Television viewing and abdominal obesity in young adults: is the association mediated by food and beverage consumption during viewing time or reduced leisure-time physical activity?[1–3]

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ABSTRACT

Background: The behavioral pathways through which television (TV) viewing leads to increased adiposity in adults are unclear.

Objective: We wanted to determine whether the association between TV viewing and abdominal obesity in young adults is mediated by food and beverage consumption during TV viewing time or by a reduction in overall leisure-time physical activity (LTPA).

Design: This study involved a cross-sectional analysis of data from 2001 Australian adults aged 26–36 y. Waist circumference (WC) was measured at study clinics, and TV viewing time, frequency of food and beverage consumption during TV viewing, LTPA, and demographic characteristics were self-reported.

Results: Women watching TV >3 h/d had a higher prevalence of severe abdominal obesity (WC: ≥88 cm) compared with women watching ≤1 h/d [prevalence ratio (PR): 1.89; 95% CI: 1.32, 2.71]. Moderate abdominal obesity (WC: 94–101.9 cm) was more prevalent in men watching TV >3 h/d than in men watching ≤1 h/d (PR: 2.16; 95% CI: 1.37, 3.41). Adjustment for LTPA made little difference, but adjustment for food and beverage consumption during TV viewing attenuated the associations (PR: 1.48; 95% CI: 1.01, 2.17 for women; PR: 1.73; 95% CI: 1.06, 2.83 for men).

Conclusions: The association between TV viewing and WC in young adults may be partially explained by food and beverage consumption during TV viewing but was not explained by a reduction in overall LTPA. Other behaviors likely contribute to the association between TV viewing and obesity. *Am J Clin Nutr* 2008;87:1148–55.

INTRODUCTION

Time spent engaged in sedentary behaviors, such as television (TV) viewing, is thought to be one of the factors underlying the increasing prevalence of overweight and obesity observed in many populations around the world (1, 2). Positive associations between TV viewing and adiposity are consistently observed, with several large well-conducted studies having found that men and women watching the most TV have a 2-4-fold increased risk of obesity compared with those watching the least TV (3–6). In Australia, men and women on average watch 1.9 and 1.7 h, respectively, of TV per day (7), suggesting that this is a common activity that occupies a significant amount of time.

The reasons why increased TV viewing leads to obesity remain unclear but may include those that decrease overall energy expenditure or increase overall energy intake. For example, it was hypothesized that TV viewing might displace participation in higher-intensity discretionary physical activities (3, 5, 6, 8). However, studies of adults have not shown a strong relation between TV viewing and physical activity (4, 9, 10). In one study of adults, pedometer-determined physical activity declined an average of only 144 steps/d for each hour of TV viewing (9). Further, correlations between hours of daily TV viewing and self-reported physical activity have generally been weak (Spearman's $\rho = -0.03$ to -0.11) (4, 10). The lack of a strong association between TV viewing and energy expenditure from physical activity suggests that TV viewing may tend to displace other types of low-intensity sedentary activity.

An alternate hypothesis is that TV viewing may increase overall energy intake either indirectly by increased exposure to advertising of food and beverages or directly through consumption of energy-dense foods and beverages during TV viewing time (3, 5, 6, 8). Although these hypotheses were not examined in an adult population, research in children has been undertaken. A number of studies in children have reported positive associations between TV viewing and intake of foods such as soda, pizza, and high-energy snacks (11–13). Additional evidence from experimental studies suggests that children's energy intake is higher when watching TV than it is in control conditions when the TV is switched off (14). In contrast, association studies have observed no correlation between children's body mass index (in kg/m^2) and total energy or energy from fat consumed during TV viewing (15, 16).

These hypotheses were not tested in adults, who exhibit different sedentary and physical activity behaviors than children (17). Furthermore, the patterns of food and beverage consumption of adults during TV viewing have not been characterized. This study therefore aimed to *1*) characterize the patterns of food and beverage consumption of young adults during TV viewing and *2*) determine whether the association between TV viewing

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and abdominal obesity could be explained by increased energy intake during TV viewing or by displacement of leisure-time physical activity (LTPA).

SUBJECTS AND METHODS

Participants

Data were collected from young Australian adults from 2004 to 2006 as part of the Childhood Determinants of Adult Health study (18), a follow-up of the 1985 Australian Schools Health and Fitness Survey (19, 20). Details of the sampling strategy and follow-up techniques used were described elsewhere (18). Briefly, in 1985 schools were randomly sampled with a probability proportional to size ($n = 109$; 90.1% response rate), and students were randomly selected within each age and sex strata ($n = 8498$; 67.5% response rate).

