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Title: Contribution of take-out food consumption to socioeconomic differences in fruit and vegetable intake: a mediation analysis

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Abstract

Lower fruit and vegetable intake among socioeconomically disadvantaged groups has been well documented, and may be a consequence of a higher consumption of take-out foods. This study examined whether, and to what extent, take-out food consumption mediated (explained) the association between socioeconomic position and fruit and vegetable intake. A cross-sectional postal survey was conducted among 1500 randomly selected adults aged 25–64 years in Brisbane, Australia in 2009 (response rate = 63.7%, N = 903). A food frequency questionnaire assessed usual daily servings of fruits and vegetables (0 to 6), overall take-out consumption (times/week) and the consumption of 22 specific take-out items (never to \geq once/day). These specific take-out items were grouped into “less healthy” and “healthy” choices and indices were created for each type of choice (0 to 100). Socioeconomic position was ascertained by education. The analyses were performed using linear regression, and a bootstrap re-sampling approach estimated the statistical significance of the mediated effects. Mean daily serves of fruits and vegetables was 1.89 (SD 1.05) and 2.47 (SD 1.12) respectively. The least educated group were more likely to consume fewer serves of fruit ($\beta = -0.39$, $p < 0.001$) and vegetables ($\beta = -0.43$, $p < 0.001$) compared with the highest educated. The consumption of “less healthy” take-out food partly explained (mediated) education differences in fruit and vegetable intake; however, no mediating effects were observed for overall and “healthy” take-out consumption. Regular consumption of “less healthy” take-out items may contribute to socioeconomic differences in fruit and vegetable intake, possibly by displacing these foods.

INTRODUCTION

Socioeconomically disadvantaged groups experience a higher prevalence of cardiovascular disease, type 2 diabetes and their associated risk factors including overweight/obesity (1-3). The likelihood of developing these chronic conditions can be lowered by regularly consuming an adequate amount of fruit and vegetables (4,5). Socioeconomically disadvantaged groups are more likely to have a diet that is characterized by lower fruit and vegetable intake compared with their advantaged counterparts (6-8), and these dietary differences are thought to be one contributing factor to socioeconomic health inequalities (1,2).

To date, most studies have documented the nature and extent of socioeconomic differences in fruit and vegetable intake (6, 9); however, very few have investigated why these intake differences exist. One possible explanation for the lower fruit and vegetable intake among lower socioeconomic groups is their take-out food consumption. Socioeconomically disadvantaged groups are more likely to eat/purchase take-out and fast-food compared with advantaged groups (10-12), and these foods are associated with low diet quality, including reduced fruit and vegetable intake (13-15). These findings suggest that take-out food consumption may be displacing fruit and vegetable intake.

Previous studies have primarily examined fast-foods which are typically energy dense (10-14). Take-out foods, on the other hand, encompass a wide variety of food types that range from energy dense to relatively nutrient rich, and can be categorized into “less healthy” and “healthy” choices according to their nutritional profiles. Choosing different take-out food-types may be socioeconomically patterned, as disadvantaged groups tend to have less healthy diets (16,17). Furthermore, depending on the types of take-out food choices, the magnitude of the effect on fruit and vegetable intake may be different. A recent Australian study reported that participants who consumed “less healthy” take-out foods in the previous 24-hours were

significantly less likely to eat any fruit and vegetables compared with those who did not; however, opposite associations were seen for “healthy” take-out foods (18). From these findings, it was hypothesized that socioeconomic differences in fruit and vegetable intake may be mediated by take-out food consumption and, especially, by the choice of take-out food. This previous Australian study, however, had a number of limitations. First, it used 1995 data, and the range and sales of take-out food have increased substantially during the last 16 years (19,20). Second, the study did not quantify the contribution of take-out food to socioeconomic inequalities in fruit and vegetable intake. Third, the study combined fruit and vegetable intake into a single dichotomized measure (consumed, not consumed) which did not allow a separate examination of the association between take-out food consumption and fruit and vegetable intake, or an assessment of how take-out foods are associated with meeting the recommended intakes of fruit and vegetables.

