Title page : Australian Journal of Rural Health Manuscript ID AJRH-03-2015-0048

Title: The association between self-reported diet quality and health-related quality of life in rural and urban Australian adolescents

Running title: Diet and HRQoL in rural vs. urban adolescents

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Author contribution

KB conceptualised the study, managed data, conducted analysis and interpretation, and prepared the manuscript. FJ provided critical support for the diet scoring methodology. FJ, SA and PK provided input regarding analysis of data. All authors provided intellectual input, and have read and approved the final manuscript.

Abbreviations

HRQoL: health-related quality of life; **AQoL-6D:** Assessment of Quality of Life-6D

Received Date : 01-Mar-2015

Revised Date : 30-Aug-2015

Accepted Date : 23-Oct-2015

Article type : Original Research

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Abstract

Objective

This study examines the relationship between diet quality and health-related quality of life (HRQoL) in rural and urban Australian adolescents, and gender differences.

Design

Cross-sectional

Setting

Secondary schools

Participants

Students: 722 rural and 422 urban from 19 secondary schools.

Main outcome measures

Self-report dietary-related behaviours, demographic information, HRQoL (AQoL-6D) were collected. Healthy and unhealthy diet quality scores were calculated; multiple linear regression investigated associations between diet quality and HRQoL.

Results

Compared to urban students, rural students had higher HRQoL, higher healthy diet score, lower unhealthy diet score, consumed less soft drink and less frequently, less takeaway and a higher proportion consumed breakfast ($p<0.05$). Overall, males had higher unhealthy diet score, poorer dietary behaviours but a higher HRQoL score compared to females ($p<0.05$). In all students, final regression models indicated: a unit increase in healthy diet score was associated with an increase in HRQoL (unstandardised coefficient(B)±standard error(SE); B= 0.02±0.01(SE); $p<0.02$); and a unit increase in unhealthy diet scores was associated with a decrease in HRQoL (-0.01±0.00; $p<0.05$). In rural students alone, a unit increase in unhealthy diet score was associated with a decrease in HRQoL (B= -0.01±0.00; $p=0.002$), and

in urban students a unit increase in healthy diet score was associated with an increase in HRQoL (B= 0.02±0.00; p<0.001).

Conclusions

Cross-sectional associations between diet quality and HRQoL were observed. Dietary modification may offer a target to improve HRQoL and general well-being; and consequently the prevention and treatment of adolescent health problems. Such interventions should consider gender and locality.

Key words (5 key words which are not in the title)

Eating habits, mental health, geographic location, gender, adolescence

What this paper adds

What is already known on this subject?

- Emerging evidence suggests dietis associated with HRQoL and mental health in adolescents, with studies largely conducted in urban adolescent populations.
- Diet has been suggested to be a modifiable risk factor for ill health.
- There is a significant gap in knowledge regarding diet and HRQoL in rural adolescents.

What does this study add?

- This is the first study to examine diet quality and HRQoL in rural compared to urban adolescents.
- Cross-sectional inverse associations between diet quality and HRQoL were observed.
- Geographic location and gender were associated with dietary behaviours and HRQoL.
- The study highlights the importance of diet as a correlate of HRQoL. Interventions involving dietary modification should consider gender and locality.

Rapid physical, psychological and social developm

related quality of life (HRQoL) is an individual's assessment of their satisfaction or happiness with various domains in life that affect or are affected by health.[3] Health-related quality of life is a multidimensional measure[3] and captures several domains of physical and psychosocial functioning (including mental health).[4] Recent evidence has suggested HRQoL to be influenced by gender (males have increased HRQoL compared to females); age (older ages have poorer HRQoL compared to younger), weight status (overweight and obese have

poorer HRQoL compared to healthy weight).[5] Few studies have examined the factors influencing HRQoL which are associated with excess body weight – in particular – diet quality and physical activity.[6] However, one study has reported obesogenic behaviours (i.e. low fruit and vegetables, low physical activity, high screen time, high energy-dense nutrient poor food) to negatively influence HRQoL.[7]

Dietary habits are a risk factor that can influence physical and psychosocial health which in turn may contribute to the development of life threatening diseases.[8] Few studies examining the relationship between HRQoL and diet have been conducted in the general population[8] (typically treatment seeking or clinical populations). However, emerging evidence suggests that healthy diets are positively associated and unhealthy diets negatively associated with mental health among adolescents.[1, 9, 10] Half of all mental disorders first manifest before the age of 14 years,[2] pointing to the importance of optimising mental health in early adolescence. Existing studies examining diet quality and HRQoL have been conducted mainly in urban populations and less is known about this relationship in adolescents living in rural settings. This represents a significant gap in knowledge considering that adult rural dwellers are at increased risk of developing overweight/obesity compared to urban dwellers [11, 12] and that obesity has a direct and bidirectional relationship with mental health problems.[13, 14] This study aimed to examine the relationship between diet quality and HRQoL in rural Victorian adolescents compared to urban counterparts. An additional aim was to examine possible gender differences in diet quality and HRQoL.