Participants were traced with the use of the Australian Electoral Roll, electronic phone directories, and contact with classmates; 6840 were located (80.5%), with 5170 of participants contacted agreeing to provide follow-up data (75.6%). A total of 2410 young adults attended a study clinic at 26–36 y of age for physical measurements and were eligible for inclusion in this cross-sectional analysis. The Childhood Determinants of Adult Health study was approved by the Southern Tasmanian Medical Research Ethics Committee, and written informed consent was obtained from all participants before participation.

Measures

Waist circumference was measured at the narrowest point between the lower costal border and the iliac crest to the nearest 0.1 cm with the use of a nonstretch steel measuring tape and followed a standardized protocol. Measures of waist circumference were shown to have excellent reproducibility in other studies (21–24). All technicians were trained by the same accredited kinanthropometrist. Abdominal obesity was classified with the use of World Health Organization cutoffs (25). Moderate abdominal obesity was defined as a waist circumference between 94 and 101.9 cm for men and between 80 and 87.9 cm for women. Severe abdominal obesity was defined as a waist circumference $\geq$ 102 cm in men and $\geq$ 88 cm in women.

Participants were asked to report the total time during the past week that they spent watching TV, digital video disks, or videocassettes when this was the main activity they were doing. This question was asked in relation to weekdays (total of 5 d of TV viewing) and weekend days (total of 2 d of TV viewing). To determine average daily TV viewing time, TV viewing time on weekdays and weekend days were summed and divided by 7. This question has shown a 1-wk test-retest reliability intraclass correlation of 0.82 (95% CI: 0.75, −0.87) and a Spearman correlation of 0.3 with a 3-d sedentary behavior log in Australian adults (26). Time spent in LTPA in the past week was assessed with the use of the long version of the International Physical Activity Questionnaire (IPAQ-L) and categorized into 4 groups according to quartile splits (27). In a 12-country, 14-site reliability and validity study (27), 1-wk test-retest reliability of the IPAQ-L showed a pooled correlation coefficient $\rho = 0.81$ (95% CI: 0.79, 0.82). Fair-to-moderate agreement between the IPAQ-L and accelerometers worn for 1 wk was observed, with a pooled correlation coefficient of $\rho = 0.33$ (95% CI: 0.26, 0.39).

Participants separately reported how often they consumed a meal, snack, soft drink, or alcoholic drink during TV viewing. Response options were always (every day), usually (5–6 times/wk), sometimes (3–4 times/wk), rarely (1–2 times/wk), or never. The always and usually categories were collapsed into one group ($\geq$5 times/wk) because of the small number of participants reporting these behaviors, particularly in relation to beverage consumption during TV viewing. A summary variable, "overall consumption during TV," was generated for those participants who provided responses for each question about meal, snack, soft drink, and alcoholic drink consumption during TV viewing. Three categories were created for overall consumption during TV viewing: high ($\geq$5 times/wk consumes $\geq$1 items), medium (3–4 times/wk consumes $\geq$1 items), and low ($\leq$2 times/wk consumes all 4 items).

Demographic characteristics were self-reported and treated as follows: highest level of education (university, vocational or diploma, school only), occupation (manager or professional, white collar, blue collar, not in labor force), marital status (single, married or living as married, separated or divorced), smoking status (current smoker, current nonsmoker) and, in women only, number of live births (0, 1, 2, $\geq$3).

Statistics

Final analyses were restricted to the 2001 participants (947 men and 1054 nonpregnant women) with data available for waist circumference, food and beverage consumption during TV viewing, highest level of education, current occupation, LTPA, and time spent watching TV. A small number of participants had missing values for $\geq$1 of the 4 variables of food and beverage consumption. The number of participants in some analyses therefore varies depending on the factor being addressed, but at a minimum there are 910 men and 1000 women. All analyses were conducted separately for men and women with the use of STATA, version 9.2 (Stata Corp, College Station, TX).

To examine the association between daily TV viewing and the frequency of food and beverage consumption during TV viewing, median (and interquartile range) durations of TV viewing were calculated within categories of food and beverage consumption. The Kruskal-Wallis equality-of-populations rank test was used to determine whether significant differences existed across categories of consumption. Because of the skewed nature of the data, Spearman rank-order correlation coefficients were used to examine the relation between TV viewing and LTPA and between TV viewing and waist circumference.

