Public Health Nutrition: 19(1), 55–70 doi:10.1017/S1368980015001081

Socio-economic position as a moderator of 9–13-year-old children's non-core food intake

Dorota M Zarnowiecki[1,*], Natalie Parletta[1] and James Dollman[2]
[1]School of Population Health, Sansom Institute for Health Research, University of South Australia, GPO Box 2471, Adelaide, SA 5001, Australia: [2]School of Health Sciences, Sansom Institute for Health Research, University of South Australia, Adelaide, South Australia, Australia

Submitted 6 October 2014: Final revision received 9 February 2015: Accepted 9 March 2015: First published online 23 April 2015

Abstract
Objective: There is limited understanding as to why children of low socio-economic position (SEP) consume poorer diets than children of high SEP. Evidence suggests that determinants of dietary intake may differ between SEP groups. The present study aimed to determine if SEP moderated associations of personal and environmental predictors with children's non-core food and sweetened drink intakes and unhealthy dietary behaviours.
Design: Children completed online questionnaires and parents completed computer-assisted telephone interviews to assess intrapersonal and environmental dietary predictors. Dietary intake was measured using an FFQ. Parents reported demographic information for maternal education, occupation and employment, and household income.
Setting: Twenty-six primary schools in South Australia, Australia.
Subjects: Children aged 9–13 years and their parents (*n* 395).
Results: Multiple personal and home environment factors predicted non-core food and sweetened drink intakes, and these associations were moderated by SEP. Maternal education moderated associations of girls' sweetened drink intake with self-efficacy, cooking skills and pressure to eat, and boys' non-core food intake with monitoring, parent's self-efficacy and home environment. Maternal occupation and employment moderated associations of sweetened drink intake with attitudes, self-efficacy, pressure to eat and food availability, and non-core food intake with parents' self-efficacy and monitoring. Income moderated associations with pressure to eat and home environment.
Conclusions: Identifying differences in dietary predictors between socio-economic groups informs understanding of why socio-economic gradients in dietary intake may occur. Tailoring interventions and health promotion to the particular needs of socio-economically disadvantaged children may produce more successful outcomes and reduce socio-economic disparities in dietary intake.

Keywords
Socio-economic position
Social ecological framework
Non-core food
Children's dietary intake

Poor eating patterns, in combination with less physical activity and higher sedentariness, can contribute to excess energy intake and higher risks of obesity and associated lifestyle diseases[1]. Trajectories of health behaviours and obesity suggest that these may track from childhood into adulthood, with poorer childhood behaviours and earlier development of obesity contributing to poorer health and higher obesity rates in adulthood[2–5]. Therefore, fostering better health behaviours from childhood, such as regular physical activity and healthier dietary patterns, may contribute to better health behaviours in adulthood. Socio-economic gradients in health indicate that children of low socio-economic position (SEP) are more likely to be overweight and obese and have poorer quality of dietary intake than children of high SEP[6–8]. In particular, children of low SEP may be more likely to consume non-core foods high in fat and sugar[8–10], sweetened drinks[11] and fast foods[12] than children of high SEP.

Differences between socio-economic groups in intrapersonal and environmental predictors may provide some explanation for socio-economic gradients in children's diet[13]. Cognitive factors such as nutrition knowledge, self-efficacy and attitudes to health behaviours have been shown to mediate associations of SEP with diet[12,14,15]. Environmental factors such as lower availability of fruits and vegetables and higher availability of non-core snack foods

*Corresponding author: Email dorota.zarnowiecki@unisa.edu.au

and sweetened drinks in low-SEP homes may contribute to differentials in food intake between socio-economic groups[12,16–18]. Low-SEP adolescents may receive less support for healthy eating from their family, which may mediate SEP differences in fruit intake[12,19]. Parents of low SEP may also employ different feeding practices compared with parents of high SEP, including exerting more restriction, pressure to eat and monitoring of food intake, which may contribute to non-core food intake[20,21].

SEP may act as a moderator of the predictors of children's dietary intake by influencing the strength and direction of relationships between predictors and dietary intake[22]. Few studies have considered the role of SEP as a moderator in children with mixed findings. Home fruit availability was significantly related to 11–12-year-old children's fruit intake in high SEP but not in mid and low SEP, whereas self-efficacy was most strongly associated with intentions to eat fruit in low-SEP children[19]. Low-SEP adolescents may be more susceptible to the influence of their peer groups and fast-food availability in their neighbourhood, which may contribute to higher consumption of snack foods and fast foods[23,24]. Adolescents' snack food intake was positively related with peer snack food intake in low-educated adolescents but not high-educated adolescents[24]. In low-affluence but not high-affluence families of Hong Kong adolescents, the presence of more fast-food shops was associated with increased consumption of junk foods and soft drinks, whereas lower restaurant availability of fruits and vegetables was associated with lower fruit and vegetable intake[23].

These studies provide some preliminary evidence of the role of SEP as a moderating variable for predictors of children's dietary intake; however, these studies are few and evaluate a number of different SEP indices across varied predictor–diet relationships. It is difficult to compare these studies, necessitating further evidence to provide better understanding of the drivers of socio-economic disparities in children's diets and to inform tailoring of health promotion strategies and interventions to specific needs of socio-economic groups. This is important, as to date strategies for improving children's dietary intake appear to provide only small or short-term improvements[25]. A considerable body of literature has identified that a combination of intrapersonal and environmental factors influence children's dietary intake[6] and studies conducted to date suggest that both intrapersonal and environmental dietary determinants may be moderated by SEP. Therefore a social ecological framework was employed in the present study. The social ecological paradigm emphasises that environmental contexts have a key role in determining health behaviours, but acknowledges that intrapersonal factors determine an individual's response to his/her environments[26]. The aim of the present study was to determine if SEP moderated associations of personal and environmental predictors with children's non-core food and sweetened drink intakes and unhealthy dietary behaviours.

Methods

The present study was a cross-sectional investigation of personal and environmental determinants of 9–13-year-old children's dietary intake. Data collection was conducted in Adelaide, South Australia from February to November 2010, and involved two phases: in phase 1, children completed the Child Nutrition Questionnaire (CNQ); and in phase 2, parents completed computer-assisted telephone interviews (CATI). Other findings from the present study, including a detailed description of the methods, have been published previously[13,27].

Participants were recruited from grade 5 to grade 7 classes of primary schools in Adelaide. The School Card Register (SCR), a ranking representing the proportion of students receiving means-tested Government assistance to meet the cost of school attendance, was used to rank and classify schools into SEP tertiles. Schools were randomly selected from each SEP tertile and invited to participate in the study. Oversampling in low-SEP schools was necessary to achieve an equal sample size across socio-economic groups, as the response rate from participants was lower (43 %) compared with high-SEP schools (56 %). Eighty-two schools were approached with information about the study and twenty-seven schools participated in the study (32·9 % response rate). All children and parents who were able to communicate in English with sufficient fluency to complete questionnaires and interviews were eligible to participate. In total, 2575 children received study information and 1257 parents consented to participate (48·8 % response rate), of which 1201 children were present at school on the day of data collection. Of participating children, 1059 completed the CNQ and were eligible for their parents to complete the CATI in phase 2. Participants from phase 1 were stratified by SEP and randomly selected to participate in the CATI. It was necessary to contact 525 participants (76·2 % response rate) to achieve the required sample size of 400 participants (multivariate regression analysis with fifteen to twenty variables, powered at 0·08 with α of 0·05). It was not possible to include all participants from phase 1 due to funding limitations. Five children were excluded as their responses to the CNQ were found to be incomplete, providing n 395 sets of matched data from children and parents for the current analysis.

Protocol

Phase 1 data collection was conducted at schools, utilising school computer facilities. Children completed online questionnaires in groups ranging from ten to thirty students, guided by research assistants. Phase 2 CATI were conducted at the completion of phase 1 data collection. Parents of children completing the CNQ in phase 1 were contacted by telephone and invited to participate in phase 2. The CATI was completed by the parent primarily responsible for their child's food provision.

https://doi.org/10.1017/S1368980015001081 Published online by Cambridge University Press

Study measures

The CNQ is an existing nutrition questionnaire which has been shown to be valid and reliable[28]. The CNQ utilises a semi-quantitative FFQ to measure children's usual intake of non-core foods and sweetened drinks, and unhealthy eating behaviours. Non-core foods are those which are not considered to be core components of a healthy diet and are deemed as discretionary foods or 'extras' in dietary guidelines, including chips, chocolate, lollies, biscuits, takeaway and fast foods. Two scales measuring sweetened drink intake and non-core food intake were implemented as described in the original questionnaire[28] (Table 1). The scoring of the original scale measuring children's engagement in eight eating behaviours[28] was modified for the present study into two scales with improved internal consistency representing 'healthy behaviours' (Cronbach's $\alpha = 0{\cdot}54$) and 'unhealthy behaviours' (Cronbach's $\alpha = 0{\cdot}57$), of which only the unhealthy behaviours scale is reported herein.