This current study advances knowledge of the factors contributing to the lower fruit and vegetable intake of socioeconomically disadvantaged groups by examining whether take-out food consumption mediates socioeconomic differences in fruit and vegetable intake, using data collected in 2009 and more detailed fruit and vegetable intake measures. Take-out food is defined as foods or meals that are pre-prepared commercially and require no further preparation by the consumer, and can be consumed immediately after purchase.

METHODS

Ethical approval was granted by the Queensland University of Technology Human Research Ethics Committee (ID 0900000445).

Study participants

This cross-sectional study was conducted in the Brisbane metropolitan area (Australia) between July and September 2009. A total of 1500 adults aged between 25–64 years were randomly selected from the electoral roll of the Brisbane statistical sub-division. Data were collected by a self-administered postal survey (21) that asked about usual take-out food consumption, fruit and vegetable intake, and socio-demographic characteristics. A total of 903 participants completed the survey (response rate 63.7%). Respondents who had missing or inadequate information on age, sex, education, take-out food consumption, fruit and vegetable intake were excluded from the analyses (n=98), reducing the analytical sample to N=805.

Outcome measures

Standard questions were used to assess fruit and vegetable intake (22). These questions are used widely (15,23,24) and have been shown to be valid measures of fruit and vegetable intake (25). Fruit intake included pure juices, raw, cooked, canned, frozen, or dried fruits, and was measured by asking respondents how many serves of fruit they usually ate daily. A standard serve size for fruit was defined as one medium piece or two small pieces; or 1/2 cup of juice. Five response options ranged from “don’t eat fruit”, to “≥ six serves per day”. Similar to that used in previous studies (26-28), responses were recorded to: don’t eat fruit=0.0, ≤ one serve per day=1.0, two to three serves per day=2.5, four to five serves per day=4.5, and ≥ six serves per day=6.0.

Vegetable intake was measured using an identical format and method to that used for fruit, and included intakes of all raw, cooked, frozen, canned or dried vegetables and legumes, but excluded potatoes. One serving of vegetables was defined as 1/2 cup of cooked vegetables/beans, or 1 cup of salad vegetables. The test-retest reliability of fruit and vegetable intake was assessed by weighted kappa statistic in a separate sample (n=37) who completed the same survey twice, one month apart. The kappa coefficient was 0.54 for fruit intake and 0.65 for vegetable intake.

Mediators

Overall take-out food consumption

Participants were asked how often they usually consumed take-out foods in the last 12 months (“never” to “once per day”). Similar to the fruit and vegetable intake measures, responses were re-coded to: never=0, rarely=0.1, < once a month=0.2, one to three times per month=0.5, once per week=1.0, two to three times per week=3.0, five to six times per week=5.5, and once per day=7.0. The weighted kappa coefficient for this measure was 0.71.

“Less healthy” and “healthy” take-out food-types

Participants who reported consuming take-out foods in the last 12 months (n=804) were asked how often they usually ate each of 22 take-out foods, identified to be the most frequently consumed take-out foods in Australia (18). Similar to overall take-out food consumption, seven response options ranged from “never or rarely” to “once per day”.

Each of these 22 items was classified as either “less healthy” or “healthy” choices. Similar to a previous study (18), this classification was based on the Australian Guide to Healthy Eating (29) which categorizes foods into five groups: cereals, vegetables, fruit, dairy, meat, and “extra” foods. The “extra” foods (e.g. cakes and deep-fried take-out foods) are a non-

essential part of a diet and are typically high in fat, salt, or sugar. Most of the “less healthy” take-out items were consistent with the “extra” foods. To classify foods not identified in the “extra” food list, nutrient composition data were used (30,31). Foods meeting \geq one of the following criteria were classified as “less healthy”: >2500 kJ of energy per serve; >3 g of saturated fat; <2 g of fiber per serve. Beverages classified as “less healthy” were those containing ≥ 600 kJ of energy per serve and/or >3 g of saturated fat per 100g. Foods or beverages not meeting any of these criteria were considered “healthy” options. This classification resulted in 13 “less healthy” items and nine “healthy” items.