Log multinomial regression was used to calculate prevalence ratios for moderate and severe abdominal obesity across increasing categories of food and beverage consumption during TV viewing and across increasing categories of daily time spent in TV viewing. To identify potential confounding factors, demographic variables (age, highest level of education, current occupation, marital status, smoking status, and number of live births) were entered into the model one at a time. Variables that resulted in a >10% change in the coefficients were included as covariates in the adjusted model (age, highest level of education, and current occupation). In analyses that examined the association between abdominal obesity and food and beverage consumption during TV viewing, daily time spent watching TV (in log h/d) was included as a covariate. To examine the association between abdominal obesity and TV viewing time, a base model was fit, adjusting for demographic characteristics (age, education, and

occupation). A second model adjusted for LTPA, and a third model examined the effect of adjusting for meal, snack, soft drink, and alcoholic drink consumption during TV viewing. A fourth model included both LTPA and food and beverage consumption during TV viewing.

RESULTS

Characteristics of the sample

The demographic characteristics of participants and their food and beverage consumption behaviors during TV viewing are presented in **Table 1**. Men had significantly larger mean (±SD) waist circumferences than did women (men, 89.5 ± 10.5 cm; women, 78.2 ± 11.4 cm; $P < 0.01$) and watched significantly more TV per day (men, 2.1 ± 1.6 h/d; women, 1.7 ± 1.2 h/d; $P < 0.01$). In addition, 16.1% of men ($n = 152$) and 16.8% of women ($n = 177$) had moderate abdominal obesity, whereas a further 11.3% of men ($n = 107$) and 17.6% of women ($n = 185$) were classified with severe abdominal obesity.

Nearly half of participants reported consuming a meal ≥5 times/wk while watching TV, and most reported consuming a snack ≥3 times/wk while watching TV. Both soft and alcoholic drinks were consumed ≤2 times/wk during TV viewing by most participants. Half of the women and more than half of the men reported consuming at least one food or beverage item ≥5 times/wk during TV viewing.

TV viewing and LTPA were not correlated in men (Spearman's $\rho = -0.03$) or in women (Spearman's $\rho = -0.07$). No significant differences were observed in LTPA by food or beverage consumption patterns during TV viewing in men or women.

Association between food and beverage consumption during TV viewing and daily TV viewing time

In both men and women, the median reported time spent watching TV increased with increasing frequency of consuming food and beverages during TV viewing time (**Table 2**). The difference in TV viewing time between those reporting the lowest and highest amounts of food and beverage consumption during viewing time ranged from 0.4 to 1.7 h/d in men and from 0.6 to 1.1 h/d in women.

Association between food and beverage consumption during TV viewing and abdominal obesity

After adjusting for demographic factors and time spent watching TV, higher overall consumption of food and beverages during TV viewing was significantly associated with a nearly 3-fold increase in the prevalence of moderate abdominal obesity in men (**Table 3**). Among the specific types of consumption, the prevalence of moderate abdominal obesity was 67% and 76% higher in men who reported consuming soft drinks and alcoholic drinks ≥ 5 times/wk during TV viewing, respectively. No significant associations were noted between food and beverage consumption during TV viewing and severe abdominal obesity in men, and no significant changes in the results were observed when adjusted for LTPA (data not shown).

In women, the prevalence of severe abdominal obesity was 60% higher in those reporting the highest overall consumption of food and beverages during TV viewing than in women reporting the lowest overall consumption (**Table 4**). When

TABLE 1
Characteristics of the sample, by sex[1]

	Men ($n = 947$)	Women ($n = 1054$)	P^2
Education [*n* (%)]			
University	381 (40.2)	519 (49.2)	<0.01
Vocational or diploma	339 (35.8)	258 (24.5)	
School only	227 (24.0)	277 (26.3)	
Occupation [*n* (%)]			
Manager or professional	565 (59.7)	546 (51.8)	<0.01
White collar	73 (7.7)	281 (26.7)	
Blue collar	279 (29.5)	48 (4.6)	
Not in labor force	30 (3.2)	179 (17.0)	
Smoking status [*n* (%)]			
Nonsmoker	724 (76.5)	830 (78.9)	0.20
Current smoker	222 (23.5)	222 (21.1)	
Marital status [*n* (%)]			
Single	286 (30.2)	299 (28.4)	<0.05
Married or living as married	641 (67.7)	712 (67.6)	
Separated or divorced	20 (2.1)	43 (4.1)	
Live births [*n* (%)]			
0	—	541 (51.3)	
1	—	173 (16.4)	
2	—	236 (22.4)	
≥3	—	104 (9.9)	
TV viewing [*n* (%)]			
≤1 h/d	260 (27.5)	375 (35.6)	<0.01
1.1–2.0 h/d	290 (30.6)	368 (34.9)	
2.1–3.0 h/d	232 (24.5)	185 (17.6)	
>3.0 h/d	165 (17.4)	126 (12.0)	
Overall consumption during TV viewing [*n* (%)]			
Low	114 (12.5)	200 (20.0)	<0.01
Medium	240 (26.4)	281 (28.1)	
High	556 (61.1)	519 (51.9)	
Consumption of meal during TV viewing [*n* (%)]			
0 times/wk	87 (9.3)	136 (13.1)	<0.01
1–2 times/wk	193 (20.6)	235 (22.6)	
3–4 times/wk	207 (22.0)	236 (22.7)	
≥5 times/wk	452 (48.1)	432 (41.6)	
Consumption of snack during TV viewing [*n* (%)]			
0 times/wk	76 (8.0)	124 (12.2)	<0.01
1–2 times/wk	289 (31.0)	387 (37.5)	
3–4 times/wk	315 (33.8)	315 (30.5)	
≥5 times/wk	253 (27.1)	206 (20.0)	
Consumption of soft drink during TV viewing [*n* (%)]			
0 times/wk	325 (35.3)	510 (50.4)	<0.01
1–2 times/wk	315 (34.2)	286 (28.2)	
3–4 times/wk	153 (16.6)	126 (12.4)	
≥5 times/wk	128 (13.9)	91 (9.0)	
Consumption of alcohol during TV viewing [*n* (%)]			
0 times/wk	291 (31.2)	457 (44.5)	<0.01
1–2 times/wk	379 (40.6)	408 (39.8)	
3–4 times/wk	161 (17.2)	110 (10.7)	
≥5 times/wk	103 (11.0)	51 (5.0)	

