Association between child and adolescent television viewing and adult health: a longitudinal birth cohort study

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Summary

Background Watching television in childhood and adolescence has been linked to adverse health indicators including obesity, poor fitness, smoking, and raised cholesterol. However, there have been no longitudinal studies of childhood viewing and adult health. We explored these associations in a birth cohort followed up to age 26 years.

Methods We assessed approximately 1000 unselected individuals born in Dunedin, New Zealand, in 1972–73 at regular intervals up to age 26 years. We used regression analysis to investigate the associations between earlier television viewing and body-mass index, cardiorespiratory fitness (maximum aerobic power assessed by a submaximal cycling test), serum cholesterol, smoking status, and blood pressure at age 26 years.

Findings Average weeknight viewing between ages 5 and 15 years was associated with higher body-mass indices ($p=0\cdot0013$), lower cardiorespiratory fitness ($p=0\cdot0003$), increased cigarette smoking ($p<0\cdot0001$), and raised serum cholesterol ($p=0\cdot0037$). Childhood and adolescent viewing had no significant association with blood pressure. These associations persisted after adjustment for potential confounding factors such as childhood socioeconomic status, body-mass index at age 5 years, parental body-mass index, parental smoking, and physical activity at age 15 years. In 26-year-olds, population-attributable fractions indicate that 17% of overweight, 15% of raised serum cholesterol, 17% of smoking, and 15% of poor fitness can be attributed to watching television for more than 2 h a day during childhood and adolescence.

Interpretation Television viewing in childhood and adolescence is associated with overweight, poor fitness, smoking, and raised cholesterol in adulthood. Excessive viewing might have long-lasting adverse effects on health.

Introduction

Children in developed countries watch a lot of television. Surveys suggest that time spent watching television during childhood and adolescence might even exceed time spent in school.[1] There is increasing concern that the amount of television watched by children could have adverse effects on health. Television viewing might not only displace more energetic activities (contributing to poor fitness and obesity), but also encourage poor dietary habits, violent behaviour, and substance abuse due to the messages conveyed through programme content and advertising.[2]

Studies in children and adolescents have linked television viewing to obesity,[3–6] poor physical fitness,[7,8] lipid abnormalities,[9] and smoking.[10] However, several studies have found the associations to be weak or non-significant,[11–13] and none has addressed the long-term effects of childhood television viewing. In particular, there is no information on whether childhood television viewing affects adult health. To address this issue, we examined the association between child and adolescent television viewing and a range of adult health indicators in a birth cohort of approximately 1000 New Zealanders.

Methods

Participants

Study members were born in Dunedin, Otago province, New Zealand, between April, 1972, and March, 1973.[14] We invited all children who still resided in Otago to participate in the first follow-up assessment at age 3 years. 1037 children (91% of eligible births; 535 [52%] boys, 502 [48%] girls) attended the initial follow-up, constituting the base sample for our study. Further follow-up assessments were undertaken at ages 5 (n=991), 7 (n=954), 9 (n=955), 11 (n=925), 13 (n=850), 15 (n=976), 18 (n=993), 21(n=992), and most recently at age 26 years, when we assessed 980 (96%) of 1019 study members who were still alive. Cohort families represented the full range of socioeconomic status in the South Island, New Zealand, and were mostly of New Zealand European ethnicity. At age 26 years, 73 (7·4%) study members identified themselves as Maori, and 15 (1·5%) as Pacific Islanders. We obtained written informed consent for each assessment. Our study was approved by the Otago Ethics Committee.

Procedures

Information was obtained on television viewing at ages 5, 7, 9, 11, 13, 15, and 21 years. Between ages 5 and 11 years, parents were asked how much time study members spent watching weekday television. At ages 13, 15, and 21 years, study members themselves were asked how long they usually watched television on weekdays and at weekends. Our summary variable was a composite of child and adolescent viewing calculated