Predictors of children's dietary intake were measured in section two of the CNQ and in the parent CATI. Within social ecological frameworks, personal and environmental factors symbiotically influence children's eating behaviours, whereby the environment may facilitate an individual's engagement in eating behaviours, while personal attributes determine individual responses to environmental factors[26]. Twenty-six predictors were measured, of which eight were from children's responses to the CNQ and eighteen were from parent CATI responses. Where appropriate, scores were derived from existing validated instruments, while some scores were developed for the present study using confirmatory factor analysis and Cronbach's α to form scales with appropriate properties. More detailed information about the scales, including the psychometric properties for scales developed and psychometrically tested in the present study, is provided in Table 1.

Demographic information was reported by parents in the CATI. Maternal education, occupation and employment, and household income were tested as moderating variables. Mother's education rather than father's was used as it has been consistently associated with children's food intake[6] and most mothers still have primary responsibilities in the household for feeding children[29]. Education level was reported on an eight-point scale ranging from 1 = never attended school to 8 = completed postgraduate education. Occupation has been associated with predictors of children's dietary intake and may moderate predictor–diet associations[19]. Mother's job title was coded using the eight-tier Australian and New Zealand Standard Classification of Occupations (ANZSCO) which hierarchically groups occupations requiring similar levels of skills, education, responsibility and experience[30]. An additional category was created for individuals 'not in the labour force', comprising individuals engaged in full-time home duties, retired persons, unemployed and students. Where insufficient information was provided in the job title to accurately classify an individual, for example 'public servant', these data points were not coded and treated as missing data. An additional variable representing maternal employment was created, dichotomised as 'not in the labour force' and 'employed'. Income was tested as it has been consistently associated with poorer dietary outcomes among youth, but to the best of our knowledge has not been tested as a moderator of dietary predictors in children of this age. Annual gross household income, including pensions and government assistance, was reported using seven income brackets ranging from 1 = up to \$AU 12 000 to 7 = more than \$AU 100 000.

Data analysis

All analyses were conducted separately for boys and girls as initial bivariate analyses along with previous studies indicate that there may be differences between boys and girls in dietary predictors. First predictors of diet were identified using correlated component regression (CCR), and subsequently the identified predictors were tested for moderation by SEP using partial least squares structural equation modelling (PLS-SEM).

CCR (XLSTAT 2012) employs cross-validation with a step-down algorithm, reducing the number of predictors in the final model by partitioning sample data using bootstrapping into smaller subsets used in multiple regression rounds[31]. This regression approach is suited to application within a social ecological framework as it allows for many independent variables to be considered simultaneously, including variables with mixed scale types and those which are correlated with one another[31]. All predictor variables were entered simultaneously into the CCR model along with education, income, occupation and employment. Potential demographic covariates, child age, marital status, mother's age and SEIFA (Socioeconomic Index for Areas, an area-level measure of socio-economic status determined from home postcode) were included in all CCR models.

Following identification of dietary predictors in CCR, structural equation models were built for each dietary intake variable with corresponding predictors, testing for moderation by each of the socio-economic predictors. Only variables identified by CCR analysis to predict the corresponding dietary outcome were tested for moderation to limit the number of tests conducted. Covariates identified as predictors (i.e. mother's age, SEIFA) were not tested for moderation. This stepwise procedure was employed to reduce the risk of Type I errors that may arise from conducting multiple moderation analyses with a large number of predictor variables. Moderation was conducted using PLS-SEM (using Warp3 PLS, by WarpPLS2·0) as it is more powerful for detecting small moderation effects than regression, particularly where the sample size is small. Resampling was conducted by jack knifing and missing data imputed by the Warp program as column averages.

A sample size of 100–150 was needed, therefore the sample size was sufficient to conduct separate analyses

Table 1 Questionnaire items for variables assessed in the Child Nutrition Questionnaire (CNQ) and computer-assisted telephone interview (CATI; *n* 395)

							All		Boys		Girls	
Scale	Survey	No. of items	Response	Range	Cronbach's α	ICC	Mean	SD	Mean	SD	Mean	SD
Dietary intake scores†												
Non-core food intake‡	CNQ	11	Tick if consumed yesterday;	0–33	–	–	3·7	2·3	3·7	2·5	3·8	2·2
Sweetened drinks intake‡	CNQ	6	weighted 5-point scale from 0 = never/rarely to 1 = every day	0–14	–	–	1·8	1·4	1·9	1·4	1·7	1·3
Unhealthy behaviours‡	CNQ	3	5-point scale from 1 = never/rarely to 5 = every day	3–15	0·57	–	7·7	2·7	7·6	2·8	7·8	2·7
Intrapersonal (child)												
Self-efficacy for healthy eating	CNQ	6	5-point scale from 1 = strongly disagree to 5 = strongly agree	6–30	0·83	–	24·2	4·2	24·3	4·4	24·2	4·0
Attitude to fruit†	CNQ	5	5-point scale from 1 = strongly disagree to 5 = strongly agree	5–25	0·81	–	21·8	3·1	21·9	3·2	21·6	3·1
Attitude to vegetables†	CNQ	4	5-point scale from 1 = strongly disagree to 5 = strongly agree	4–20	0·75	–	15·3	3·1	15·2	3·1	15·4	3·0
Cooking skills	CATI	2	4-point scale from 1 = strongly disagree to 4 = strongly agree	2–8	0·62	0·88**	5·8	1·1	5·7*	1·1	6·0*	1·1
Parent												
Parent fruit & vegetable intake§	CATI	2	No. of servings/d	–	–	0·90**	4·5	1·7	4·6	1·8	4·5	1·7
Parent nutrition knowledge§	CATI	8	Correct = 1; incorrect or don't know = 0	0–8	0·62	0·49**	7·2	1·2	7·2	1·2	7·2	1·3
Parent cooking skills	CATI	2	4-point scale from 1 = strongly disagree to 4 = strongly agree	2–8	0·71	0·77**	6·4	1·2	6·4	1·3	6·3	1·2
Parent health considerations	CATI	6	4-point scale from 1 = strongly disagree to 4 = strongly agree	4–24	0·87	0·61**	21·5	2·4	21·5	2·4	21·5	2·4
Parent self-efficacy for healthy eating§	CATI	4	4-point scale from 1 = not at all confident to 4 = very confident	4–16	0·70	0·73**	14·0	2·0	14·2	2·0	13·9	2·0
Parent barriers to healthy eating‖	CATI	5	4-point scale from 1 = not at all to 4 = very much	5–20	0·63	0·71**	6·8	2·1	6·7	2·3	6·8	1·9
Authoritative parenting style¶	CNQ	6	4-point scale from 1 = not like my mum to 4 = just like my mum	6–24	0·69	–	19·3	3·3	19·3	3·4	19·4	3·1
Non-authoritative parenting style¶	CNQ	3	4-point scale from 1 = not like my mum to 4 = just like my mum	3–12	0·74	–	8·8	2·6	8·5*	2·7	9·2*	2·4
Restriction††	CATI	6	5-point scale from 1 = disagree to 5 = agree	6–30	0·81	–	21·0	7·4	20·7	7·6	21·2	7·2
Food as reward††	CATI	2	5-point scale from 1 = disagree to 5 = agree	2–10	0·69	–	3·7	2·5	3·5	2·3	3·9	2·6
Pressure to eat††	CATI	4	5-point scale from 1 = disagree to 5 = agree	4–20	0·64	–	9·5	4·6	9·3	4·3	9·6	4·9
Monitoring food intake††	CATI	4	5-point scale from 1 = never to 5 = always	4–20	0·90	–	15·9	4·0	16·0	4·2	15·8	3·8
Perceived feeding responsibility††	CATI	3	5-point scale from 1 = never to 5 = always	3–15	0·68	–	12·9	1·8	13·0	1·8	12·8	1·9

Table 1 *Continued*

Scale	Survey	No. of items	Response	Range	Cronbach's α	ICC	All		Boys		Girls	
							Mean	SD	Mean	SD	Mean	SD
Home environment												
Family barriers to healthy eating	CATI	4	4-point scale from 1 = strongly disagree to 4 = strongly agree; 4-point scale from 1 = not at all to 4 = very much	4–16	0·74	0·55*	7·8	2·8	6·7	2·3	7·7	2·7
Supportive home environment for healthy eating	CNQ	7	5-point scale from 1 = strongly disagree to 5 = strongly agree	7–35	0·71	–	30·4	3·4	30·7	3·5	30·2	3·3
Unsupportive home environment for healthy eating	CNQ	4	5-point scale from 1 = strongly disagree to 5 = strongly agree	4–20	0·69	–	10·8	3·5	10·8	3·7	10·8	3·3
Home fruit and vegetable availability	CATI	5	5-point scale from 1 = never to 5 = always	5–25	0·52	0·62**	24·1	1·4	24·1	1·2	24·1	1·5
Home non-core food and drink availability	CATI	4	5-point scale from 1 = never to 5 = always	4–20	0·61	0·83**	12·8	2·9	12·8	3·0	12·7	2·8
Social environment												
Parent upbringing in relation to food	CATI	2	4-point scale from 1 = strongly disagree to 4 = strongly agree	2–8	0·75	0·91**	5·9	1·4	6·1*	1·2	5·7*	1·5
Peer influences	CNQ	4	5-point scale from 1 = strongly disagree to 5 = strongly agree	4–20	0·85	–	13·9	3·5	13·4*	3·6	14·3*	3·3
Neighbourhood environment												
Neighbourhood food environment	CATI	3	4-point scale from 1 = strongly disagree to 4 = strongly agree	3–12	0·55	0·85**	9·8	1·5	9·8	1·5	9·7	1·5
Perceived cost of healthy foods	CATI	3	4-point scale from 1 = strongly disagree to 4 = strongly agree	3–12	0·69	0·83**	6·6	1·9	6·5	1·9	6·7	1·8