“Less healthy” take-out foods comprised: potato chips, hamburger, pizza, savory pies, fried fish/seafood, fried chicken, fried dim-sum, curry, cakes, non-diet soft drink, thick/milk shake, flavored milk, and ice-cream. “Healthy” take-out foods comprised: kebab, sandwiches, fried rice, pasta, Asian-style noodles, sushi, salad, diet soft drink, and fruit/vegetable juices. A score was calculated to characterize each participant’s take-out food consumption as follows: never/rarely consumed the take-out item=0, consumed $<$ once a month=1, one to three times per month=2, four times per month=3, two to four times per week=4, five to six times per week=5, and \geq once a day=6. “Less healthy” and “healthy” take-out food indices were created by summing the items. Each respondent’s score was rescaled to range 0–100. Higher scores were indicative of consuming a wider variety or greater frequency of consumption in the last 12 months. The weighted kappa coefficients for “less healthy” take-out foods ranged from 0.34–0.66 (mean 0.53, SD 0.08) and “healthy” items ranged from 0.17–0.71 (mean 0.48, SD 0.16).

Independent variable and covariates

Education was used as the socioeconomic measure and ascertained by the highest completed qualification. Participant’s education was coded as 1) bachelor degree or higher (latter

includes graduate diploma, graduate certificate, and postgraduate degree); 2) diploma (includes associate degree which is generally not a university-level education in Australia); 3) vocational (trade or business certificate); and 4) no post-school qualifications. Covariates used in the mediation analyses were age (continuous) and sex.

Statistical analyses

For the bivariate analyses, ANOVA was used for categorical variables, Pearson's correlation was used for normally distributed variables, and Spearman's correlation was used for non-normally distributed variables. The contribution of take-out food consumption to education differences in fruit and vegetable intake was examined using the mediation test outlined by Baron and Kenny (32). A series of multiple regression models evaluated the various associations: Path a) associations between education and take-out food consumption behaviors ; Path b) associations between take-out food consumption behaviors and fruit and vegetable intake; Path c) association between education and fruit/vegetable intake; Path c') examines the association between education and fruit/vegetable intake controlling for take-out food consumption behaviors; this is, a mediated effect by which education affects fruit/vegetable intake through take-out food consumption.

The mediated (indirect) effect was formally tested using a non-parametric bootstrapping procedure (n=5000 samples) that estimated the sampling distribution of the indirect effect and the corresponding bias-corrected and accelerated 95% confidence interval (95% CI) (33); this procedure is more statistically robust than the Sobel test (33-35). Indirect effects were considered significant when the 95% CI did not include zero. For all other tests, statistical significance was considered at $p \leq 0.05$ (two-tailed). All analyses were performed in SPSS (version 18.0.1, 2009, SPSS Inc., Chicago, Illinois).

RESULTS AND DISCUSSION

Characteristics of participants

Compared with 2006 census data (36), participants were slightly older and over-represented by women and the more educated (Table 1). The median overall take-out food consumption was one to three times per month. A global test (ANOVA) showed education was significantly associated with daily servings of fruit ($p=0.001$) and vegetables ($p<0.001$) and intakes were highest among participants with a bachelor degree or higher. All take-out food consumption measures were negatively correlated with fruit and vegetable intake (all $p<0.001$ except “healthy” take-out food and fruit intake).

