Does food store access modify associations between intrapersonal factors and fruit and vegetable consumption?

Running title: Modifying effect of food store access

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ABSTRACT

Background/Objectives: Existing theoretical frameworks suggest healthy eating is facilitated by an individual's ability, motivation, and environmental opportunities. It is plausible, though largely untested, that the importance of factors related to ability and motivation differ under varied environmental conditions. This study aimed to determine whether the magnitude of associations between fruit and vegetable consumption and intrapersonal factors (ability and motivation) were modified by differences in access to stores selling these items (environmental opportunities).

Subjects/Methods: Cross-sectional analysis of 4,335 women from socioeconomically disadvantaged neighbourhoods in the state of Victoria, Australia. Self-reported fruit and vegetable consumption was assessed against a number of ability and motivation-related factors. To examine whether associations were modified by store access, interactions with access to supermarkets and greengrocers within 2-kilometres of participants' households were tested.

Results: Of the two factors related to ability and seven factors related to motivation, almost all were associated with fruit and vegetable consumption. In general, associations were not modified by store access suggesting that these factors were not tempered by environmental opportunities.

Conclusions: This study provides little support for the hypothesis that the importance of intra-personal factors to fruit and vegetable consumption is modified by food store access. Further research on this topic is required to inform behaviour change interventions.

BACKGROUND

Inequalities in health outcomes persist in many developed nations.[1-4] Socioeconomic gradients in dietary quality contribute to these inequalities,[5] with individuals from socioeconomically disadvantaged backgrounds more likely to have diets that do not align with recommended guidelines.[6-8] Population-wide, increasing fruit and vegetable consumption is viewed as one approach to reduce the global burden of disease from obesity, cardiovascular disease and some cancers.[5, 9] Rates of fruit and vegetable consumption are below recommended levels in many nations.[10, 11] In Australia, only 48.3% of adults meet the recommended intake level of at least two serves of fruit per day whilst only 8.3% meet the recommended level of at least five serves of vegetables per day.[12]

Consumption of fruit and vegetables is lower amongst those living in socioeconomically disadvantaged neighbourhoods.[13, 14] Both compositional (e.g. socioeconomic characteristics of individuals) and contextual factors (e.g. the local food environment) are likely contributors to this.[15, 16] However, whilst a range of individual-level and neighbourhood-level factors have been reported to be correlated with diet,[7, 17-19] little is known about how these factors operate in tandem to predict diet.

Using existing theoretical frameworks,[20] Brug has argued that in order to eat a healthy diet, an individual has to be confident about their abilities, motivated to want to do so, and exposed to environments that offer opportunities to procure healthy food.[16] When the environment does not offer these opportunities, it is plausible that factors related to ability and motivation may be more important drivers of healthy eating (i.e. an individual requires greater ability and motivation to seek healthy foods in an environment that does not offer these products). Conversely, a more supportive environment may result in behaviours that are more automated

and thus individual-drivers become less influential.[21, 22] This hypothesis, while plausible, remains untested.

This study aims to examine individual-level ability and motivation factors associated with consumption of fruit and vegetables amongst women living in socioeconomically disadvantaged neighbourhoods, and whether these associations differ in neighbourhoods with varied levels of access to supermarkets and greengrocers (as markers of fruit and vegetable retailers). It is hypothesised that individual-level factors are more important correlates of fruit and vegetable consumption for those living in areas without access to these stores than for those living in areas with access. Understanding whether certain individual-level factors are more influential in unsupportive environments is important for informing nutrition promotion policy and practice, since employing strategies to engage and motivate individuals may be more important in areas which are not supportive of fruit and vegetable consumption and where environmental change may be slower and more expensive to effect.

METHODS

This paper utilised baseline data collected in 2007-08 for the Resilience for Eating and Activity Despite Inequality (READI) study[23] with the collection of the data approved by the Deakin University Human Research Ethics Committee. Forty urban and 40 rural suburbs were randomly selected from the most disadvantaged tertile of suburbs within Victoria, Australia, with levels of disadvantage defined by the 2001 Socio-Economic Index for Areas (SEIFA) Index of Relative Disadvantage (IRSD). The IRSD is calculated from numerous area-level variables including (but not limited to) proportion of low income households, proportion of people who do not speak English well and proportion of people with no post-school qualifications.[24]