	Mean (SD) viewing hours		Correlation coefficients						
	Male	Female	5 years	7 years	9 years	11 years	13 years	15 years	21 years
Age (years)									
5*	1·91 (1·23)	1·91 (1·35)	..	0·35	0·33	0·21	0·19	0·16	0·08†
7*	1·87 (0·97)	1·69 (0·94)	..	..	0·42	0·38	0·27	0·23	0·14
9*	2·22 (1·03)	2·04 (1·03)	..	..	..	0·41	0·30	0·24	0·21
11*	2·60 (1·16)	2·41 (1·12)	..	..	..	..	0·29	0·28	0·19
13‡	3·86 (1·57)	3·54 (1·48)	..	..	..	..	..	0·52	0·33
15‡	3·58 (1·79)	3·19 (1·71)	..	..	..	..	..	..	0·42
21‡	3·07 (1·73)	3·07 (1·79)	..	..	..	..	..	..	..
5–15*	2·42 (0·86)	2·24 (0·89)	0·60	0·64	0·67	0·65	0·68	0·67	0·32

*Weekday average. All correlations are significant p<0·0001, except †p=0·0221. ‡Daily average.

Table 1: **Mean viewing hours and correlation between ages**

as the mean viewing hours per weekday, between ages 5 and 15 years. We also analysed the associations between television viewing in two developmental epochs: childhood (mean viewing hours per weekday at ages 5–11 years) and adolescence (mean viewing hours per day at ages 13–15 years, including weekends).

Participants at age 26 years were studied to assess adult health. We measured height (without shoes) and weight (in light clothing) to calculate body-mass index (kg/m^2). Blood pressure (the mean of three measurements all preceded by 5-min rest) was recorded from the right arm with a random zero sphygmomanometer (Hawksley, Lancing, UK) with a constant deflation valve. Submaximum exercise testing was undertaken with a cycle ergometer (Monarch 818, Varberg, Sweden). A 2-min warm-up at 50 W was used to gauge the heart-rate response. We adjusted the intensity of exercise to elicit a steady-state heart rate of 130–170 beats per min during a further 5–6 min exercise at constant power. We calculated maximum aerobic power (VO_2max) from final heart rates for the 785 (80%) study members who completed the test by using the modified Åstrand-Rhyming method.[15] Non-fasting blood samples were collected about 4 h after lunch for 882 (90%) 26-year-old participants, and analysed on a Hitachi 717 analyser with a cholesterol oxidase method (coefficient of variation 2·7–2·9%; Roche, Mannheim, Germany). We defined current cigarette smoking as smoking daily for at least 1 month in the previous year.

Covariate measures were obtained at several ages: we recorded socioeconomic status of study members' families 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).[16] Childhood socioeconomic status was calculated as the mean of assessments between birth and age 15 years. At age 15 years, we used the modified Minnesota Leisure Time Physical Activity Questionnaire to assess physical activity.[17] Smoking habits of both parents were ascertained in the assessments at 9, 11, and 13 years of age. At the assessment at age 11 years, parental body-mass index was estimated from self-reports of the height and weight of parents for 839 (81%) mothers and 798 (77%) fathers. We obtained body-mass index measurements from 893 study members at age 5 years. Missing body-mass index values were imputed from measurements taken at age 3 years for a further 120 participants.

Statistical analysis

We used linear regression to examine the association between television viewing and health indicators

	BMI (kg/m^2)			VO_2max (L/min)			Cholesterol (mmol/L)			Current smoking			Systolic BP (mm Hg)		
	n	β (SE)	p	n	β (SE)	p	n	β (SE)	p	n	Odds ratio (95% CI)	p	n	β (SE)	p
Mean child and adolescent (age 5–15) television viewing															
Unadjusted	929	0·54 (0·17)	0·0013	773	−0·11 (0·03)	0·0003	842	0·11 (0·04)	0·0037	937	1·36 (1·17–1·58)	<0·0001	919	0·64 (0·38)	0·0885
Adjusted*	709	0·48 (0·19)	0·0121	657	−0·12 (0·04)	0·0009	838	0·09 (0·04)	0·0383	907	1·28 (1·08–1·51)	0·0043	915	0·46 (0·40)	0·2430
Television viewing during developmental epochs															
Childhood† (age 5–11 years)	924	0·49 (0·18)	0·0054	771	−0·10 (0·03)	0·0010	837	0·12 (0·04)	0·0029	932	1·41 (1·19–1·65)	<0·0001	914	0·57 (0·40)	0·1530
Adolescence‡ (age 13–15 years)	817	0·33 (0·10)	0·0009	687	−0·06 (0·02)	0·0008	745	0·06 (0·02)	0·0183	820	1·12 (1·02–1·23)	0·0167	810	0·28 (0·23)	0·2339
Early adulthood‡ (age 21 years)	825	0·23 (0·09)	0·0071	691	−0·05 (0·02)	0·0016	754	0·04 (0·02)	0·0578	830	1·16 (1·07–1·26)	0·0004	819	0·002 (0·20)	0·9912