ICC, intra-class correlations used to determine test–retest reliability of CATI scores in a sub-sample of thirty-one parents who completed the CATI on two occasions approximately one week apart. Unless indicated below, scales were developed for the present study and psychometric properties were evaluated using confirmatory factor analysis and Cronbach's α, as presented in table. Psychometric properties were re-evaluated for scales noted below as 'adapted' from original instrument.
*$P < 0·05$; **$P < 0·001$.
†Dietary scores utilised from Wilson *et al.*[28]. Refer to reference for psychometric properties of dietary intake scores.
‡Non-core food items measured were: potato crisps, chocolate, lollies, muesli bars, savoury biscuits, sweet biscuits, ice cream/ice block, hot chips, pie/pasty/sausage roll, hot dog and pizza. Sweetened drinks measured were: fruit juices, cordials, soft drinks, sports drinks and energy drinks. Unhealthy behaviours measured were: consumption of dinner/snacks in front of the television and fast-food consumption.
§Scale adapted from Ball *et al.*[59].
‖Scale adapted from Williams *et al.*[60].
¶Scale from Jackson *et al.*[61].
††Scale from Birch *et al.*[43].

by gender. Using PLS-SEM allowed the detection of moderating effects of small magnitude which may not have been identified using regression. To interpret significant moderation effects, predictor variable scales were rescored into tertiles of participant responses and means of the dietary variable within each tertile of the predictor score were graphed. An α level of 0·05 was used for all statistical tests.

Results

Participants were distributed evenly across socio-economic strata for all SEP indices except occupation, where fewer mothers were employed as technicians, tradespeople or labourers than other occupation types (Table 2). Most parents who completed the CATI were female (87·1 %), indicating that in this sample mostly mothers were responsible for their children's food provision. There were no significant differences between boys and girls for any of the dietary outcomes (Table 1).

Predictors of outcome measures

Predictors of non-core dietary intake were varied and different for boys and girls (Table 3). The only predictor of girls' non-core food intake was children's attitude to fruit, whereby better attitude to fruit predicted lower non-core food intake. Ten predictors explained 4·0 % of variance in boys' non-core food intake. Higher availability of non-core foods at home predicted higher non-core food intake in boys. Employing more restrictive feeding practices predicted higher non-core food intake among boys, whereas more monitoring of food intake predicted lower non-core food intake. Counterintuitively, boys of parents with stronger self-efficacy for healthy eating were more likely to eat non-core foods. The strongest predictive model was obtained for girls' sweetened drink intake, whereby sixteen predictors explained 11·8 % variance. Lower sweetened drink intake was predicted by higher self-efficacy, attitudes to fruits and vegetables, children's cooking skills, a more supportive home environment for healthy eating, higher availability of healthy foods and higher parent nutrition knowledge. Unhealthy behaviours among boys and girls were predicted by less supportive home environments for healthy eating; and less unhealthy behaviours in girls were predicted by a more supportive home environment.

Moderation of predictors of children's non-core food intake, sweetened drink intake and unhealthy dietary behaviours by socio-economic position

Full moderation results are shown in Table 4 and only those relationships with significant moderation effects across multiple socio-economic indices are described in detail below (see online supplementary material, Supplemental Figure 1 for additional results on moderation not described in detail in the text). In brief, a number of intrapersonal, parent and home environment predictors of children's non-core food intake were moderated by SEP, with different moderation effects observed for boys and girls. For girls, attitudes to healthy eating, self-efficacy, cooking skills, parental pressure to eat and unhealthy food availability at home were moderated by SEP. Parent's nutrition knowledge and healthy food availability at home were not moderated by SEP. For boys, parents' self-efficacy, monitoring and unsupportive home environments for healthy eating were moderated by SEP, whereas no moderation was observed for cooking skills, restriction and non-core food availability at home.

Moderation of self-efficacy by socio-economic position

The association of child self-efficacy as a predictor of girls' sweetened drink intake was moderated by education and occupation (Fig. 1(a) and (b)). There was no relationship between girls' sweetened drink intake and child self-efficacy in the high-educated group, whereas in girls of low- and middle-educated parents sweetened drink intake was lower among girls with higher self-efficacy. Lower sweetened drink intake was associated with higher self-efficacy for all four occupation groups, but this effect was small in the white collar and professionals groups. The moderator effect appeared to be due to a stronger association between self-efficacy and sweetened drink intake in the not in the labour force group compared with the other occupation groups. It should be noted that the results of the blue collar group are difficult to fully interpret as no girls in this group reported high self-efficacy.

The association of parent self-efficacy as a predictor of boys' non-core food intake was moderated by education, occupation and employment (Fig. 1(c) to (e)). Among low-educated mothers, higher parent self-efficacy was positively associated with boys' non-core food intake, whereas there was no association between parents' self-efficacy and non-core food intake in the mid and high education groups. There was no association of parents' self-efficacy with boys' non-core food intake in mothers employed in blue collar, white collar and professional occupations. In boys of mothers not in the labour force, self-efficacy was positively related with non-core food intake.

Moderation of parent feeding practices by socio-economic position

The association of pressure to eat with girls' sweetened drink intake was moderated by all four socio-economic variables (Fig. 2(a) to (d)). The same moderation pattern was observed for education and income, whereby more pressure to eat was associated with higher sweetened drink intake in low SEP, and there was no relationship in middle and high SEP. The moderating effect of occupation was due to differences between not in the labour force and other occupation groups. In girls with mothers not in the labour force, more pressure to eat was associated with higher sweetened drink intake. The white collar group

Table 2 Demographic characteristics of participants: children aged 9–13 years and their parents, Adelaide, South Australia, February–November 2010

Demographic characteristic	All (*n* 395)	Boys (*n* 184)	Girls (*n* 211)
Child age (years)			
Mean	11·3	11·3	11·3
SD	0·9	0·9	0·9
Mother's age (years)			
Mean	41·7	41·8	41·6
SD	5·6	5·4	5·8
Sex of parent completing CATI (%)			
Female	87·1	83·7	90·0
Male	12·9	16·3	10·0
Marital status (%)			
Partner	79·2	76·6	81·0
No partner	20·8	22·8	19·0
Country of birth (%)			
Australia	71·6	71·7	71·6
UK and Ireland	12·7	9·8	15·2
Other	15·7	18·5	13·2
Aboriginal or Torres Strait Islander	3·3	3·2	3·3
Mother's education level† (%)			
Did not complete high school	22·8	20·1	24·8
Completed high school	17·9	17·9	17·5
Trade or diploma	25·6	22·3	28·2
University degree	21·5	23·4	19·4
Higher university degree	12·2	14·1	10·2
Gross household income‡ (%)			
Low	34·3	32·9	35·5
Mid	36·4	38·7	34·5
High	29·2	28·3	30·0
SEIFA§ (%)			
Low	32·9	32·1	33·6
Mid	33·2	34·2	32·2
High	33·9	33·7	34·1
Mother's occupation‖ (%)			
Managers & professionals	30·9	31·0	30·8
Technicians and trades	4·8	6·0	3·8
Community and personal service	11·4	10·3	12·3
Clerical, administrative & sales	22·0	25·0	19·4
Machinery operators, drivers and labourers	5·6	7·6	3·8
Not in the labour force	20·0	15·8	23·7

CATI, computer-assisted telephone interview.
Data are reported as mean and standard deviation or as percentage, as indicated.
†Education level measured on an eight-point scale ranging from 'never attended school' to 'higher university degree'. For ease of reporting, categories 1–4 are combined.
‡Gross household income reported in \$AU per annum, for all household income before tax, including wages, salaries, pensions and allowances. Low, <\$AU 60 000 per annum; mid, \$AU 60 001–100 000 per annum; high, >\$AU 100 000 per annum. Missing income responses (*n* 22) 'refused to answer' or 'unsure'.
§SEIFA, Socioeconomic Index for Areas, is an area-level measure of socio-economic status determined from home postcode.
‖Mother's occupation coded into categories according to Australian and New Zealand Standard Classification of Occupations (ANZSCO)[30]. Additional category for not in the labour force included individuals engaged in full-time home duties, retired persons, unemployed and students. Missing occupation responses (*n* 16) where participants provided insufficient information for accurate occupation coding.

followed a similar trend, but the association was not as strong, and there was no association for blue collar and professionals groups. Examining the effect of employment confirmed that the moderating effect was due to differences between employed mothers and those not in the labour force.

