mean of the assessments between birth and 15 years. A report of the height and weight of the Study member's parents was obtained for 81% of mothers and 77% of fathers at the age 11 years assessment and used to estimate parental BMI. BMI measurements were obtained at age 5 years from 893 study members. Missing age 5 years BMI values were imputed from BMI measurements at age 3 years for a further 120 Study members.

Analyses examined the associations between BMI at each age and the mean viewing hours per weekday reported up to that age was measured using linear regression adjusting for sex. The associations between overweight (including obesity) at each age and mean weekday television viewing up to that age were assessed using logistic regression. Overweight was defined according to the standard of the International Obesity Task Force.⁶ Further analyses included childhood socio-economic status, BMI at age 5 years and parental BMI (both parents) in the linear regression model. Linear regression models were checked by the visual inspection of residuals to ensure that these were approximately normal in distribution and that they were randomly scattered versus

the fitted values. As Study members were seen around the time of their birthday (usually within a month) and it is plausible that those interviewed during winter were likely to report watching more television, we tested for an interaction between television viewing and time of birth (winter = June–September) in the analyses. Cross-sectional, prospective and cumulative correlation coefficients between BMI at each age and hours of television viewing reported at that age, before that age, and up to and including that age were calculated. Statistical analyses were performed using Stata 8.0 (TX, USA).

Results

Study members reported watching television for a mean (s.d.) of 2.33 (0.88) h of television on weeknights between age 5 and 15 years. At 13 and 15 years, they reported a mean (s.d.) of 24.6 (10.5) h per week (including weekends). The results of sex-adjusted regression analyses between BMI at each age and the mean hours of weeknight television viewing reported at the assessments up to that age are shown in Table 1. At each age, the mean hours television viewing reported up to and including that age was significantly associated with BMI. At the age of 15 years, the findings differed for male and female Study members and the results are also shown separately for each sex. These indicate that the relation between television viewing and BMI tended to be stronger in girls, particularly during adolescence. Table 1 also includes the results of regression analyses adjusting for sex, socio-economic status, mother's and father's BMI. These show that the association between television viewing and BMI remains significant after adjustment for these potential confounders. After additional adjustment for the age of 5 years BMI the regression analysis of BMI at age 15 years remained statistically significant ($n=736$, coefficient (95% CI) = 0.30 (0.07, 0.53), $P=0.011$). Those born during winter reported slightly more hours of television viewing between age 5 and 15 years ($P=0.01$) but there was no significant interaction between the season of birth and the effect of television viewing on BMI. The findings from the logistic

Table 1 Coefficients (Coef.) from linear regression represent the increase in BMI units (kg/m^2) for each hour of weeknight television viewing on average reported up to and including that age

Age	Both sexes ^a			Girls			Boys			Adjusted ^b		
	n	Coef. (95% CI)	P	n	Coef. (95% CI)	P	n	Coef. (95% CI)	P	n	Coef. (95% CI)	P
5	878	0.11 (0.05, 0.17)	<0.001	426	0.12 (0.03, 0.20)	0.007	452	0.11 (0.02, 0.20)	0.015	692	0.09 (0.02, 0.15)	0.012
7	867	0.21 (0.12, 0.30)	<0.001	418	0.22 (0.08, 0.35)	0.002	449	0.20 (0.07, 0.33)	0.002	693	0.18 (0.07, 0.28)	0.001
9	811	0.15 (0.01, 0.28)	0.035	384	0.25 (0.04, 0.45)	0.018	427	0.04 (-0.14, 0.23)	0.642	670	0.18 (0.03, 0.33)	0.017
11	711	0.26 (0.07, 0.46)	0.009	339	0.40 (0.12, 0.69)	0.005	372	0.12 (-0.15, 0.40)	0.374	603	0.33 (0.12, 0.54)	0.002
13	736	0.35 (0.12, 0.58)	0.002	355	0.45 (0.10, 0.79)	0.011	381	0.26 (-0.04, 0.56)	0.091	628	0.27 (0.02, 0.52)	0.038
15	956	0.38 (0.18, 0.58)	<0.001	461	0.58 (0.30, 0.86)	<0.001	495	0.19 (-0.10, 0.47)	0.207	740	0.28 (0.04, 0.51)	0.020

For example, for the age 9 years BMI regression, the mean television viewing reported at age 5, 7 and 9 years is used as the independent variable. n = number of study members in the regression model. ^aRegression analyses of both sexes together include a term for sex in the model. ^bAdjusted analyses include sex, socio-economic status and mother's and father's BMI in the model.