Analyses exclude pregnant women (n=33) and are adjusted for sex. Analyses involving VO_2max are also adjusted for bodyweight. β=beta coefficient. BP=blood pressure. BMI=body-mass index. †Mean hours per weekday. ‡Mean hours per day including weekends. Adjusted regression models include childhood socioeconomic status for all outcomes and the following additional covariates: BMI at age 5 years and parental BMI for BMI, reported physical activity at age 15 years for VO_2max, and parental smoking for current smoking.

Table 2: **Regression of health outcomes at age 26 years on television viewing during childhood, adolescence, and early adulthood**

(body-mass index, cardiorespiratory fitness [VO_2max], serum cholesterol, and systolic blood pressure) at age 26 years, and logistic regression for the relation between television viewing and current smoking. All analyses were adjusted for sex. Analyses involving VO_2max were also adjusted for bodyweight. We excluded pregnant women (n=33) from all analyses. We checked linear regression models by visual inspection of the residuals to ensure that they were normal in distribution and that they were randomly scattered versus the fitted values. Statistical analyses were done with Stata 8.0 (Stata Corporation, College Station, TX, USA)

Additional analyses were adjusted for potential confounding factors: childhood socioeconomic status for all outcomes, body-mass indices at age 5 years and of both parents for body-mass index analysis at age 26 years, physical activity at 15 years of age for analysis of cardiorespiratory fitness, and smoking history of either parent for analysis of smoking at 26 years of age. To examine whether the effects of child and adolescent television viewing were mediated by the continuity between child and adult viewing, further regression analyses used child and adolescent viewing as the independent variable and viewing at age 21 years as a covariate.

The prevalence of overweight (body-mass index ⩾25 kg/m²), lowest-quartile VO_2max (adjusted for bodyweight and sex), raised cholesterol (>5·5 mmol/L), current smoking, and highest-quartile systolic blood pressure (for each sex) at age 26 years were calculated according to the mean hours of weekday television viewing from age 5 to 15 years. Population-attributable fractions were calculated according to whether a study member watched an average of more than 2 h television on weekdays between ages 5 and 15 years.

Role of the funding source

The sponsors of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results

Table 1 summarises the mean viewing hours reported, and their correlations between ages. Child and adolescent viewing (age 5–15 years) correlated with lower childhood socioeconomic status (n=1013, *r*=0·31, p<0·0001), increased parental smoking (n=998, *r*=0·11, p=0·0005), higher maternal and paternal body-mass indices (n=839, *r*=0·09, p=0·0086; n=798, *r*=0·11, p=0·0013, respectively), and higher body-mass index at age 5 years (n=996, *r*=0·11, p=0·0004). Physical activity at 15 years of age did not correlate with overall child and adolescent viewing, but was significantly correlated with fewer hours of adolescent viewing (n=825, *r*=–0·09, p=0·0101).

Childhood and adolescent (age 5–15 years) television viewing predicted a higher body-mass index, lower VO_2max, higher serum cholesterol, and increased cigarette smoking at age 26 years. No significant association between television viewing and blood pressure was noted. Similar patterns of results were seen for childhood (age 5–11 years), adolescence (age 13–15 years), and early adulthood (age 21 years; table 2).

Distributions of the residuals from the linear regression analyses of body-mass index, VO_2max, and serum cholesterol were slightly skewed. Repeated analyses after log-transformation of these variables corrected this problem, and provided similar results to those of untransformed variables: ln (body-mass index) β coefficient (SE)=0·02 (0·006), p=0·0004; ln (VO_2max)=–0·03 (0·009), p=0·0003; ln (cholesterol)=0·02 (0·008), p=0·0052.