The association of monitoring as predictor of boys' non-core food intake was moderated by education, occupation and employment (Fig. 2(e) to (g)). Monitoring was not associated with non-core food intake in the low education group. Contrastingly, there was an inverse relationship between monitoring and non-core food intake in boys of high-educated mothers, whereas the relationship between non-core food intake and monitoring was positive in the mid education group. There was no relationship between monitoring and non-core food intake for boys of mothers employed in blue collar and white collar occupations. At higher levels of monitoring non-core food intake was lower among boys of mothers employed in professional occupations. Contrastingly, higher monitoring was associated with higher non-core food intake among boys with mothers not in the labour force, which was also observed upon comparing moderation by employment status.

Moderation of home environment variables by socio-economic position

Associations of boys' non-core food intake and unhealthy behaviours with unsupportive home environments were

Table 3 Predictors of non-core dietary outcomes, identified using correlated component regression, among children aged 9–13 years (*n* 395), Adelaide, South Australia, February–November 2010

Variable	CV predictor count†	Regression coefficients		Model goodness-of-fit indices‡
		B	*β*	
Predictors of girls' non-core food intake (*n* 211)				
Child attitude to fruit	100	−0·145	−0·202	R^2 = 0·041
				R^2(CV) = 0·021
				SD (CV) = 0·008
Predictors of girls' sweetened drink intake (*n* 211)				
Income	100	−0·069	−0·082	R^2 = 0·187
Supportive family environment	100	−0·039	−0·090	R^2 (CV) = 0·118
Fruit & vegetable home availability	100	−0·076	−0·086	SD (CV) = 0·016
Parent nutrition knowledge	95	−0·080	−0·077	
Mother's age	69	−0·016	−0·067	
Child attitude to vegetables	63	−0·027	−0·063	
Child attitude to fruit	60	−0·026	−0·060	
Child cooking skills	57	−0·067	−0·055	
Mother's employment	52	0·149	0·048	
Mother's education	51	−0·050	−0·049	
Unsupportive family environment	50	0·019	0·049	
Child self-efficacy	49	−0·016	−0·048	
Mother's occupation	49	0·022	0·046	
Home non-core availability	45	0·021	0·044	
SEIFA	42	−0·068	−0·043	
Pressure to eat	38	0·011	0·041	
Predictors of girls' unhealthy behaviours (*n* 211)				
Unsupportive family environment	100	0·409	0·515	R^2 = 0·342
Supportive family environment	97	−0·181	−0·209	R^2(CV) = 0·317
				SD (CV) = 0·012

Variable	CV predictor count†	Regression coefficients		Model goodness-of-fit indices‡
		B	*β*	
Predictors of boys' non-core food intake (*n* 184)				
Parent self-efficacy	80	0·278	0·217	R^2 = 0·209
Employment	79	2·100	0·308	R^2(CV) = 0·040
Home non-core availability	79	0·131	0·217	SD (CV) = 0·017
Mother's age	77	−0·088	−0·189	
Restriction	71	0·064	0·193	
Mother's occupation	70	−0·161	−0·168	
Unsupportive family environment	70	0·093	0·141	
SEIFA	55	0·415	0·136	
Monitoring	55	−0·078	−0·131	
Child cooking skills	43	−0·288	−0·131	
Predictors of boys' sweetened drink intake (*n* 184)				
Mother's employment	36	0·595	0·151	R^2 = 0·023
				R^2(CV) = 0·028
				SD (CV) = 0·009
Predictors of boys' unhealthy behaviours (*n* 184)				
Unsupportive home environment	80	0·377	0·496	R^2 = 0·246
				R^2(CV) = 0·234
				SD (CV) = 0·011

SEIFA, Socioeconomic Index for Areas.
†Cross-validated predictor count. Represents the number of occasions the variable appeared as a predictor in rounds of cross-validated regression models. For instance, a value of 100 indicates predictor appeared in every round of analyses, a smaller value indicates predictor appeared less frequently. Provides an indication of 'magnitude' of association in addition to beta coefficient.
‡R^2, variance explained by initial model prior to cross-validation; R^2(CV), variance explained by final optimised predictive model; SD (CV), standard deviation of R^2(CV).

Table 4 Moderation of predictors of non-core dietary outcomes by socio-economic position, using partial least squares structural equation modelling, among children aged 9–13 years (*n* 395), Adelaide, South Australia, February–November 2010

	Education				Income				Occupation				Employment			
Predictors tested for moderation	*β*	SE	R^2	*P*	*β*	SE	R^2	*P*	*β*	SE	R^2	*P*	*β*	SE	R^2	*P*
Girls (*n* 211)																
Non-core foods																
Fruit attitudes	−0·01	0·02	0·06	0·42	0·05	0·05	0·06	0·16	−0·11	0·07	0·06	0·06	**−0·18**	**0·08**	**0·08**	**0·01**
Sweetened drinks																
Vegetable attitude	−0·05	0·62	0·14	0·47	0·13	0·09	0·19	0·08	−0·16	0·07	0·15	0·07	**−0·16**	**0·08**	**0·15**	**0·02**
Fruit attitude	−0·05	0·11	0·05	0·32	0·08	0·07	0·10	0·12	−0·10	0·07	0·06	0·09	**−0·14**	**0·07**	**0·07**	**0·02**
Child self-efficacy	**0·12**	**0·10**	**0·07**	**0·03**	0·06	0·12	0·09	0·30	**−0·12**	**0·07**	**0·06**	**0·05**	−0·09	0·09	0·05	0·18
Child cooking skills	**−0·13**	**0·08**	**0·10**	**0·05**	−0·05	0·12	0·11	0·34	−0·01	0·08	0·07	0·43	−0·12	0·10	0·09	0·12
Parents' nutrition knowledge	0·06	0·30	0·09	0·42	0·09	0·07	0·12	0·11	−0·12	0·10	0·08	0·12	−0·13	0·11	0·13	0·08
Pressure to eat	**−0·19**	**0·07**	**0·09**	**0·003**	**−0·26**	**0·08**	**0·14**	**<0·001**	**0·19**	**0·06**	**0·08**	**0·001**	**0·16**	**0·08**	**0·06**	**0·02**
Supportive family environment	−0·03	0·19	0·10	0·44	0·09	0·08	0·13	0·12	−0·06	0·08	0·09	0·22	−0·09	0·09	0·10	0·14
Fruit/vegetable home availability	0·02	0·14	0·10	0·44	−0·02	0·19	0·12	0·47	0·15	0·27	0·01	0·29	−0·05	0·75	0·09	0·48
Unsupportive family environment	−0·08	0·15	0·07	0·29	−0·11	0·10	0·11	0·13	0·10	0·17	0·06	0·17	**0·18**	**0·10**	**0·08**	**0·04**
Home non-core availability	−0·03	0·22	0·06	0·44	−0·04	0·16	0·09	0·40	**0·18**	**0·07**	**0·07**	**0·004**	**0·17**	**0·09**	**0·07**	**0·03**
Unhealthy behaviours																
Supportive family environment	0·04	0·26	0·10	0·45	0·09	0·08	0·10	0·11	−0·03	0·05	0·12	0·30	−0·02	0·09	0·10	0·40
Unsupportive family environment	−0·06	0·05	0·32	0·11	0·03	0·08	0·31	0·34	0·02	0·05	0·34	0·36	−0·04	0·07	0·33	0·30
Boys (*n* 184)																
Non-core foods																
Child cooking skills	0·00	0·13	0·03	0·50	−0·20	0·64	0·07	0·38	0·08	0·57	0·02	0·44	0·19	0·82	−0·08	0·41
Parent self-efficacy	**−0·16**	**0·06**	**0·06**	**0·01**	0·03	0·08	0·03	0·35	**0·14**	**0·06**	**0·06**	**0·01**	**0·19**	**0·08**	**0·07**	**0·01**
Monitoring	**−0·12**	**0·05**	**0·04**	**0·01**	−0·09	0·07	0·03	0·08	**0·21**	**0·08**	**0·07**	**0·01**	**0·26**	**0·09**	**0·09**	**0·001**
Restriction	0·05	0·35	0·05	0·45	0·09	0·03	0·06	0·38	0·02	0·15	0·06	0·45	0·09	0·14	0·08	0·25
Unsupportive family environment	**0·11**	**0·07**	**0·02**	**0·05**	**0·15**	**0·08**	**0·02**	**0·02**	−0·13	0·16	0·17	0·20	0·07	0·23	0·01	0·38
Home non-core food availability	0·04	0·31	0·08	0·45	0·07	0·12	0·07	0·27	0·31	0·22	0·16	0·08	0·38	0·24	0·17	0·06
Unhealthy behaviours																
Unsupportive family environment	0·05	0·07	0·28	0·24	**0·17**	**0·06**	**0·25**	**0·01**	**−0·12**	**0·07**	**0·17**	**0·05**	−0·006	0·12	0·24	0·32

β, path coefficient for interaction term; SE, standard error of the path coefficient for interaction term; R^2, explained variance of the interaction model.
Significant moderation effects are indicated in bold font.