Table 2 Percent of Study members overweight at each age

Age	% Overweight	Both sexes ^a			Girls			Boys		
		n	OR (95% CI)	P	n	OR (95% CI)	P	n	OR (95% CI)	P
5	11.2	878	1.24 (1.09, 1.42)	0.001	426	1.24 (1.04, 1.48)	0.014	452	1.24 (1.01, 1.51)	0.040
7	7.4	867	1.61 (1.28, 2.02)	<0.001	418	1.66 (1.24, 2.23)	0.001	449	1.52 (1.05, 2.19)	0.025
9	5.9	811	1.23 (0.89, 1.70)	0.221	384	1.32 (0.88, 1.98)	0.180	427	1.08 (0.63, 1.86)	0.780
11	7.6	711	1.44 (1.04, 2.00)	0.029	339	1.53 (0.96, 2.45)	0.076	372	1.37 (0.87, 2.16)	0.180
13	13.5	736	1.30 (0.99, 1.69)	0.055	355	1.33 (0.94, 1.89)	0.109	381	1.25 (0.83, 1.87)	0.281
15	10.7	956	1.48 (1.17, 1.88)	0.001	461	1.78 (1.29, 2.45)	<0.001	495	1.18 (0.83, 1.68)	0.365

Odds ratios (OR) from logistic regression represent the increase in odds of overweight for each hour of weeknight television viewing on average reported up to and including that age. For example, for age 9 years overweight, the mean television viewing reported at age 5, 7 and 9 years is used as the independent variable. *n* = number of Study members in the model. ^aAnalyses of both sexes together include a term for sex in the model.

Table 3 Correlation coefficients between BMI at each age with cross-sectional, prospective and cumulative measures of weekday television viewing hours

Age	Cross-sectional		Prospective		Cumulative	
	r	P	r	P	r	P
5	0.12	<0.001				
7	0.10	0.003	0.14	<0.001	0.15	<0.001
9	0.06	0.115	0.08	0.028	0.07	0.054
11	0.12	0.002	0.07	0.063	0.12	0.002
13	0.05	0.215	0.10	0.005	0.10	0.006
15	0.06	0.083	0.10	0.002	0.09	0.012

Prospective correlations are between BMI and the mean hours television viewing reported before that age (e.g. between BMI at age 9 years and television viewing at age 5 and 7 years). Cumulative correlations include television viewing reported at the age of BMI measurement (e.g. between BMI at age 9 years and television viewing at age 5, 7 and 9 years).

regression analyses of overweight at each age and television viewing are similar and are shown in Table 2. In general, the correlation coefficients between BMI at each age and estimates of previous and cumulative television viewing tended to be higher than the cross-sectional correlations with current viewing only (Table 3).

Discussion

This study has confirmed that watching television in childhood is associated with an increased BMI. These associations were stronger and consistently statistically significant in girls. In boys, the associations were consistently positive, but were generally weaker and often not significant, particularly at the older ages. Importantly, these significant associations remained after adjusting for the potential confounding influences of socio-economic status and familial tendency to overweight. The association also remained significant when the regression analysis of age 15 years BMI was further adjusted for the Study members own BMI at age 5 years. The

findings were similar using logistic regression for overweight defined by international standards.⁶ These data add further evidence for a cause-and-effect association between television viewing and overweight.

The longitudinal design of this study helps to establish the temporal sequence of the association between television viewing and BMI. Our primary measure of television viewing at each age was the mean reported weeknight viewing hours up to and including that age. This includes an estimate of both previous and current viewing habits and it may be argued that results shown in Tables 1 and 2 are from mixed cross-sectional and prospective analyses. Truly prospective correlations are shown in Table 3, where BMI at each age is correlated with mean reported television viewing before that age (e.g., age 9 years BMI is correlated with mean television viewing reported at age 5 and 7 years). The correlation coefficients from these analyses are similar to those from analyses using cumulative viewing estimates.

It is not clear why the association between television viewing and BMI was stronger in adolescent girls. It is possible that this is a spurious finding. Indeed, formal tests for a sex × television viewing interaction only approached significance at age 15 years (*P* = 0.054). Alternatively, it may be because this reflects differences in the physiology or lifestyles of adolescent boys and girls. It is worth noting that the long-term association between childhood television viewing and adult BMI was similar for male and female Study members.³

The findings from this study are in accordance with the large number of cross-sectional surveys, a smaller number of longitudinal studies and one randomised trial which indicate that television viewing is a risk factor for childhood obesity.² The consistency of this finding is not disputed, but the question remains as to whether the association between television viewing and BMI is clinically important.² In this cohort, the cross-sectional correlation coefficients between television viewing and BMI at the same age varied between 0.05 and 0.12 (Table 3). These values are similar to those reported in other studies.² Correlation coefficients of this magnitude are generally regarded as indicating a small effect size and suggests that television viewing explains little of the

variance in BMI.⁷ Does this mean that television viewing habits are not an important cause of childhood overweight? There are several arguments against this interpretation.