Television viewing between ages 5 and 15 years remained a significant predictor of adult body-mass index, VO_2max, cholesterol, and smoking, after adjustment for childhood socioeconomic status (table 2). Child and adolescent television viewing remained a significant predictor of adult body-mass index after

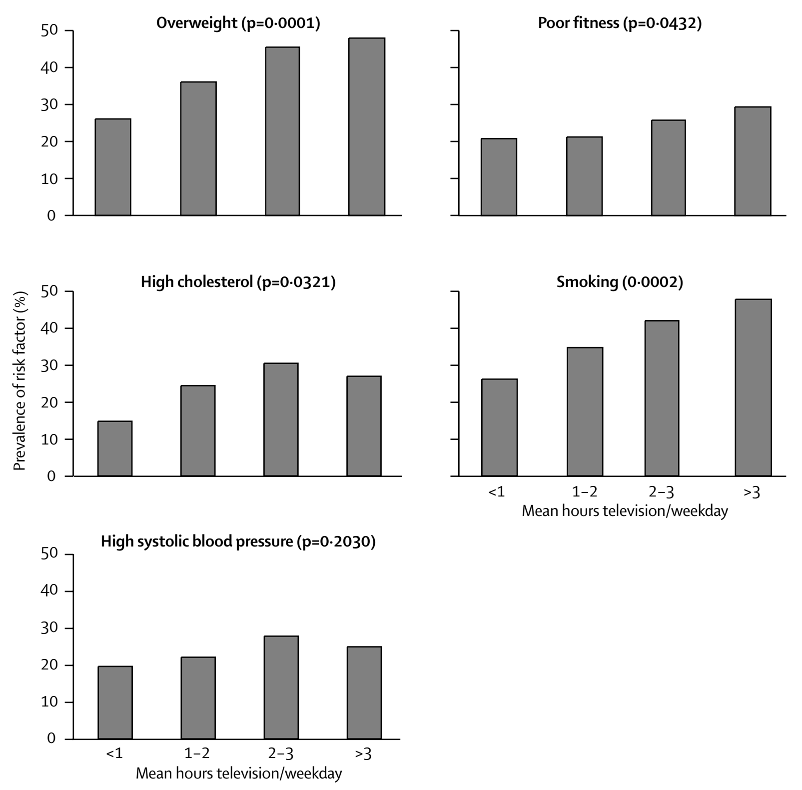

Figure: **Child and adolescent television viewing and prevalence of risk factors at age 26 years**
Prevalence of risk factors at age 26 years according to mean hours of television viewing per weekday between ages 5 and 15 years. The proportion of study members in each group was: ⩽1 h 6·8%, 1–2 h 32·2%, 2–3 h 40·9%, >3 h 20·2%. p values refer to trends across each risk factor.

additional adjustment for body-mass index at age 5 years and the estimated body-mass indices of both parents. Additional adjustment for reported physical activity at age 15 years did not change the association between child and adolescent television viewing and VO_2max at age 26 years. Additional adjustment for parental smoking history made little difference to the relation between child and adolescent television viewing and adult smoking (table 2).

In analyses adjusting for viewing at age 21 years, child and adolescent television viewing remained a significant predictor of higher body-mass index (p=0·0394), reduced VO_2max (p=0·0086), higher serum cholesterol (p=0·0060), and cigarette smoking (p=0·0243) at age 26 years.

622 (61%) study members watched television for an average of more than 2 h per weekday between ages 5 and 15 years. Population-attributable fractions calculated on unadjusted results indicate that 17% (95% CI 7–25) of overweight, 15% (–2 to 29) of poor cardiorespiratory fitness, 15% (0–27) of raised cholesterol, and 17% (7–26) of current smoking in 26-year-olds could be attributed to exceeding this limit. The prevalence of each adverse outcome according to the mean hours of television watched per weekday is shown in the figure.

Discussion

Our results show that television viewing during childhood and adolescence is associated with overweight, poor cardiorespiratory fitness, raised serum cholesterol, and cigarette smoking in early adulthood. We found no significant association between television viewing and blood pressure.

To measure television viewing we used parental reports (for ages 5, 7, 9, and 11 years) and self-reports (for ages 13 and 15 years). We have no way to assess the accuracy of these reports. Furthermore, we did not ask about weekend viewing between ages 5 and 11 years. However, we believe that the associations between child and adolescent television viewing and adult health are unlikely to be because of measurement error for three reasons. First, weekday viewing seems to be a reasonable indicator of total television viewing time; at ages 13 and 15 years, there were significant correlations between reported weekday and weekend viewing (r=0·55 and 0·56, respectively, p<0·0001). Second, we averaged the parental and self-report viewing estimates at several ages. Third, measurement error could only explain the associations if there was a systematic bias, such that children who were destined to be unhealthy adults (and their parents) overestimated viewing times, whereas those destined to be healthy underestimated their viewing. Such a social desirability bias seems very unlikely, given that the associations were independent of both parental body-mass index and smoking.