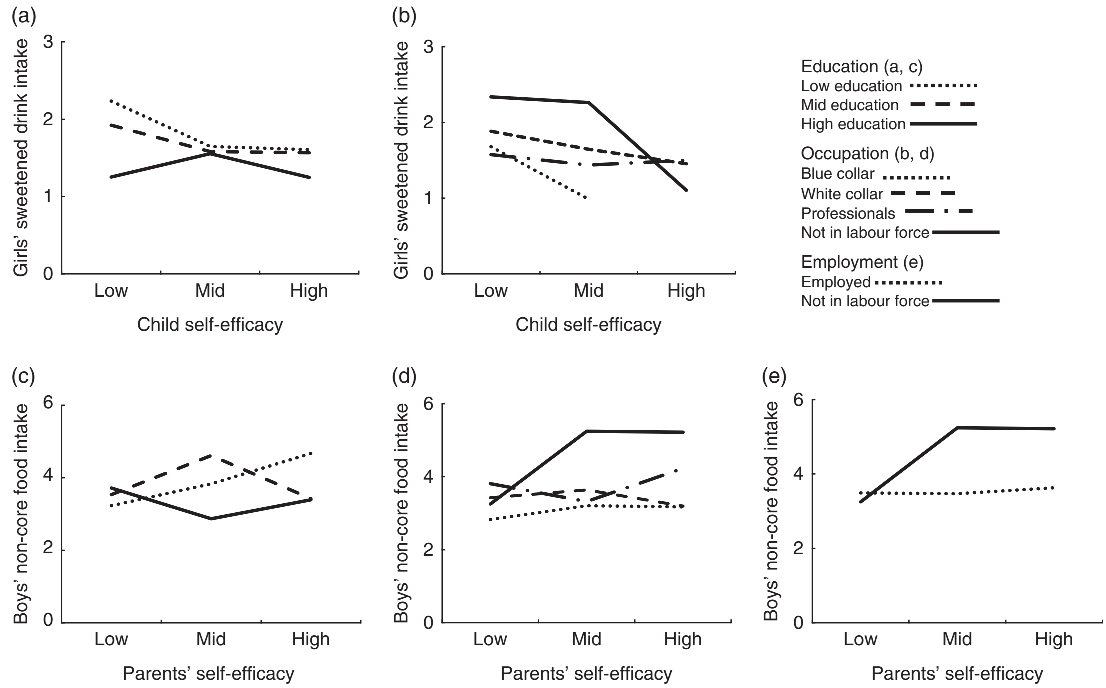

Fig. 1 Moderation by socio-economic position of the associations of child and parent self-efficacy for healthy eating with non-core food and sweetened drink intakes among children aged 9–13 years and their parents (*n* 395), Adelaide, South Australia, February–November 2010. (a, b) Moderation of child self-efficacy and girls' sweetened drink intake by (a) maternal education and (b) maternal occupation; moderation effects significant at $P \leq 0{\cdot}05$. (c, d, e) Moderation of parents' self-efficacy and boys' non-core food intake by (c) maternal education, (d) maternal occupation and (e) maternal employment; moderation effects significant at $P \leq 0{\cdot}01$. Tertiles of participant scores: child self-efficacy (low = 6–22; mid = 23–26; high = 27–30); parents' self-efficacy (low = 4–13; mid = 14–15; high = 16)

moderated by education, income, occupation and employment (Fig. 3(a) to (d)). For both education and income, the association between dietary outcomes and unsupportive home environments was stronger for high-SEP groups compared with middle and low SEP. Unsupportive home environments for healthy eating were positively related with boys' non-core food intake and unhealthy behaviours in high SEP, but not in low SEP. There was no overall association between unsupportive environments and non-core food intake in the low education group, whereas in middle and high education groups, unsupportive environments were positively related with boys' non-core food intake.

Association of home non-core food and drink availability and girls' sweetened drink intake was moderated by occupation and employment (Fig. 3(e) and (f)). There was no effect of availability on sweetened drink intake in the professional, white collar and blue collar groups. Conversely, sweetened drink intake was positively associated with non-core availability in girls of mothers not in the labour force.

Discussion

The present study used a social ecological framework to identify whether intrapersonal and environmental predictors of children's non-core food intake, sweetened drink intake and unhealthy dietary behaviours interact with SEP. A large number of personal and home environment factors, but no peer or neighbourhood factors, predicted dietary intake; and SEP moderated a number of the identified predictor–diet relationships. Education, income, occupation and employment all acted as moderators of the predictors of children's diet. Moderation effects were identified for children's attitudes to fruit and vegetable intake, self-efficacy and cooking skills, parent feeding practices, unhealthy food availability at home and unsupportive home environments for healthy eating. The strongest moderation effects across multiple indices of SEP were identified for associations of non-core food intake with parent self-efficacy, monitoring and unsupportive home environments, and associations of sweetened drink intake with pressure to eat and unhealthy food availability. Mother's education, occupation and employment were the most prominent moderating SEP variables. In particular, mother's occupation and employment moderated many predictors of children's diet; however, this moderation effect appeared to be mostly due to time spent in employment (being employed *v.* not in the labour force) than due to socio-economic factors.

A combination of child- and parent-reported factors predicted unhealthy eating, and predictors varied considerably between boys and girls. Contrastingly, predictors

https://doi.org/10.1017/S1368980015001081 Published online by Cambridge University Press

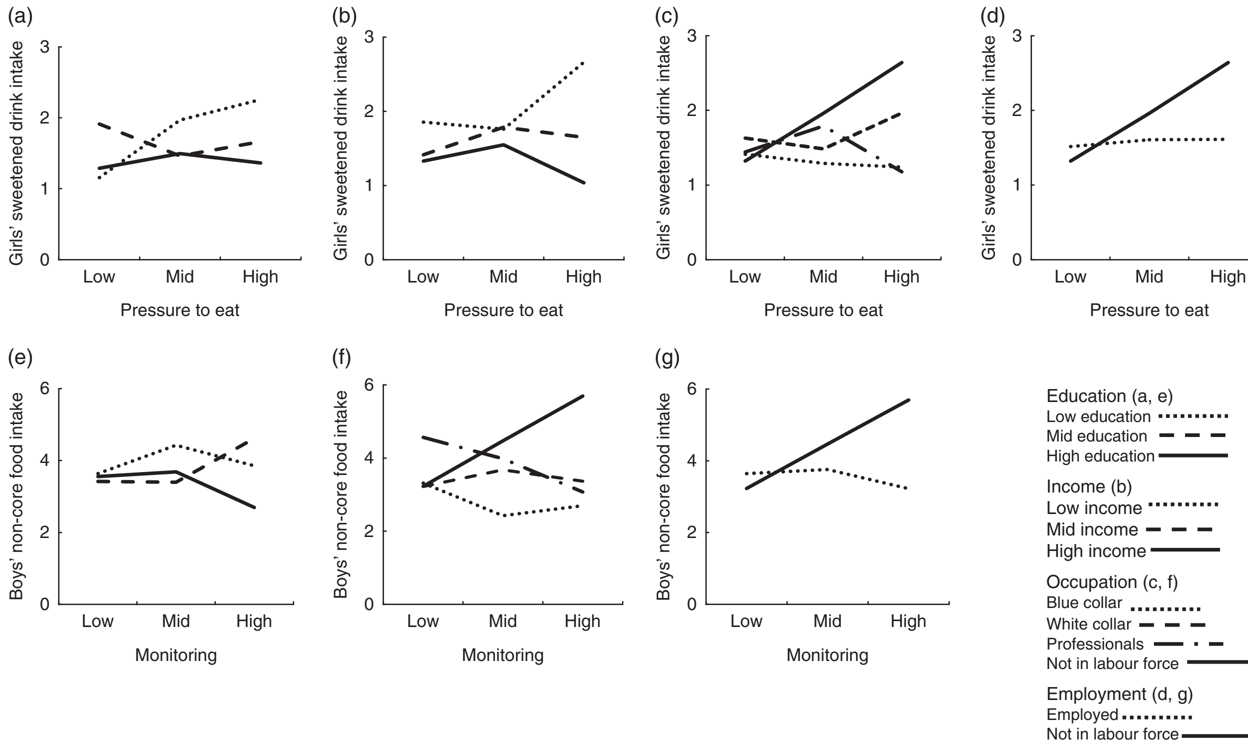

Fig. 2 Moderation by socio-economic position of the associations of parent feeding practices with non-core food and sweetened drink intakes among children aged 9–13 years and their parents (*n* 395), Adelaide, South Australia, February–November 2010. (a, b, c, d) Moderation of pressure to eat and girls' sweetened drink intake by (a) maternal education, (b) household income, (c) maternal occupation and (d) maternal employment; moderation effects significant at $P \leq 0{\cdot}01$. (e, f, g) Moderation of monitoring and boys' non-core food intake by (e) maternal education, (f) maternal occupation and (g) maternal employment; moderation effects significant at $P \leq 0{\cdot}01$. Tertiles of participant scores: pressure to eat (low = 4–6; mid = 7–11; high = 12–20); monitoring (low = 4–15; mid = 16–19; high = 20)

of healthy eating were consistent for boys and girls across different domains of healthy eating[27], suggesting that the drivers of unhealthy eating may be more complex and gendered than those of healthy eating. This is consistent with findings of Johnson *et al.*[32], who determined that the only common predictor of 11-year-old children's core and non-core food intake was mothers' intake. It has been proposed that cognitive factors are more important predictors of healthy eating, whereas food availability is more important for the consumption of energy-dense snacks and fast foods[12]. It may be that not just availability, but a range of environmental factors determine non-core food consumption, as is reflected in the findings of the present study. Differences in dietary predictors between boys and girls may arise from gender differences in health beliefs and attitudes. From an early age, girls are socialised differently with regard to food and this may result in more concern for weight, differences in health beliefs, attitudes and weight perceptions which may translate into different dietary patterns[33–35].