First, self- and parent estimates of viewing hours contain inaccuracies^{8,9} that will reduce the strength of the association. In this study, viewing hours were assessed at multiple ages, which should improve the estimation of childhood television viewing. Hence, the correlations between BMI and cumulative estimates of mean television viewing over multiple ages tended to be higher than the cross-sectional values (Table 3). Even so, 2-yearly self-reports of viewing hours during weekdays provide only an approximation of total viewing time and this could lead to underestimation of the strength of the television–BMI association.

Second, overweight and obesity were relatively uncommon in these children (Table 2). The definition of overweight and obesity in childhood is problematic, but according to recent standards of the International Obesity Task Force,⁶ 11% were overweight at age 15 years and only 1% was obese. Therefore, the correlation coefficients between television viewing and BMI are obtained from a group of individuals who are mostly within the normal range, and it should not be surprising if these appear weak. Although these children appear to have grown up before the global epidemic of childhood obesity reached New Zealand, this advantage was short-lived. By age 26 years, 41% were either overweight or obese, an outcome that was significantly related to the amount of television they watched during childhood.³

Third, correlations between a risk factor and outcome underestimate the true strength of the association when the entire population is exposed to the risk. As Rose¹⁰ pointed out, cohort methods will fail to detect an aetiological agent if exposure to it is homogeneous within the population. In this cohort, only 6.8% of Study members watched on an average of 1 h or less per weeknight between 5 and 15 years and only one Study member consistently denied watching any television. Correlations within this study, as in most other studies of television viewing, therefore compare outcomes between those who watch television for a moderate amount of time with those who watch a lot. There is no control group of children who were unexposed to television. Even those who watched very little may have been indirectly influenced by television through its effects on their peer group. Thus, television has altered what is regarded as ‘normal’ childhood behaviour – it is difficult to play team sports after school if your potential team-mates are indoors watching television.

Finally, before we dismiss the correlation between television viewing and BMI as ‘weak’ and therefore clinically unimportant,² we should consider the strength of the associations between BMI and other causal factors. Obesity can only occur if energy intake in the diet exceeds energy expenditure. However, studies have struggled to find strong associations between children’s energy intake and their BMI.^{11–15} Similarly, studies have generally found only weak

or no association between physical activity measures and BMI.^{13–17} Indeed, time spent watching television appears to be a better predictor of BMI than either dietary intake or physical activity.^{13,15,18} In our study, we have data on physical activity at age 15 years, which were inversely associated with time spent watching television,³ but not a significant predictor of BMI.

These children were born in 1972/1973 and became 15-years-old in 1987–1988. While they were growing up, New Zealand had two television channels, both of which had limited viewing hours. Since then, the number of free-to-air television channels increased from two to four, the time given to advertising increased, pay satellite television became available, viewing hours increased to provide 24-h coverage, more homes have video or DVD players and many homes have acquired a computer and internet access.¹⁹ Thus, despite the apparently heavy television use in this cohort, the opportunities for ‘screen-time’ are far higher for children today. The mean BMI and prevalence of overweight in our cohort were similar to that measured in 12 to 13-year-olds in another region of New Zealand in 1989.²⁰ A follow-up survey in the same region in 2000 found that overweight had increased from 11 to 21% and obesity had risen nearly fourfold from 2.4 to 9.1%. Although, the aetiology of overweight and obesity involves a complex mix of environmental and genetic factors, this huge increase at the population level must be largely driven by changes in children’s diet or levels of activity. Time spent watching television may be related to both.^{3,21}

In summary, we provide further evidence of an association between television viewing and childhood BMI. This association appears to be more important in girls than boys. Our study addresses some of the problems with previous studies by establishing the temporal sequence of the association and controlling for important confounding influences. Although the effect size appears small, the correlation between television viewing and BMI is stronger than reported correlations between BMI and diet or physical activity. We believe that watching television is an important contributing factor to the current epidemic of childhood obesity.

Conflict of interest statement

Neither author has any conflict of interest in the publication of this paper.

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