Women within the 80 selected suburbs were identified using the Australian electoral roll (registration on the electoral roll is compulsory for all Australian citizens) with 150 women aged 18-45 years randomly selected to participate from each suburb (n=11,940; some included areas had <150 eligible women). Respondents replied to a postal invitation to complete a questionnaire and, after excluding those who failed to meet eligibility criteria (e.g. respondents who had moved from the sampled neighbourhood prior to completing the survey, who were not the intended participant, those who withdrew their data after completing the survey, or were <18 or >46 years old), there were 4,349 eligible participants (39% of those who were delivered a survey). Geocoding[25] of household addresses was possible on 4,335 (99.7%) of these participants. Those not geocoded (n=14) were excluded from analysis as no environmental attribute data was available for these individuals.

Dependent variables: Fruit and vegetable consumption

Using separate questions for fruit and vegetables, respondents were asked to report on how many serves of each they usually eat per day (excluding fruit juice (fruit) and potatoes, hot chips or fried potatoes (vegetables)). Serving size example were provided (e.g. for fruit the following statement appeared: “1 serve = 1 medium piece or 2 small pieces of fruit or 1 cup of diced pieces”). Response options ranged from none to ≥6 serves per day. Fruit outcome data was coded to reflect those who consumed ≥2 serves per day and those who did not meet this recommended amount. Considering vegetable intake, only 5.8% of the sampled women reported the recommended consumption levels of at least five serves of vegetables per day. Therefore, vegetable intake was dichotomised for those who consumed ≥3 serves per day and those who reported eating less than three serves per day.

Independent variables: Ability and motivation

Two indicators of ability were examined: (i) How confident are you that you could shop regularly for healthy nutritious foods over the next year? and (ii) How confident are you that you could prepare/cook healthy nutritious foods over the next year? Response categories were on a 5-point Likert scale ranging from 'not at all confident' to 'extremely confident'. Due to the small number of participants in some response categories, the responses were collapsed for analysis to 'not at all/slightly confident', 'moderately confident' and 'very/extremely confident'.

Questions related to motivation included: (i) How much attention do you usually pay to eating a healthy low-fat diet? (5-point scale inclusive of 'none', 'a little', 'some', 'much', 'very much'; coded to 'low' (none/a little); 'mid' (some); 'high' (much/very much)); and (ii) How much do you agree or disagree that you make time to eat healthy foods even when you are busy looking after your family (5-point scale from 'strongly disagree' to 'strongly agree' with an additional option of 'not applicable'; coded to 'agree' (agree/strongly agree) and 'do not agree' (all other response options including not applicable). Additional questions on motivation to eat fruit and vegetables were based on five key influences on food consumption (taste, nutrition, cost, convenience, and weight control concerns) reported by Glanz and colleagues.[26] These outcome expectations are used as a marker of motivation, in line with the predictions of expectancy theory.[27] The following statements were provided to participants to assess why they eat fruit/vegetables (asked separately for fruits and vegetables): (i) they taste good (taste); (ii) the vitamins and minerals they have (nutrition); (iii) they are cheap (cost); (iv) they are easy to prepare (convenience); and (v) they are good for your health (health benefits (as proxy for weight control)). Response options were on a 5-point scale from 'strongly disagree' to 'strongly agree' with an additional option: 'I don't eat

fruit/vegetables'. Options were coded to either 'agree' (agree/strongly agree) or 'do not agree' (all other response options including 'I don't eat fruit/vegetables') to represent those with positive views towards fruit and vegetable consumption relative to other respondents.

Moderator: Food store access

Data on the location of the stores were obtained from a variety of sources including company websites and business directories and were cleaned to remove duplicates. Chain supermarkets were defined as those from the following chains: Aldi; Bi-Lo; Coles; FoodWorks; IGA/IGA-Supa/IGA-Richies; and Safeway/Woolworths. Greengrocers were identified as retail businesses that predominantly sell fresh fruit and vegetables. Using ArcGIS 9.3,[28] the number of chain supermarkets and greengrocers within a 2-kilometre (km) road network distance[25] from each individual's household location was calculated. For sensitivity analysis, access within 0.8km and 3km buffers were also created. These data were positively skewed and therefore access was categorised to no stores, 1-2 stores, and 3 or more stores for the 0.8km distance and no stores, 1-2 stores, 3-4 stores, and 5 or more stores for the 2km and 3km distances. The categorisation of this variable was preferred over transformation so as to differentiate between those with no stores available, limited availability and higher availability of stores.