As in any observational study, we cannot prove a causal association. Television viewing might be a marker for some unidentified determinant of adult health, and individuals who have a natural tendency to obesity and poor physical fitness might prefer to watch television than do other activities. However, this study has a number of strengths that support causal inference. Our data on television viewing were collected prospectively throughout childhood and adolescence, and we were able to control for socioeconomic status recorded at the same time. Importantly, we could also control for study members with an early tendency to be overweight at the beginning of the television viewing period using age-5 body-mass index values, and a familial tendency to overweight using parental values. Even though both of these factors were significantly associated with television viewing and were independent predictors of the study member's adult body-mass index, adjustment for these variables did not reduce the association between child and adolescent television viewing and adult body-mass index (table 2).

Several childhood behaviours could explain the association between television viewing and health. The most obvious of these are physical activity and diet. Although these are potential confounding influences, they might also be in the causal pathway. For example, watching television could affect fitness and obesity by displacing time which would otherwise be spent on more active pursuits. Physical activity at age 15 years was inversely correlated with adolescent television viewing, and significantly predicted adult cardiorespiratory fitness. Although adjustment for physical activity at age 15 years did not alter the association between childhood television viewing and adult fitness, we did not record information on general physical activity earlier in childhood, and therefore we cannot exclude the possibility that physical activity mediates the association. Television advertising in New Zealand also tends to promote an unhealthy diet.[18,19] Unfortunately, we do not have sufficient information on the diets of study members to explore the possibility that dietary practices might mediate the association between viewing and health.

Watching television might also influence other behaviours, such as cigarette smoking, which we found to be significantly associated with television viewing. Adjustment for parental smoking made no difference to this association, suggesting that television has an effect that is independent of family health practices. Although television advertising of tobacco was banned in New Zealand before study members were born, programmes have continued to show frequent images of smoking during children's viewing time.[20] For example, tobacco sponsorship of sport continued until 1995, and there is evidence that New Zealand children have been affected by such advertising because watching televised sport has been reported to be an independent risk factor for smoking in 14–15 year-olds.[21]

We found moderate correlations between reported television viewing at different ages (table 1). These data indicate that viewing habits established in childhood might persist into early adulthood. This in itself is a cause for concern. However, it suggests that child and adolescent viewing might be associated with poor adult health because it is correlated with viewing in adulthood. Because we did not obtain information on television viewing at age 26 years, we could not test this hypothesis directly. However, controlling for television viewing at 21 years of age did not eliminate the association between earlier viewing and age-26 outcomes. Indeed, age-26 health was better predicted by television viewing in childhood and adolescence than at age 21 years. Although viewing time estimates at age 21 years might have been less accurate than the composite measure at age 5 to 15 years, this finding suggests that television viewing during childhood and adolescence is associated with long-lasting detrimental effects.

How much television should young people watch, and how important are the health effects of watching too much? So few study members watched no television that we are unable to define a safe limit below which there were no health effects. Children and adolescents who watched 1 h or less a day were the healthiest (figure), although not many were in this group (30 [5·7%] male study members, 39 [7·9%] female study members). The American Academy of Pediatrics recommends that parents limit their child's viewing to 2 h per day.[2] About half of study members during childhood and more than two-thirds of those during adolescence exceeded this limit on weekdays. If we assume a causal association between child and adolescent television viewing and adult health, calculations of population-attributable fractions indicate that exceeding the 2 h limit might be responsible for 17% of overweight, 15% of poor fitness, 15% of raised serum cholesterol, and 17% of smoking at age 26 years.

Although the adult health indicators that we have found to be associated with child and adolescent television viewing are unlikely to result in clinical health problems by the age of 26 years, they are well established risk factors for cardiovascular morbidity and mortality later in life. Our results suggest that excessive television viewing in young people is likely to have far-reaching consequences for adult health. We concur with the American Academy of Pediatrics[2] that parents should limit children's viewing to 1–2 h per day; in fact, data suggest that less than 1 h a day would be even better. Although parents might find this difficult to maintain, lifestyle modifications in adulthood to reverse overweight, poor fitness, high blood cholesterol, and smoking are also notoriously difficult to achieve. Parents will need support and encouragement at an individual, community, and societal level. Adults are likely to obtain health benefits themselves if they lead by example and turn off the television. We believe that reducing television viewing should become a population health priority.