A moderation effect was observed for the association of parents' self-efficacy with boys' non-core food intake, but opposite to what would be expected, boys had a higher non-core food intake if their parents had higher self-efficacy. This moderation effect occurred only in the low education group, with no association in boys of middle- and high-educated mothers. It may be that despite feeling confident to make healthy food choices, low-educated parents do not have adequate nutrition knowledge and this is reflected in more non-core food intake by their children[36,37]. Rimal[38] found that parents' self-efficacy was predicted by their health knowledge, which in turn was independently predicted by education and income. This may also indicate that low-SEP parents reported they were more confident in preparing healthy foods for their family than they actually were, driven by social desirability in responding[39].

The most prominent moderation by SEP was observed for parent feeding practices, in particular monitoring and pressure to eat. The association of monitoring with boys' non-core food intake was moderated by education. At higher levels of monitoring, boys of high-educated mothers had lower non-core food intake; conversely in the middle education group non-core food intake was higher with more monitoring. Monitoring may reflect how much parents oversee the types of foods their children consume, and can therefore determine the types of practices parents employ to control and restrict the types of foods consumed[40]. Monitoring and control of food intake may be done by 'overt' or 'covert' methods, and these may

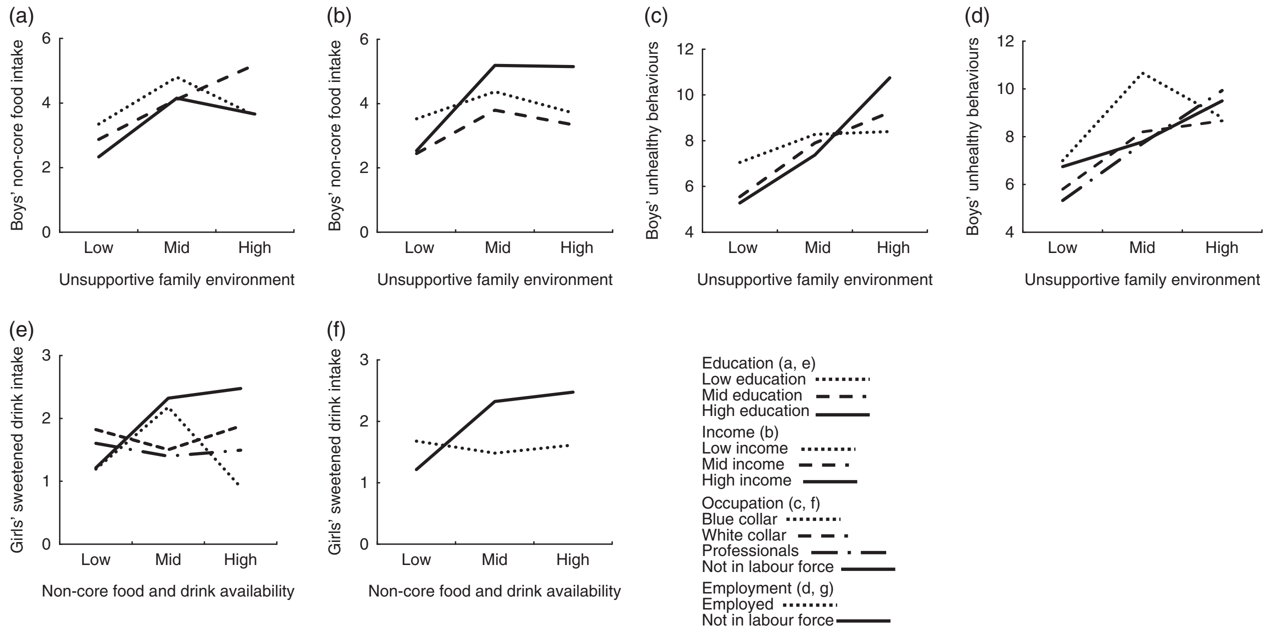

Fig. 3 Moderation by socio-economic position of the associations of home environment with non-core food and sweetened drink intakes and unhealthy dietary behaviours among children aged 9–13 years and their parents (*n* 395), Adelaide, South Australia, February–November 2010. (a, b) Moderation of unsupportive family environment and boys' non-core food intake by (a) maternal education and (b) household income; moderation effects significant at $P \leq 0{\cdot}05$. (c, d) Moderation of unsupportive family environment and boys' unhealthy behaviours by (c) household income and (d) maternal occupation; moderation effects significant at $P \leq 0{\cdot}01$ (c) and $P \leq 0{\cdot}05$ (d). (e, f) Moderation of girls' non-core food and drink availability and sweetened drink intake by (e) maternal occupation and (f) maternal employment; moderation effects significant at $P \leq 0{\cdot}01$ (e) and $P \leq 0{\cdot}05$ (f). Tertiles of participant scores: unsupportive family environment (low = 4–9; mid = 10–12; high = 13–20); non-core food and drink availability (low = 5–11; mid = 12–14; high = 15–20)

be differentially associated with children's eating[41]. Covert control is conducted by controlling the environment within which the child accesses food in a way that is not detected by the child and may be associated with less unhealthy snacking behaviours[41,42]. Overt control can be detected by the child and is conducted by direct instruction and restriction of food intake[41]. The results of the present study suggest that mothers of high education may be employing more covert methods of monitoring, which may be associated with lower non-core food intake, while the middle-educated group may have employed more overt practices. The Child Feeding Questionnaire monitoring score measures how often parents monitor children's intake of snack foods and drinks, but does not capture the ways in which parents monitor intake[43]. Future studies should consider whether differences exist among parents from different socio-economic groups in the manner in which they monitor children's food intake.

In children of low-educated mothers, non-core food intake remained fairly constant across all levels of monitoring, suggesting that monitoring of unhealthy eating was low in this group and therefore did not have an effect on intake; or that another factor exerted a stronger influence on non-core food intake. The first hypothesis is consistent with a study conducted in 3–6-year-old children which showed mothers of low education reported less monitoring of their children's food intake than high-educated mothers[44]. Alternatively, in low-SEP families, more availability of non-core foods compared with middle- and high-SEP families may exert a stronger influence on intake than feeding practices. The availability of energy-dense snack foods at home was found to be the strongest mediator of the relationship between SEP and snack food consumption in adolescents[12]. Children were more likely to consume snack foods and soft drinks if they were easily accessible at home, and this may have displaced fruit and vegetable intake[11,12,45,46]. In the current study, associations of home environment variables were moderated by SEP. Opposite to what would be expected, in high-income families associations of boys' non-core food intake and unhealthy behaviours with unsupportive family environments were stronger than for low-income families. In family environments more supportive of healthy eating, boys of low-income families reported higher non-core eating scores than middle- and high-income boys. The relationships of SEP with the home environment and other drivers of unhealthy eating are complex and likely due to complex interactions between a range of factors (for instance feeding practices). The present study was cross-sectional and there may be other unmeasured variables that are influencing this relationship. This area warrants further research to gain a clearer understanding of how SEP differences in unsupportive home environments for healthy eating may impact children's eating.

The positive association of pressure to eat with girls' sweetened drink intake was found only for girls of low SEP. To the best of our knowledge, no other studies have investigated the moderating effects of SEP on associations of feeding practices and diet in children of this age, and few studies have measured socio-economic differences in feeding practices in other age groups. Loth *et al.*[21] determined that parents of low education and income reported exerting more pressure to eat on middle- and high-school adolescents. In contrast, the use of pressure did not differ between low-, middle- and high-educated European mothers of pre-school aged children[47]. Applying more pressure to eat may reflect parents' concerns that their children are not eating enough. Australian girls of low SEP were more likely to skip breakfast regularly than their middle- and high-SEP counterparts[34]. Families with limited financial resources may apply added pressure on children to consume food when it is readily available if they have experienced periods of food insecurity in the past. Kuyper *et al.*[48] found that low-income and low-educated mothers of young children who had experienced food insecurity in the past reported less monitoring of their children's sweet and snack food intake, although pressure to eat was not related with food insecurity.

Many moderation effects were due to the effect of time spent in employment by mothers rather than mother's occupation. Differences in work hours are likely to present different challenges for providing food for children. In children of mothers who were not in the labour force, non-core food and sweetened drink intakes were positively related with monitoring and pressure to eat, whereas there was no relationship with these feeding practices in children with employed mothers. Mothers who are not employed may spend more time with their children during meals and therefore may have more opportunities to monitor and control their children's food intake[49]. Children of employed mothers may spend more time in alternative care arrangements, such as after-school hours care, friends' or grandparents' homes, where they may consume meals and snacks[50]. In care arrangements mothers have less or no control of the types of foods that their children consume and may also have less opportunity to monitor their children's food intake.