Association between education and take-out food consumption behaviors (Path a)

Participants with a diploma-level education had significantly higher overall take-out food consumption than those with a bachelor degree or higher ($\beta=0.317$ times per week, $p=0.017$). For the “less healthy” take-out food, participants with vocational education ($\beta=1.818$, $p=0.042$) and no post-school qualifications ($\beta=2.910$, $p=0.001$) scored significantly higher compared with those with a bachelor degree or higher. Higher “healthy” take-out scores were observed among participants with a diploma-level education ($\beta=3.186$, $p=0.015$) compared with those with a bachelor degree or higher. In all take-out food consumption measures, those with a bachelor degree or higher showed the lowest consumption. Similar to a previous Australian study, lower educated groups were more likely to consume “less healthy” take-out foods compared with highly educated groups (18). These results were generally consistent in showing that socioeconomically disadvantaged groups had poorer dietary intakes (37,38), and higher rates of diet-related chronic diseases (1,39) and overweight/obesity (37,39).

Association between take-out food consumption behaviors and fruit and vegetable intake (Path b)

Overall and “less healthy” take-out food consumption was negatively associated with fruit intake. A one-unit increase in overall take-out food consumption was associated with a reduction of 0.08 daily serves of fruit ($p=0.011$), while a one-unit increase on the “less healthy” take-out food score was associated with a reduction of 0.01 daily serves ($p=0.002$). There was no significant association between the “healthy” take-out food index and fruit intake.

Likewise, overall and “less healthy” take-out food consumption was negatively associated with vegetable intake: a one-unit increase in overall take-out food consumption was associated with a reduction of 0.14 daily serves of vegetables ($p<0.001$) whereas a one-unit increase on the “less healthy” take-out food score was associated with a reduction of 0.02 daily serves ($p<0.001$). “Healthy” take-out food consumption was not associated with vegetable intake. These findings suggest that consuming “healthy” take-out food frequently may not have a detrimental effect on fruit and vegetable intake. Previous research has reported associations between higher nutritional knowledge and higher fruit and vegetable intake (40), suggesting that health promotion strategies that impart the skills and knowledge to select healthy take-out foods may improve fruit and vegetable intake. However, as the majority of participants in this present study reported not consuming the recommended amount of vegetables (\geq five serves) (29), programs and policies are still needed to improve vegetable intake among the whole population.

Education differences in fruit and vegetable intake (Path c) and the mediation effect of take-out food consumption (Path c')

Lower educated groups reported fewer daily serves of fruit (Path c, Table 2). Participants with no post-school qualifications ($p < 0.001$) and those with a vocational education ($p = 0.009$) had significantly lower fruit intake compared with those with a bachelor degree or higher. When take-out food consumption measures were included in the model (Path c'), all associations were slightly attenuated; however, those with no post-school qualifications and vocational education remained significantly different from the highest educated in terms of their fruit intake. The indirect effects through overall take-out food were significant among participants with no post-school qualifications and diploma-level education as the 95% CI did not include zero. Likewise, the indirect effects of “less healthy” take-out food were significant at all education levels. There was no significant indirect effect through “healthy” take-out food at any education level.

For vegetables, lower educated groups consumed fewer serves per day (Path c): participants with no post school qualifications had a significantly lower intake ($p < 0.001$) compared with those with a bachelor degree or higher. Those with vocational ($p = 0.059$) and diploma-level education ($p = 0.051$) also showed reduced intake; however, the differences were not statistically significant at $p \leq 0.05$. After the inclusion of any take-out food consumption variables (Path c'), the associations became slightly weaker for all education levels. Among the least educated, however, the association remained significant ($p < 0.001$) with adjustment for each type of take-out food. Significant indirect effects were observed for overall take-out food among participants with no post-school qualifications and diploma-level education, and all education levels for “less healthy” take-out food. No significant indirect effects were observed for “healthy” take-out food consumption.