Contributors

R J Hancox generated the hypotheses, analysed data, and prepared the manuscript. B J Milne analysed data and critically reviewed the manuscript. R Poulton provided general oversight to the study, collected data, and critically reviewed the manuscript.

Conflict of interest statement

None declared.

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References

1 Strasburger VC. Children, adolescents and television. *Pediatr Rev* 1992; **13:** 144–51.

2 American Academy of Pediatrics. Committee on Public Education. Children, adolescents, and television. *Pediatrics* 2001; **107:** 423–26.

3 Dietz WH Jr, Gortmaker SL. Do we fatten our children at the television set? Obesity and television viewing in children and adolescents. *Pediatrics* 1985; **75:** 807–12.

4 Gortmaker SL, Must A, Sobol AM, Peterson K, Colditz GA, Dietz WH. Television viewing as a cause of increasing obesity among children in the United States, 1986–1990. *Arch Pediatr Adolesc Med* 1996; **150:** 356–62.

5 Hernández B, Gortmaker SL, Colditz GA, Peterson KE, Laird NM, Parra-Cabrera S. Association of obesity with physical activity, television programs and other forms of video viewing among children in Mexico City. *Int J Obes Relat Metab Disord* 1999; **23:** 845–54.

6 Robinson TN. Reducing children's television viewing to prevent obesity: a randomized controlled trial. *JAMA* 1999; **282:** 1561–67.

7 Tucker LA. The relationship of television viewing to physical fitness and obesity. *Adolescence* 1986; **21:** 797–806.

8 Armstrong CA, Sallis JF, Alcaraz JE, Kolody B, McKenzie TL, Hovell MF. Children's television viewing, body fat, and physical fitness. *Am J Health Promot* 1998; **12:** 363–68.

9 Wong ND, Hei TK, Qaqundah PY, Davidson DM, Bassin SL, Gold KV. Television viewing and pediatric hypercholesterolemia. *Pediatrics* 1992; **90:** 75–79.

10 Gidwani PP, Sobol A, DeJong W, Perrin JM, Gortmaker SL. Television viewing and initiation of smoking among youth. *Pediatrics* 2002; **110:** 505–08.

11 DuRant RH, Baranowski T, Johnson M, Thompson WO. The relationship among television watching, physical activity, and body composition of young children. *Pediatrics* 1994; **94:** 449–55.

12 Katzmarzyk PT, Malina RM, Song TM, Bouchard C. Television viewing, physical activity, and health-related fitness of youth in the Québec Family Study. *J Adolesc Health* 1998; **23:** 318–25.

13 Robinson TN, Hammer LD, Killen JD, et al. Does television viewing increase obesity and reduce physical activity? Cross-sectional and longitudinal analyses among adolescent girls. *Pediatrics* 1993; **91:** 273–80.

14 Silva PA, Stanton WR, eds. From child to adult: The Dunedin

Multidisciplinary Health and Development Study. Auckland: Oxford University Press, 1996.

15 Cullinane EM, Siconolfi S, Carleton RA, Thompson PD. Modification of the Åstrand-Rhyming sub-maximal bicycle test for estimating VO_2max of inactive men and women. *Med Sci Sports Exerc* 1988; **20:** 317–18.

16 Elley WB, Irving JC. The Elley-Irving socioeconomic index 1981 census revision. *N Z J Educat Stud* 1985; **29:** 115–28.

17 Taylor HL, Jacobs DR Jr, Schucker B, Knudsen J, Leon AS, Debacker G. A questionnaire for the assessment of leisure time physical activities. *J Chronic Dis* 1978; **31:** 741–55.

18 Hammond KM, Wyllie A, Casswell S. The extent and nature of televised food advertising to New Zealand children and adolescents. *Aust N Z J Public Health* 1999; **23:** 49–55.

19 Wilson N, Quigley R, Mansoor O. Food ads on TV: a health hazard for children? *Aust N Z J Public Health* 1999; **23:** 647–50.

20 Thomson G, Wilson N. Children and tobacco imagery on New Zealand television. *N Z Med J* 1998; **111:** 129–30.

21 Ford DJ, Scragg R, Weir J, Gaiser J. A national survey of cigarette smoking in fourth-form school children in New Zealand. *N Z Med J* 1995; **108:** 454–57.