Other covariates

The following covariates were considered potential confounders (selected based on a priori knowledge of previously reported associations) and controlled for in analysis: age of respondent, country of birth (coded as Australia; overseas), marital status (married/de facto;

previously married; never married), number of children under the age of 18 years living in the household (none; one; two; three or more), education (low: did not complete high school; medium: completed high school, trade certificate or diploma; high: completed tertiary education); hours worked in paid employment in the last week (no paid work; 1-15 hours; 16-24 hours; 25-34 hours; 35-40 hours; 41 hours or more); and residential locality (urban; rural).

Statistical analysis

Generalised estimating equations with an exchangeable correlation structure and robust standard errors to take into account the clustering of participants within suburbs were used for analysis in 2014 to estimate marginal models of the binary outcomes (fruit/vegetable consumption), adjusting for confounders. Those with missing data on any of the confounders were omitted across all models; however sample sizes varied slightly for each model due to variations in missing data in both the dependent and independent variable (range n=4053 – 4085).

To determine whether or not there were differences in the patterns of association between motivation or ability and fruit and/or vegetable intake by access to supermarkets and greengrocers, interactions between ability and motivation variables and store access within 2kms were considered in additional models. It is known that varying the distance and type of access measure can influence associations.[29, 30] In this instance, the 2km distance had a higher variability in exposure (no stores 18%; 1-2 stores 34%; 3-4 stores 27%; ≥5 stores 21%) than the 0.8km (~10 minute walk) (no stores 69%; 1-2 stores 23%; ≥3 stores 7%) and 3km buffers (no stores 8%; 1-2 stores 27%; 3-4 stores 24%; ≥5 stores 41%) and was determined as the most appropriate access measure for this analysis although the 0.8km and 3km buffers were used for sensitivity analysis.

RESULTS

Description of sample

Sample characteristics of the women in the READI study are presented in Table 1. The mean age of these women was 34 years. The majority of women were born in Australia (89%), were married or in a de facto relationship (65%), and lived in a household with at least one child under the age of eighteen (59%). Half of the women completed high school and/or some additional training whilst a further 26% were tertiary educated. A quarter of the sample reported not undertaking any hours of paid work in the prior week whilst 36% worked at least 35 hours. Just over half of the respondents were from rural areas (54%) with the remainder from urban localities.

Self-reported fruit and vegetable consumption frequency is reported in Supplementary Table S1. Around half of the sample (48%) reported that they consumed two or more serves of fruit per day and 40% reported consuming three or more serves of vegetables per day.

Bivariate associations

In Supplementary Table S1, the distribution of independent variables related to motivation and ability is shown by fruit/vegetable consumption. Around two thirds of the higher fruit and vegetable consumers reported high confidence in their ability to shop for and cook healthy food whilst less than half of those who consumed lower amount of these products reported high confidence in healthy shopping and cooking ability. More than half of the higher fruit and vegetable consumers reported that they paid a high amount of attention to a healthy diet compared to around ~30% of those who consumed lower fruits and vegetables. Most respondents agreed fruit/vegetables taste good, have vitamins/minerals, are easy to prepare

and are good for health (with higher percentages noted amongst higher fruit/vegetable consumers) however less than a third agreed that they are cheap.

Adjusted associations of ability and motivation with fruit and vegetable intake

With respect to factors related to ability, positive associations between shopping and cooking confidence with fruit and vegetable consumption were observed. Individuals with high confidence in their ability to shop for and/or cook healthy food (compared to low confidence) had at least three times greater odds of consuming recommended levels of fruit and at least three portions of vegetables per day (Table 2).

There was strong evidence of an association between all of the motivation factors and fruit and vegetable intake, with the exception that agreement that vegetables are cheap was not associated with vegetable intake (Table 3).