[1] Number of participants ranged from 910 to 947 men and 1000 to 1054 women because of missing data for some variables of food and beverage consumption. TV, television.

[2] Determined by chi-square test for differences between men and women.

TABLE 2
Daily hours of television (TV) viewing across categories of food and beverage consumption during TV viewing, by sex

Food and beverage consumption	Men		Women	
	Subjects	TV viewing	Subjects	TV viewing
	n	*h/d*	*n*	*h/d*
Overall				
Low	114	0.8 (0.4–1.6)[1]	200	0.9 (0.5–1.5)
Medium	240	1.4 (0.9–2.3)	281	1.4 (0.9–2.0)
High	556	2.1 (1.3–3.0)	519	1.8 (1.1–2.7)
P for trend[2]		<0.01		<0.01
Meals				
0 times/wk	87	1.3 (0.6–2.3)	136	1.0 (0.6–1.7)
1–2 times/wk	193	1.3 (0.6–2.3)	235	1.1 (0.6–2.0)
3–4 times/wk	207	1.7 (0.9–2.3)	236	1.4 (0.9–2.0)
≥5 times/wk	452	2.3 (1.3–3.1)	432	1.9 (1.1–2.9)
P for trend[2]		<0.01		<0.01
Snacks				
0 times/wk	76	0.9 (0.4–1.7)	124	0.9 (0.5–1.7)
1–2 times/wk	289	1.4 (0.9–2.1)	387	1.3 (0.7–2.0)
3–4 times/wk	315	2.0 (1.1–2.9)	315	1.6 (1.0–2.3)
≥5 times/wk	253	2.6 (1.4–3.4)	206	2.0 (1.1–3.2)
P for trend[2]		<0.01		<0.01
Soft drinks				
0 times/wk	325	1.4 (0.7–2.3)	510	1.3 (0.7–2.0)
1–2 times/wk	315	2.0 (1.1–2.9)	286	1.6 (0.9–2.4)
3–4 times/wk	153	2.1 (1.3–3.0)	126	1.9 (0.9–3.0)
≥5 times/wk	128	2.4 (1.3–3.6)	91	2.0 (1.1–3.0)
P for trend[2]		<0.01		<0.01
Alcohol				
0 times/wk	291	1.6 (0.7–2.6)	457	1.4 (0.7–2.3)
1–2 times/wk	379	1.9 (1.1–2.7)	408	1.6 (0.9–2.3)
3–4 times/wk	161	2.0 (1.0–2.9)	110	1.5 (0.9–2.1)
≥5 times/wk	103	2.0 (1.3–3.0)	51	2.0 (1.3–2.6)
P for trend[2]		<0.01		<0.01

[1] Median; interquartile range in parentheses (all such values).
[2] Determined by Kruskal-Wallis equality-of-populations rank test.

specific types of consumption were examined individually, the prevalence of severe abdominal obesity was nearly twice as great in those women reporting the most frequent consumption of snacks and soft drinks during TV viewing in those women reporting the least consumption. Interestingly, the prevalence of severe abdominal obesity decreased significantly with increasing consumption of alcohol during TV viewing. Although few consistent associations were noted for moderate abdominal obesity in women, a significant increase in the prevalence of moderate abdominal obesity was observed across increasing categories of snacking while watching TV. No significant changes in the results were observed when adjusted for LTPA (data not shown).