The results suggest that the frequency and choice of take-out food may play an important role in fruit and vegetable intake. However, the observed contributions of “less healthy” take-out food to education differences in fruit and vegetable intake were small although

statistically significant. These may be attributable to the dietary assessment tool employed: dietary intake assessed by a self-administered survey is typically misreported (41,42) and generally food frequency questionnaires underestimate “true” energy intakes (43).

Disadvantaged groups are likely to have lower abilities to recall and estimate dietary intakes (44) and lower educated groups have been shown to underreport total energy intake measured by self-reported dietary behaviors (41). People underreporting energy intake are more likely to report lower daily consumption of take-out food types such as muffins, donuts, and soft-drinks (45). Therefore, take-out consumption may be underestimated by lower educated groups.

The largest absolute indirect effects, on average, were observed among participants with no post-school qualifications for “less healthy” take-out food consumption compared with other groups. This suggests that discouraging the lower educated groups from consuming “less healthy” take-out food may reduce the education differences in fruit and vegetable intake. However, take-out food consumption is unlikely to be the sole explanation for the education variations in fruit and vegetable intake, and other factors may be contributing to these differences. Previous research has identified other possible mediators including: nutritional knowledge (46), weight concerns (47), and belief and concerns for health (48). Furthermore, social and environmental factors such as accessibility and availability of fast-food (12,49,50), and exposure to food advertisements (51) may also influence socioeconomic inequalities in fruit and vegetable intake. Environmental factors, however, may not play as big role in dietary inequalities in Australia as in the US (52). Most Australian studies have shown that there is little difference in the price and availability of healthy/less healthy foods and food stores across different socioeconomic areas (53-55). Similarly, determinants of fast-food and take-out meal purchasing seem to have more individual characteristics rather than environmental (12,56).

Limitations

The statistical mediation model assumes temporal direction of causal order (i.e. independent variable precedes mediator, and mediator precedes outcome variable) (57). However, due to the cross-sectional study design causality cannot be attributed. All measures were self-reported, and self-reported dietary measures, in particular, are prone to bias. Furthermore, the lower educated groups were under-represented suggesting that the true education differences in take-out food consumption are likely to be underestimated. Lastly, this study employed education as a socioeconomic indicator. Results may differ if other indicators are used. Despite these limitations, this is the first known study to provide evidence for a mediating effect of take-out food consumption on education differences in fruit and vegetable intake.

CONCLUSION

“Less healthy” take-out food consumption appeared to partly explain education inequalities in fruit and vegetable intake. The results highlight potentially important points for interventions to educate the population about how to choose healthy take-out foods, especially among lower educated groups. This may increase fruit and vegetable intake and, subsequently, reduce the risks of developing diet-related chronic disease and socioeconomic differences in these. Further research is required to confirm the observed findings and investigate why take-out food consumption patterns were different across socioeconomic groups.

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Table 1: Characteristics of participants and bivariate associations for fruit and vegetable intake by socio-demographic and take-out food variables among Australian adults aged between 25 and 64 years

	Total (N = 805)	Census ^a	Fruit intake (serves per day)	Mean (SD)	Vegetable intake (serves per day)
Sex (%)					
Male	41.5	49.2	1.77 (1.12)		2.24 (1.05)
Females	58.5	50.8	1.98 (0.99)		2.64 (1.14)
Overall			1.89 (1.05)		2.47 (1.12)
			p = 0.003 ^b		p < 0.001 ^b
Highest completed education (%)					
Bachelor degree or higher	35.7	28.7	2.09 (1.09)		2.68 (1.03)
Diploma	11.9	10.0	1.89 (0.91)		2.43 (1.04)
Vocational	18.4	19.0	1.80 (0.96)		2.44 (1.18)
No post-school qualifications	34.0	42.3 ^c	1.74 (1.07)		2.28 (1.17)
			p = 0.001 ^b		p < 0.001 ^b
Age (years)	44.0 (11.1) ^d	42.7 (11.0) ^d	0.09*	Pearson's correlation	-0.01
Overall take-out food consumption (times/week)	0.5 (0.8) ^e		-0.17**	Spearman's correlation	-0.18**
“Less healthy” take-out food index^f	12.8 (11.5) ^e		-0.19**		-0.18**
“Healthy” take-out food index^f	13.0 (13.0) ^e		-0.06		-0.04**

^a Compared with 2006 Census data (Australian Bureau of Statistics 2010)(36).