The cross-sectional nature of the present study means that causal pathways cannot be fully determined from the results. For instance, it may be that children's eating habits and behaviours determine the foods that parents purchase or feeding practices they employ. Longitudinal data may provide a better understanding of the directionality of these associations, as well as providing insights into how eating and associated predictors may evolve in older adolescents. Self-reported data may be subject to misreporting and socially desirable response bias, and this may affect responses non-randomly across SEP groups. Individual SEP may predict participation in research, with lower participation rates among individuals of low SEP, and non-responders to dietary surveys may differ from responders on dietary intake behaviours and attitudes[51,52]. A self-selection bias for individuals more interested in health and nutrition is a common limitation encountered in nutrition research and may be more pronounced in non-responders of low SEP[51]. Incentives (supermarket vouchers) were offered to participants in order to recruit participants who were not interested in health and nutrition, but nevertheless potential respondent bias may be a limitation of the present study and may have implications for the identified moderation effects. Some additional limiting factors may have contributed to difficulties with interpreting the moderating effects of mother's occupation. The distribution of participants within the occupation groups was unbalanced: the numbers of participants who were not in the labour force (*n* 79) and blue collar employees (*n* 22) were quite small. Most mothers reported being employed in white collar occupations (*n* 151). There is a risk that few scores may have a large effect on the mean for groups with fewer participants, thereby obscuring the true effects or showing a false moderation effect.

School and participant recruitment presented a challenge in the study. At the time of the study there was a difficult environment for conducting research within schools in South Australia, which is reflected in the low school response rate. Schools were hesitant to participate in research studies due to an oversaturation of research within schools in previous years (ethics officer, South Australian Department of Education and Children's Services, personal communication), the release of government numeracy and literacy targets for schools to meet[53], and the initiation of a school-based Obesity Prevention and Lifestyle (OPAL) programme by South Australian government which excluded a number of schools from participation in the current study[54]. The response rate in our study is consistent with a steady decline in South Australian school participation in research from 85 % in 2000 to 45 % in 2008[55,56]. The participant response rate was also low; however, it was consistent with or higher than that in other studies using school-based recruitment approaches in Australia, in which response rates have ranged from 34 % to 46 %[12,57,58]. The average parent response rate across all socio-economic groups was influenced by a lower response rate among parents of low SEP (43 %) and mid SEP (44 %) compared with high SEP (56 %). However, oversampling was employed to achieve a sample that was relatively evenly distributed across socio-economic groups and comprising participants recruited from diverse regions of metropolitan Adelaide. This type of sampling does not provide a sample representative of the population, but was necessary to undertake comparisons between socio-economic groups.

The present study is one of few considering the moderating effects of SEP on the predictors of children's dietary intake, building on previous research by focusing on non-core dietary outcomes and comparing a number of socio-economic indicators. Due to a lack of a comprehensive literature base from which to draw evidence about the predictor and SEP variables that should be included in the analysis, the present study included multiple comparisons and was largely exploratory in nature. As a result, multiple comparisons were conducted that may have may have led to Type I errors, and therefore most confidence can be placed in moderation effects seen across multiple SEP indicators. To reduce the number of comparisons made, a theoretically driven stepwise statistical approach was employed, which first identified significant predictors of dietary intake before conducting moderation analyses. Using CCR allowed for comparison of multiple indicators within a social ecological framework to identify predictors of each dietary outcome before testing for moderation of relevant predictor variables by SEP. The survey instruments were psychometrically tested and were shown to have good reliability and internal consistency. Evaluating the moderating effects of four SEP indices provided a better understanding of the role of SEP as a moderator of children's dietary predictors. However, there are numerous SEP indicators, including paternal SEP indicators, which may exert different moderating influences from the maternal SEP variables evaluated in the study. Future research should consider the role of maternal *v.* paternal SEP variables on predictors of children's dietary intake.

Conclusion

The present study found that children's non-core food intake is influenced by a complex range of variables at intrapersonal and home environment levels of a social ecological framework, and that these predictors of non-core food intake may be moderated by SEP. No social or neighbourhood environment factors predicted children's non-core eating. Education, income, occupation and employment all moderated dietary predictors, indicating that there may be some benefit in tailoring health promotion strategies and interventions for different socio-economic groups. Mother's occupation and employment moderated many of the predictors of children's diet; however, these moderation effects were difficult to interpret and warrant further investigation to understand how circumstances of employment and occupation may differentially influence parents' food provision. Moderation effects identified consistently across multiple SEP indicators may be proposed as features of health promotion and interventions targeted for improving dietary intake of different SEP groups. Interventions best suited for improving the dietary intake of children from low-SEP families may focus on helping parents to create supportive home environments for healthy eating by targeting feeding strategies, availability of foods, and parents' discussion and encouragement of nutrition and healthy eating with children, which may help to foster better attitudes and self-efficacy among children.

Acknowledgements

Acknowledgements: The authors acknowledge the contribution of Keren Kneebone who coordinated the study and conducted data collection. They would also like to thank the schools, children and parents who gave their time to participate in this research. *Financial support:* This study was supported by an Australian Research Council (ARC) Linkage Grant with SA Health (grant number LP 0883949). N.P. is supported by National Health and Medical Research Council (NHMRC) Programme Grant funding (grant numbers 320860 and 631947). D.M.Z. is supported by NHMRC Programme Grant funding (grant number 631947). ARC and NHMRC had no role in the design, analysis or writing of this article. *Conflicts of interest:* None. *Authorship:* Data collection was conducted by D.M.Z. All authors contributed to the study design, data analysis and writing of the manuscript, and have read and approved the final manuscript. *Ethics of human subject participation:* This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects/patients were approved by the Human Research Ethics Committees of the University of South Australia and the South Australian Department of Education and Children's Services. Written informed consent was obtained from all subjects/patients.

Supplementary material

To view supplementary material for this article, please visit http://dx.doi.org/10.1017/S1368980015001081

References

1. Lobstein T, Baur LA & Uauy A (2004) Obesity in children and young people: a crisis in public health. *Obes Rev* **5**, 4–85.
2. Juhola J, Magnussen CG, Viikari JSA *et al.* (2011) Tracking of serum lipid levels, blood pressure and body mass index from childhood to adulthood: the Cardiovascular Risk in Young Finns Study. *J Pediatr* **159**, 584–590.
3. Lien N, Lytle LA & Klepp KI (2001) Stability in consumption of fruit, vegetables, and sugary foods in a cohort from age 14 to age 21. *Prev Med* **33**, 217–226.
4. Rasmussen M, Holstein BE & Due P (2012) Tracking of overweight from mid-adolescence into adulthood: consistent patterns across socio-economic groups. *Eur J Public Health* **22**, 885–887.
5. Suppli CH, Due P, Henriksen PW *et al.* (2013) Low vigorous physical activity at ages 15, 19 and 27: childhood socio-economic position modifies the tracking pattern. *Eur J Public Health* **23**, 19–24.
6. Rasmussen M, Krølner R, Klepp KI *et al.* (2006) Determinants of fruit and vegetable consumption among children