Association between TV viewing and abdominal obesity

TV viewing was significantly correlated with waist circumference in both men ($r = 0.09$) and women ($r = 0.17$), although correlations in men became nonsignificant when adjusted for age, education, and occupation ($r = 0.06$); correlations among women remained significant ($r = 0.16$). After adjusting for demographic factors, time spent watching TV was significantly associated with moderate but not severe abdominal obesity in men and with severe but not moderate abdominal obesity in women (**Table 5**). These associations remained relatively unchanged after adjustment for LTPA (model 2) but were modestly attenuated after adjustment for meal, snack, soft drink, and alcoholic drink consumption during TV viewing (model 3). The association between TV viewing and moderate obesity in men and severe obesity in women remained statistically significant after controlling for both food and beverage consumption during TV viewing and LTPA (model 4).

DISCUSSION

Food and beverage consumption during TV viewing was postulated as a potential mechanism through which TV viewing increases the likelihood of overweight and obesity. This is the first study to examine the relation between food and beverage consumption during TV viewing and abdominal overweight and obesity in an adult population. Our findings suggest that, although food and beverage consumption during TV viewing was associated with having an elevated waist circumference, it only partly explained the association between TV viewing and abdominal obesity in young adults. An alternate hypothesis for the association between TV viewing and obesity is that TV viewing displaces physical activity that might otherwise have taken place

TABLE 3
Abdominal obesity across categories of food and beverage consumption during television (TV) viewing in men[1]

Food and beverage consumption	Moderate abdominal obesity (WC 94–101.9 cm)		Severe abdominal obesity (WC ≥ 102 cm)	
	Subjects	Adjusted PR (95% CI)[2]	Subjects	Adjusted PR (95% CI)[2]
	n (%)		*n* (%)	
Overall				
Low	6 (5.3)	1.0 (ref)	14 (12.3)	1.0 (ref)
Medium	34 (14.2)	2.42 (1.04, 5.63)	27 (11.3)	0.95 (0.52, 1.74)
High	103 (18.5)	2.82 (1.25, 6.37)	62 (11.2)	0.90 (0.51, 1.58)
P for trend		<0.05		0.75
Meals				
0 times/wk	8 (9.2)	1.0 (ref)	10 (11.5)	1.0 (ref)
1–2 times/wk	23 (11.9)	1.31 (0.62, 2.78)	26 (13.5)	1.23 (0.63, 2.42)
3–4 times/wk	34 (16.4)	1.82 (0.88, 3.73)	18 (8.7)	0.76 (0.37, 1.59)
≥5 times/wk	84 (18.6)	1.79 (0.90, 3.56)	53 (11.7)	1.01 (0.53, 1.93)
P for trend		<0.05		0.99
Snacks				
0 times/wk	9 (11.8)	1.0 (ref)	8 (10.5)	1.0 (ref)
1–2 times/wk	39 (13.5)	0.97 (0.49, 1.91)	37 (12.8)	1.00 (0.49, 2.02)
3–4 times/wk	49 (15.6)	1.00 (0.51, 1.96)	35 (11.1)	0.85 (0.41, 1.76)
≥5 times/wk	54 (21.3)	1.25 (0.63, 2.46)	25 (9.9)	0.73 (0.33, 1.58)
P for trend		0.24		0.23
Soft drinks				
0 times/wk	43 (13.2)	1.0 (ref)	25 (7.7)	1.0 (ref)
1–2 times/wk	45 (14.3)	0.92 (0.62, 1.36)	48 (15.2)	1.56 (0.99, 2.48)
3–4 times/wk	24 (15.7)	1.03 (0.65, 1.63)	14 (9.2)	0.97 (0.51, 1.81)
≥5 times/wk	34 (26.6)	1.67 (1.10, 2.54)	17 (13.3)	1.49 (0.83, 2.71)
P for trend		<0.05		0.46
Alcohol				
0 times/wk	37 (12.7)	1.0 (ref)	39 (13.4)	1.0 (ref)
1–2 times/wk	60 (15.8)	1.15 (0.79, 1.67)	45 (11.9)	0.88 (0.60, 1.30)
3–4 times/wk	26 (16.2)	1.13 (0.72, 1.78)	17 (10.6)	0.75 (0.44, 1.26)
≥5 times/wk	26 (25.2)	1.76 (1.13, 2.72)	6 (5.8)	0.48 (0.21, 1.07)
P for trend		<0.05		0.06

[1] WC, waist circumference; PR, prevalence ratio; ref, reference.
[2] Calculated from log binomial regression adjusted for age, education, occupation, and TV viewing time (in h).

in that time, resulting in an overall decrease in energy expenditure. However, the relation between LTPA and TV viewing in this study was weak, and adjusting for LTPA did not attenuate the association between TV viewing and abdominal obesity.