^b p-value for the difference between group, based on the ANOVA test between socio-demographic groups.

^c People who answered “not applicable” to non-school qualifications.

^d Mean (standard deviation).

^e Median (interquartile range).

^f Among take-out food consumers (n = 804).

*p < 0.05, **p < 0.01.

Table 2: Regression coefficients for mediation analysis and indirect effects among Australian adults aged between 25 and 64 years

Education	Mediator	Fruit intake (serves/day)					
		Path c	p	Path c'	p	Indirect effects (95% CI) ^a	% mediated
Bachelor degree or higher	Overall take-out food	–	–	–	–	–	
Diploma		–0.205	0.089	–0.179	0.138	–0.026 (–0.076, –0.003)	12.7
Vocational		–0.271	0.009	–0.263	0.011	–0.008 (–0.037, 0.006)	3.0
No post school qualifications		–0.390	<0.001	–0.375	<0.001	–0.015 (–0.047, –0.001)	3.9
Bachelor degree or higher	Less healthy take-out food	–	–	–	–	–	
Diploma		–0.205	0.089	–0.179	0.136	–0.026 (–0.067, –0.003)	12.7
Vocational		–0.271	0.009	–0.248	0.017	–0.023 (–0.059, –0.003)	8.5
No post school qualifications		–0.387	<0.001	–0.349	0.001	–0.037 (–0.074, –0.016)	9.8
Bachelor degree or higher	Healthy take-out food	–	–	–	–	–	
Diploma		–0.205	0.089	–0.200	0.097	–0.004 (–0.032, 0.016)	2.4
Vocational		–0.271	0.009	–0.269	0.010	–0.002 (–0.020, 0.005)	0.7
No post school qualifications		–0.387	<0.001	–0.384	<0.001	–0.002 (–0.021, 0.007)	0.8
Vegetable intake (serves/day)							
Bachelor degree or higher	Overall take-out food	–	–	–	–	–	
Diploma		–0.251	0.052	–0.205	0.108	–0.046 (–0.114, –0.006)	18.3
Vocational		–0.209	0.059	–0.196	0.073	–0.014 (–0.056, 0.013)	6.2
No post school qualifications		–0.429	<0.001	–0.403	<0.001	–0.026 (–0.066, –0.003)	6.1
Bachelor degree or higher	Less healthy take-out food	–	–	–	–	–	
Diploma		–0.251	0.051	–0.211	0.097	–0.041 (–0.099, –0.004)	15.9
Vocational		–0.209	0.059	–0.173	0.115	–0.036 (–0.083, –0.005)	17.2
No post school qualifications		–0.425	<0.001	–0.366	0.001	–0.058 (–0.104, –0.027)	13.9
Bachelor degree or higher	Healthy take-out food	–	–	–	–	–	
Diploma		–0.251	0.051	–0.241	0.062	–0.010 (–0.045, 0.008)	4.0
Vocational		–0.209	0.059	–0.205	0.064	–0.004 (–0.028, 0.003)	1.9
No post school qualifications		–0.425	<0.001	–0.419	<0.001	–0.006 (–0.028, 0.004)	1.4

Path c = independent variable: education, dependent variable: fruit/vegetable intake, adjusted for age and sex.

Path c' = independent variable: education, dependent variable: fruit/vegetable intake, adjusted for take-out food consumption (mediator), age and sex.

^a Bootstrap results for indirect effects with bias corrected and accelerated confidence intervals (5000 bootstrap re-samples).

% mediated = $[1 - (c'/c)] \times 100$.