and adolescents: a review of the literature. Part I: Quantitative studies. *Int J Behav Nutr Phys Act* **3**, 22.
7. Shrewsbury V & Wardle J (2008) Socioeconomic status and adiposity in childhood: a systematic review of cross-sectional studies 1990–2005. *Obesity (Silver Spring)* **16**, 275–284.
8. Cameron AJ, Ball K, Pearson N *et al.* (2012) Socioeconomic variation in diet and activity-related behaviours of Australian children and adolescents aged 2–16 years. *Pediatr Obes* **7**, 329–342.
9. Cartwright M, Wardle J, Steggles N *et al.* (2003) Stress and dietary practices in adolescents. *Health Psychol* **22**, 362–369.
10. Sweeting H & West P (2005) Dietary habits and children's family lives. *J Hum Nutr Diet* **18**, 93–97.
11. Haerens L, Craeynest M, Deforche B *et al.* (2008) The contribution of psychosocial and home environmental factors in explaining eating behaviours in adolescents. *Eur J Clin Nutr* **62**, 51–59.
12. Ball K, Macfarlane A, Crawford D *et al.* (2009) Can social cognitive theory constructs explain socio-economic variations in adolescent eating behaviours? A mediation analysis. *Health Educ Res* **24**, 496–506.
13. Zarnowiecki D, Ball K, Parletta N *et al.* (2014) Describing socioeconomic gradients in children's diets – does the socioeconomic indicator used matter? *Int J Behav Nutr Phys Act* **11**, 44.
14. Moore GF, Tapper K, Murphy S *et al.* (2007) Associations between deprivation, attitudes towards eating breakfast and breakfast eating behaviours in 9–11-year-olds. *Public Health Nutr* **10**, 582–589.
15. O'Dea JA & Wilson R (2006) Socio-cognitive and nutritional factors associated with body mass index in children and adolescents: possibilities for childhood obesity prevention. *Health Educ Res* **21**, 796–805.
16. Bere E, Van Lenthe F, Klepp K *et al.* (2008) Why do parents' education level and income affect the amount of fruits and vegetables adolescents eat? *Eur J Public Health* **18**, 611–615.
17. Edmonds J, Baranowski T, Baranowski J *et al.* (2001) Ecological and socioeconomic correlates of fruit, juice, and vegetable consumption among African-American boys. *Prev Med* **32**, 476–481.
18. Macfarlane A, Crawford D, Ball K *et al.* (2007) Adolescent home food environments and socioeconomic position. *Asia Pac J Clin Nutr* **16**, 748–756.
19. Sandvik C, Gjestad R, Samdal O *et al.* (2010) Does socio-economic status moderate the associations between psychosocial predictors and fruit intake in schoolchildren? The Pro Children Study. *Health Educ Res* **25**, 121–134.
20. Hupkens CL, Knibbe RA, Van Otterloo AH *et al.* (1998) Class differences in the food rules mothers impose on their children: a cross-national study. *Soc Sci Med* **47**, 1331–1339.
21. Loth KA, Maclehose RF, Fulkerson JA *et al.* (2013) Eat this, not that! Parental demographic correlates of food-related parenting practices. *Appetite* **60**, 140–147.
22. Fairchild AJ & Mackinnon DP (2009) A general model for testing mediation and moderation effects. *Prev Sci* **10**, 87–99.
23. Ho S, Wong BY, Lo W *et al.* (2010) Neighbourhood food environment and dietary intakes in adolescents: sex and perceived family affluence as moderators. *Int J Pediatr Obes* **5**, 420–427.
24. Wouters EJ, Larsen JK, Kremers SP *et al.* (2010) Peer influence on snacking behavior in adolescence. *Appetite* **55**, 11–17.
25. Waters E, De Silva-Sanigorski A, Hall BJ *et al.* (2011) Interventions for preventing obesity in children. *Cochrane Database Syst Rev* issue 12, CD001871.
26. Sallis JF, Owen N & Fisher EB (2008) Ecological models of health behavior. In *Health Behavior and Health Education: Theory, Research and Practice*, 4th ed., pp. 465–485 [K Glanz, BK Rimer and K Viswanath, editors]. San Francisco, CA: Jossey-Bass.
27. Zarnowiecki DM, Parletta N & Dollman J (2014) The role of socio-economic position as a moderator of children's healthy food intake. *Br J Nutr* **112**, 830–840.
28. Wilson AM, Magarey AM & Mastersson N (2008) Reliability and relative validity of a child nutrition questionnaire to simultaneously assess dietary patterns associated with positive energy balance and food behaviours, attitudes, knowledge and environments associated with healthy eating. *Int J Behav Nutr Phys Act* **5**, 5.
29. Hannon PA, Bowen DJ, Moinpour CA *et al.* (2003) Correlations in perceived food use between the family food preparer and their spouses and children. *Appetite* **40**, 77–83.
30. Australian Bureau of Statistics (2006) *Australian and New Zealand Standard Classification of Occupations (ANZSCO), First Edition. ABS Catalogue* no. 1220.0. Canberra: ABS.
31. Madigson J (2010) Correlated component regression: a prediction/classification methodology for possibly many features (Reprinted from the 2010 American Statistical Association Proceedings with Edits). http//statisticalinnovations.com/technicalsupport/CCR.AMSTAT.pdf
32. Johnson L, Van Jaarsveld CHM & Wardle J (2011) Individual and family environment correlates differ for consumption of core and non-core foods in children. *Br J Nutr* **105**, 950–959.
33. Cohen RY, Brownell KD & Felix MR (1990) Age and sex differences in health habits and beliefs of schoolchildren. *Health Psychol* **9**, 208–224.
34. O'Dea JA & Caputi P (2001) Association between socio-economic status, weight, age and gender, and the body image and weight control practices of 6- to 19-year-old children and adolescents. *Health Educ Res* **16**, 521–532.
35. Wardle J, Haase AM, Steptoe A *et al.* (2004) Gender differences in food choice: the contribution of health beliefs and dieting. *Ann Behav Med* **27**, 107–116.
36. Gibson EL, Wardle J & Watts CJ (1998) Fruit and vegetable consumption, nutritional knowledge and beliefs in mothers and children. *Appetite* **31**, 205–228.
37. Hendrie GA, Coveney J & Cox D (2008) Exploring nutrition knowledge and the demographic variation in knowledge levels in an Australian community sample. *Public Health Nutr* **11**, 1365–1372.
38. Rimal RN (2003) Intergenerational transmission of health: the role of intrapersonal, interpersonal, and communicative factors. *Health Educ Behav* **30**, 10–28.
39. Van Otterloo AH (1995) Taste, food regimens and fatness. A study in social stratification. In *Social Aspects of Obesity*, pp. 111–126 [I de Garine and NJ Pollock, editors]. Amsterdam: Gordon and Breach Publishers.
40. Birch LL & Davison KK (2001) Family environmental factors influencing the developing behavioral controls of food intake and childhood overweight. *Pediatr Clin North Am* **48**, 893–907.
41. Ogden J, Reynolds R & Smith A (2006) Expanding the concept of parental control: a role for overt and covert control in children's snacking behaviour? *Appetite* **47**, 100–106.
42. Brown KA, Ogden J, Vögele C *et al.* (2008) The role of parental control practices in explaining children's diet and BMI. *Appetite* **50**, 252–259.
43. Birch LL, Fisher JO, Grimm-Thomas K *et al.* (2001) Confirmatory factor analysis of the Child Feeding Questionnaire: a measure of parental attitudes, beliefs and practices about child feeding and obesity proneness. *Appetite* **36**, 201–210.
44. Kröller K & Warschburger P (2008) Associations between maternal feeding style and food intake of children with a higher risk for overweight. *Appetite* **51**, 166–172.
45. Boshoff K, Dollman J & Magarey A (2007) An investigation into the protective factors for overweight among low socio-economic status children. *Health Promot J Aust* **18**, 135–142.

46. Campbell KJ, Crawford DA, Salmon J *et al.* (2007) Associations between the home food environment and obesity-promoting eating behaviours in adolescence. *Obesity (Silver Spring)* **15**, 719–730.
47. Vereecken CA, Keukelier E & Maes L (2004) Influence of mother's educational level on food parenting practices and food habits of young children. *Appetite* **43**, 93–103.
48. Kuyper EM, Smith D & Kaiser LL (2009) Does food insecurity influence child feeding practices? *J Hunger Environ Nutr* **4**, 147–157.
49. Cawley J & Liu F (2012) Maternal employment and childhood obesity: a search for mechanisms in time use data. *Econ Hum Biol* **10**, 352–364.
50. Crepinsek MK & Burstein NR (2004) *Maternal Employment and Children's Nutrition. Volume I, Diet Quality and the Role of the CACFP. Report* no. E-FAN-04-006-1. Washington, DC: US Department of Agriculture, Economic Research Service.
51. Berg C, Jonsson I, Conner MT *et al.* (1998) Sources of bias in a dietary survey of children. *Eur J Clin Nutr* **52**, 663–667.
52. Turrell G, Patterson C, Oldenburg B *et al.* (2003) The socioeconomic patterning of survey participation and non-response error in a multilevel study of food purchasing behaviour: area- and individual-level characteristics. *Public Health Nutr* **6**, 181–189.
53. Department of Education, Employment and Workplace Relations (2011) Smarter schools national partnership for literacy and numeracy. http://smarterschools.gov.au/nationalpartnerships/Pages/LiteracyandNumeracy.aspx (accessed June 2012).
54. SA Health (2011) What is OPAL. http://www.sahealth.sa.gov.au/wps/wcm/connect/public+content/sa+health+internet/health+information/health+information+for+the+consumer/healthy+living/opal (accessed June 2012).
55. Dollman J, Ridley K, Magarey A *et al.* (2007) Dietary intake, physical activity and TV viewing as mediators of the association of socioeconomic status with body composition: a cross-sectional analysis of Australian youth. *Int J Obes (Lond)* **31**, 45–52.
56. Zarnowiecki DM, Sinn N, Petkov J *et al.* (2012) Parental nutrition knowledge and attitudes as predictors of 5–6-year-old children's healthy food knowledge. *Public Health Nutr* **15**, 1284–1290.
57. Timperio A, Ball K, Roberts R *et al.* (2008) Children's fruit and vegetable intake: associations with the neighbourhood food environment. *Prev Med* **46**, 331–335.
58. Campbell KJ, Crawford DA & Hesketh KD (2007) Australian parents' views on their 5–6 year old children's food choices. *Health Promot Int* **22**, 11–18.
59. Ball K, Crawford D & Mishra G (2006) Socioeconomic inequalities in women's fruit and vegetable intakes: a multilevel study. *Public Health Nutr* **9**, 623–630.
60. Williams L, Ball K & Crawford D (2010) Why do some socioeconomically disadvantaged women eat better than others? An investigation of the personal, social and environmental correlates of fruit and vegetable consumption. *Appetite* **55**, 441–446.
61. Jackson C, Bee-Gates DJ & Henriksen L (1994) Authoritative parenting, child competencies, and initiation of cigarette smoking. *Health Educ Behav* **21**, 103–116.