Interestingly, frequency of food and beverage consumption during TV viewing and time spent watching TV in men was associated with moderate but not severe abdominal obesity. This was an unexpected finding and suggests that the set of behaviors associated with severe abdominal obesity may be different from those associated with moderate abdominal obesity. For example, men with severe abdominal obesity may have a higher energy intake throughout the day, thus obscuring any relation between energy intake during TV viewing and adiposity. Because of the cross-sectional analysis used in this study, the direction of the relation between abdominal obesity and food and beverage consumption during TV viewing is uncertain. However, previous prospective studies have observed an association between a high value of TV viewing and an increased incidence of obesity (4), suggesting that reverse causation is unlikely.

Soft drink consumption during TV viewing was associated with a greater prevalence of abdominal obesity in both men and women. Although no other studies in adults have assessed the relation between soft drink consumption while watching TV and obesity, a number of studies have found an association between overall soft drink consumption and obesity. In the Nurses Health Study II (n = 51 603), women who increased their soft drink consumption from ≤1 drink/wk to ≥1 drink/wk gained the most weight during a 4-y period (28). Likewise, prospective data from participants in the Framingham Offspring Study (n = 6039) showed an increased incidence of obesity, increased waist circumference, and metabolic syndrome in those participants consuming the most soft drinks per day (29). It is plausible that higher soft drink consumption during TV viewing reflects higher soft drink consumption or energy intake overall, which may explain the association with abdominal obesity. We were unable to adjust for overall consumption of soft drink consumption because this information was not collected.

Although snacks during TV viewing were not associated with abdominal obesity in men, a strong positive relation was seen for women. Regular snack consumption during TV viewing may be associated with other dietary or physical activity behaviors in women that increase the risk of obesity. Alcohol consumption during TV viewing was associated with a significantly lower prevalence of severe abdominal obesity in women but with a

TABLE 4
Abdominal obesity across categories of food and beverage consumption during television (TV) viewing in women[1]

	Moderate abdominal obesity (WC 80–87.9 cm)		Severe abdominal obesity (WC ≥88 cm)	
Food and beverage consumption	Subjects	Adjusted PR (95% CI)[2]	Subjects	Adjusted PR (95% CI)[2]
	n (%)		*n* (%)	
Overall				
Low	27 (13.5)	1.0 (ref)	22 (11.0)	1.0 (ref)
Medium	47 (16.7)	1.22 (0.78, 1.90)	45 (16.0)	1.39 (0.88, 2.19)
High	93 (17.9)	1.26 (0.83, 1.93)	112 (21.6)	1.59 (1.04, 2.44)
P for trend		0.31		<0.05
Meals				
0 times/wk	14 (10.3)	1.0 (ref)	23 (16.9)	1.0 (ref)
1–2 times/wk	42 (17.9)	1.73 (0.98, 3.06)	29 (12.3)	0.78 (0.49, 1.26)
3–4 times/wk	44 (18.6)	1.79 (1.01, 3.16)	42 (17.8)	1.09 (0.71, 1.68)
≥5 times/wk	75 (17.4)	1.60 (0.92, 2.79)	91 (21.1)	1.08 (0.72, 1.61)
P for trend		0.30		0.16
Snacks				
0 times/wk	13 (10.5)	1.0 (ref)	13 (10.5)	1.0 (ref)
1–2 times/wk	57 (14.7)	1.43 (0.81–2.53)	60 (15.5)	1.55 (0.90, 2.68)
3–4 times/wk	64 (20.3)	1.94 (1.10, 3.43)	58 (28.4)	1.74 (1.01, 3.01)
≥5 times/wk	40 (19.4)	1.79 (0.98, 3.28)	52 (25.2)	1.95 (1.11, 3.41)
P for trend		<0.05		<0.01
Soft drinks				
0 times/wk	79 (15.5)	1.0 (ref)	58 (11.4)	1.0 (ref)
1–2 times/wk	49 (17.1)	1.09 (0.78, 1.52)	56 (19.6)	1.51 (1.09, 2.08)
3–4 times/wk	23 (18.3)	1.12 (0.73, 1.71)	42 (33.3)	2.70 (1.96, 3.71)
≥5 times/wk	20 (22.0)	1.31 (0.84, 2.06)	26 (28.6)	1.92 (1.32, 2.79)
P for trend		0.21		<0.01
Alcohol				
0 times/wk	71 (15.5)	1.0 (ref)	99 (21.7)	1.0 (ref)
1–2 times/wk	70 (17.2)	1.10 (0.81, 1.48)	66 (16.2)	0.76 (0.58, 0.99)
3–4 times/wk	19 (17.3)	1.13 (0.71, 1.80)	11 (10.0)	0.50 (0.28, 0.89)
≥5 times/wk	13 (25.5)	1.51 (0.90, 2.55)	5 (9.8)	0.40 (0.18, 0.91)
P for trend		0.16		<0.01