Effect modification by environmental access

In subsequent analysis, interaction terms between each of the independent variables presented in Table 2 and Table 3 and supermarket/greengrocer access within 2km were considered (results for interaction effects not shown). In general, results indicated that associations between fruit and vegetable consumption and factors related to ability and motivation were not modified by access to supermarkets and greengrocers in the residential environment. There was some, albeit weak, evidence that store access within 2kms may be a moderator of the association between vegetable consumption and cooking confidence ($p=0.062$), making time to eat healthily ($p=0.080$), and agreeing they like vegetables because they are nutritious (have vitamins/minerals) ($p=0.029$). Additional stratified analysis was conducted when the interaction effect was found to have $p<0.10$ (results not shown). However, whilst some

differences between store access categories were observed, there was no significant trend in the direction of the effect indicating that store access did not modify associations as hypothesised. Sensitivity analyses were conducted using the different buffer distances and overall findings were generally not altered (results not shown).

DISCUSSION

In this sample, almost all individual-level ability and motivation factors explored were associated with the consumption of fruit and vegetables. However, contrary to the hypothesis, the majority of relationships were not modified by store access, even when different distances for store access were tested.

Recent natural experiments examining the introduction of a new food retailer into a community have shown few positive benefits to dietary behaviours amongst local residents.[31, 32] Thus, changing the environment alone may not be enough to improve dietary behaviours. A recently introduced framework for behaviour change interventions[33] recognises that behavioural systems are inclusive of (cap)ability, motivation, and opportunities. Therefore, with regards to dietary behaviours it is important that future research assess the interactions between these factors to better inform complementary strategies that focus on both the individual and environment.

To better understand how environments, and specifically local residential environments, influence health behaviours, research must seek an enhanced comprehension of how different individuals interact and engage with features of their environment.[34-36] A growing body of work is recognising that many individuals in deprived areas or in areas with environments that do not have health supporting services, manage to remain healthy or engaged in health

promoting behaviours and are thus ‘resilient’ to the potential health damaging environment they are exposed to.[37, 38] However, key factors that promote this resilience remain poorly understood and further work is required to test factors associated with health behaviours amongst individuals and how different environmental exposures may further support or diminish these intrapersonal associations.

Few prior studies have explored the interactive effects of environmental and individual-level factors on eating habits. In prior research conducted by the present study’s authors, it was found that consumption of fast food was more likely amongst women who both lived in areas with more fast food outlets and had a lower confidence in their ability to shop for healthy food.[39] In this instance the environment may have supported increased consumption through making these products more convenient (particularly if the fast food outlet had drive-through service). This differs to fruit and vegetable purchasing where in-store interaction is required. In other studies of this nature it is worth noting that the focus was on testing whether the main effect of the environment was modified by differences at the individual-level. Specifically, in a US study, an association between fast food consumption and fast food restaurant access differed by individual income, with the relationship existing amongst low-income individuals only.[40] This suggests that when individuals have higher income (which may act as a proxy for ability to purchase more expensive products or for access to transport), they may be less reliant on nearby fast food restaurants. Kremers *et al.* have previously presented a framework to conceptualise relationships between environmental conditions and behavioural outcomes, including a potential moderating role of individual characteristics;[21] however, with regards to eating behaviours, these complex relationships remain largely untested.

This analysis provided a rare attempt to test whether associations between eating behaviours and intrapersonal factors vary when environmental conditions differ. It also included validated survey measures,[38] comprehensive measures of supermarket/greengrocer access, consideration of different sized environmental buffers in sensitivity analyses, and adjustment for a number of important confounders. However, potential limitations may have contributed to null findings. For example, the measures related to ability were about eating in general and were not specific to fruit and vegetable consumption. This was also the case for some of the motivation variables assessed. Some environmental factors that may have impacted on the findings were the restriction of the study area to only disadvantaged neighbourhoods (although variance in food store exposure was still observed), the absence of markets and alternative food sources from our store access measures, the absence of in-store measures related to fruit and vegetable variety, quality and price, and constricting the store access exposure measure to a boundary around the household address, which potentially ignores other key locations where individuals are exposed to and purchase fruits and vegetables (e.g. around the workplace[41]). The few significant interaction effects that were detected may have been spurious associations resulting from multiple testing.

CONCLUSION

The present study was able to provide insights into which intrapersonal factors were important determinants of fruit and vegetable consumption but found no evidence that the associations were stronger in an unsupportive environment. An alternative view may be that associations may be stronger when the environment is supportive. Again, we found no evidence to support this view. Whilst this may suggest that individual-level policy recommendations related to ability and motivation may be equally important across all

environments, future studies need to be designed to more thoroughly test whether these relationships vary under different environmental conditions.

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Supplementary information is available at EJCN's website.

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