[1] WC, waist circumference; PR, prevalence ratio; ref, reference.
[2] Calculated from log binomial regression adjusted for age, education, occupation, and TV viewing time (in h).

higher prevalence of moderate abdominal obesity in men. An inverse trend for decreasing prevalence of severe abdominal obesity with increasing alcohol consumption during TV viewing was also noted in men. Additional adjustments for smoking, marital status, and number of live births (for women) made little difference to the associations (data not shown). Inverse associations with alcohol consumption were observed previously in both men and women in cross-sectional and prospective studies (30–32), with stronger associations identified in women (30, 31, 33). Although a number of possible explanations were suggested, including interference with caloric absorption and digestion, use of energy-wasteful metabolic pathways, or relations with other behaviors such as diet or physical activity, no conclusive explanation is apparent (33).

A limitation of the current study is that we were unable to adjust for overall energy intake (data not available). It is plausible that higher food and beverage consumption during TV viewing reflects higher energy intake throughout the day, thus explaining the observed relation with obesity. The current study aimed to understand the behavioral pathways associated with TV viewing that might contribute to an increased risk of obesity rather than the relation between total energy intake and obesity, which is well-established. No population-based studies of adults have examined the relations between food and beverage consumption during TV viewing and overall energy intake, so little is known about these behaviors. One small ($n = 76$) experimental study of undergraduates (age: 22.0 ± 0.9 y) found that overall energy intake was not significantly different on days when meals were consumed with the TV on and days when meals were consumed with the TV off (34). That study also found that more food was consumed on days when TV viewing was higher. Similarly, an experimental study in young adults found that participants consume more energy in conditions with the TV on than in control conditions with the TV off (14). Those studies suggest that additional caloric intake is likely to occur when TV viewing is higher. Although it is plausible that persons may simply eat their usual meals while watching TV, which would not influence total energy expenditure, we found that meal consumption while watching TV was not associated with an increased prevalence of moderate or severe abdominal obesity in either men or women.

A number of potential confounding factors may have influenced the findings, such as chronic health conditions, hours worked, urbanization, and regional effects. Although we were unable to look at the effect of these factors directly, we were able

TABLE 5
Association between daily television (TV) viewing and abdominal obesity, by sex[1]

Daily TV viewing	Men				Women			
	Moderate obesity (WC 94–101.9 cm)		Severe obesity (WC ≥ 102 cm)		Moderate obesity (WC ≥ 88 cm)		Severe obesity (WC 80–87.9 cm)	
	Subjects	PR (95% CI)	Subjects	PR (95% CI)	Subjects	PR (95% CI)	Subjects	PR (95% CI)
	n (%)		*n* (%)		*n* (%)		*n* (%)	
Model 1[2]								
≤1 h/d	27 (10.8)	1.0 (ref)	25 (10.0)	1.0 (ref)	53 (15.1)	1.0 (ref)	50 (14.3)	1.0 (ref)
1.1–2.0 h/d	42 (14.9)	1.40 (0.90, 2.20)	36 (12.8)	1.24 (0.77, 2.00)	57 (16.2)	1.09 (0.77, 1.53)	50 (14.2)	1.00 (0.70, 1.43)
2.1–3.0 h/d	36 (16.4)	1.46 (0.92, 2.31)	21 (9.6)	0.85 (0.49, 1.47)	36 (20.5)	1.27 (0.86, 1.88)	40 (22.7)	1.44 (0.99, 2.08)
>3.0 h/d	38 (24.1)	2.16 (1.37, 3.41)	21 (13.3)	1.05 (0.61, 1.81)	21 (17.2)	1.08 (0.67, 1.71)	39 (32.0)	1.89 (1.32, 2.71)
P for trend		<0.01		0.73		0.44		<0.01
Model 2[3]								
≤1 h/d	27 (10.8)	1.0 (ref)	25 (10.0)	1.0 (ref)	53 (15.1)	1.0 (ref)	50 (14.3)	1.0 (ref)
1.1–2.0 h/d	42 (14.9)	1.42 (0.91, 2.23)	36 (12.8)	1.26 (0.79, 2.03)	57 (62.2)	1.08 (0.77, 1.52)	50 (14.2)	0.99 (0.69, 1.41)
2.1–3.0 h/d	36 (16.4)	1.53 (0.96, 2.42)	21 (9.6)	0.84 (0.49, 1.46)	36 (20.5)	1.29 (0.88, 1.90)	40 (22.7)	1.43 (0.99, 2.07)
>3.0 h/d	38 (24.1)	2.29 (1.45, 3.59)	21 (13.3)	1.06 (0.61, 1.84)	21 (17.2)	1.09 (0.69, 1.73)	39 (32.0)	1.81 (1.26, 2.59)
P for trend		<0.01		0.74		0.39		0.39
Model 3[4]								
≤1 h/d	27 (10.8)	1.0 (ref)	25 (10.0)	1.0 (ref)	53 (15.1)	1.0 (ref)	50 (14.3)	1.0 (ref)
1.1–2.0 h/d	42 (14.9)	1.29 (0.82, 2.03)	36 (12.8)	1.32 (0.81, 2.14)	57 (62.2)	1.02 (0.72, 1.45)	50 (14.2)	0.99 (0.69, 1.40)
2.1–3.0 h/d	36 (16.4)	1.28 (0.79, 2.06)	21 (9.6)	0.94 (0.53, 1.66)	36 (20.5)	1.19 (0.80, 1.78)	40 (22.7)	1.32 (0.90, 1.93)
>3.0 h/d	38 (24.1)	1.73 (1.06, 2.83)	21 (13.3)	1.25 (0.69, 2.28)	21 (17.2)	0.95 (0.58, 1.57)	39 (32.0)	1.48 (1.01, 2.17)
P for trend		<0.05		0.79		0.83		<0.05
Model 4[5]								
≤1 h/d	27 (10.8)	1.0 (ref)	25 (10.0)	1.0 (ref)	53 (15.1)	1.0 (ref)	50 (14.3)	1.0 (ref)
1.1–2.0 h/d	42 (14.9)	1.30 (0.83, 2.05)	36 (12.8)	1.35 (0.83, 2.19)	57 (62.2)	1.03 (0.73, 1.46)	50 (14.2)	0.98 (0.69, 1.41)
2.1–3.0 h/d	36 (16.4)	1.34 (0.83, 2.17)	21 (9.6)	0.91 (0.52, 1.60)	36 (20.5)	1.25 (0.85, 1.84)	40 (22.7)	1.38 (0.93, 2.06)
>3.0 h/d	38 (24.1)	1.82 (1.11, 2.98)	21 (13.3)	1.27 (0.69, 2.31)	21 (17.2)	1.07 (0.66, 1.73)	39 (32.0)	1.68 (1.11, 2.55)
P for trend		<0.05		0.82		0.45		<0.01

[1] WC, waist circumference; PR, prevalence ratio; ref; reference.
[2] Calculated from log binomial regression adjusted for age, education, and occupation.
[3] Calculated from log binomial regression adjusted for age, education, occupation, and leisure-time physical activity.
[4] Calculated from log binomial regression adjusted for age, education, occupation, and meal, snack, soft drink, and alcohol consumption during TV viewing.
[5] Calculated from log binomial regression adjusted for age; education; occupation; meal, snack, soft drink, and alcohol consumption during TV viewing; and leisure-time physical activity.

to examine the effect of entering self-reported health (overall health status excellent, very good, good, fair, or poor), employment status (employed full time, part time, or other), and language spoken at home as a child (as a proxy for ethnicity; English or other) into the models. However, there was no evidence of confounding (data not shown).

Key strengths of this study were its large sample size and ability to evaluate 2 proposed behaviors that might explain why more TV viewing is associated with an increased risk of obesity. Abdominal adiposity was objectively measured by trained technicians using a standardized protocol and was used to categorize obesity values according to internationally accepted cutoffs. In addition, this study was uniquely able to characterize the patterns of food and beverage consumption of young Australian adults during TV viewing. However, this study relied on self-reported estimates to quantify food consumption during TV viewing and LTPA. Nondifferential error in these estimates would prohibit optimal adjustment of the effects of these behaviors on the relation between TV viewing and abdominal obesity. Therefore, we cannot exclude the possibility that, if measured without error, food consumption during TV viewing or LTPA may more fully explain the association between TV viewing and abdominal obesity. Furthermore, the cross-sectional nature of this study means that we are unable to infer causality. Although selection bias is always a possibility, it was reassuring to note that the mean values for waist circumference and the daily TV viewing hours were similar in this sample to that observed in a recent representative study of Australian adults (7, 35).

In summary, the association between TV viewing and abdominal obesity in young adults was explained, in part, by amounts of food and beverage consumption during TV viewing, but it was not explained by a reduction in overall LTPA. These findings suggest that other behaviors may contribute to the association between TV viewing and obesity.

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analytic and interpretive advice, and provided input into drafts. None of the authors had a personal or financial conflict of interest.

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