Methodology

Study design

Study data comprised of baseline data (pre-intervention) collected in 2008/2009 from a large multi-setting community initiative *Health Promoting Communities Being Active Eating Well.*[16] Data was collected from rural regions in north west Victoria, and metropolitan Melbourne.

Participants

Participants were recruited through secondary schools (all year levels).[16] School teachers distributed and collected student consent forms. Parents provided written consent for their child's involvement and participants provided verbal consent prior to data collection. The participant response rate was 27%.Study approvals: Deakin University Human Research Ethics Committee (EC98-2008), the Department of Education and Early Childhood Development and the relevant Catholic dioceses. The project was registered with the Australian Clinical Trials (registration number 12609000892213).

Measures

Dietary-related behaviours

Self-reported paper-based surveys were administered to students as previously described.[16] Briefly, the survey was administered during school hours on Tuesday-Fridays and contained 10 questions specific to dietary-related behaviours such as the type and serves of foods eaten on the previous school day. Student compliance with recommended fruit and vegetable consumption were calculated using the current age- and gender-specific dietary guidelines for Australians.[17]

Health-related quality of life

Participants completed the self-reported Assessment of Quality of Life (AQoL) AQoL-6D adolescent HRQoL survey.[4] The AQoL-6D framework was based on the effects of ill health on a person's capacity to function and health descriptions established using the WHO's disabilities and impairments framework.[4] The survey consists of 20 items that produce scores on six domains; physical ability, social and family relationships, mental health, coping, pain and vision; and, hearing and communication.[4] Weighted item scores from the 20 questions were combined to form dimension scores that were added into a single multiplicative score using a scoring algorithm and includes an adjustment for Australian adolescents.[18] A score in the range of 0-1 is possible, with 0 representing worst health state and 1 representing best health state.

Socio-demographic variables

Demographic information was collected (age, gender, Aboriginal and/or Torres Strait Islander ethnicity, migration status and residential postcode). Postcode determined the area level of socio-economic status (SES) by using the Socio-Economic Index For Areas (SEIFA) score on the index of relative socio-economic disadvantage with a lower score indicating an area is more disadvantaged.[19]

Geographic location was categorised dichotomously as either "rural" or "urban" defined using the "Towns in Time" database.[20] This database utilises the Australian Systems Geographic Standard geographical framework developed by the Australian Bureau of Statistics and data from the Census of Population and Housing and categorises statistical area levels into rural or urban based upon a number of criteria including population density per square kilometre, infrastructure, access to facilities and environmental landmarks.[21]

Diet score methodology

Diet quality was described as either healthy or unhealthy by constructing scores based upon the nutrition related survey data.[9] For the healthy score, a point was allocated for each healthy dietary practice and summed; breakfast yesterday, fruit yesterday (≥2 serves), vegetables yesterday (≥5 serves), no packaged snacks yesterday, takeaway frequency of less than 2-3 times per month. For the unhealthy score, a point was allocated for unhealthy dietary practices and summed; number of packaged snacks yesterday, non-diet soft drinks and non-carbonated sugar sweetened beverages (0 for 1 serve yesterday to 9 for > 2 litres), a point for each day in a usual week that non-diet soft drinks and non-carbonated sugar sweetened beverages were consumed, takeaway (0 for once a month or less to 6 for most days).

Statistical analysis

Data were prepared and analysed using Stata 12.0. Descriptive statistics were computed for differences in demographic characteristics (mean±SD or proportions) and dietary behaviours (mean±SE or proportions). Associations were tested using Chi-square tests or t-

tests where appropriate. Multiple linear regression (MLR) analysis was used to investigate associations between HRQoL (AQoL score) and healthy diet score or unhealthy diet score (modelled separately as a continuous variable to increase statistical power). Further geographic stratification was performed whereby MLR was performed on either rural only, or urban only. MLR are reported as unstandardised coefficients (B). Two MLR models were investigated: model 1: unadjusted results; model 2: adjusted for potential confounders including gender, age, area-SES and BMI (anthropometry collected as previously described).[16] All models were adjusted for clustering by school. $p<0.05$ was considered statistically significant.

Results

Table 1 displays demographic data for the study sample. The study sample included 744 rural and 422 urban adolescents from 19 secondary schools. Significant differences between the rural and urban subsamples included rural subsamples having: more females, more Australian-born students, more students living in areas of higher socio-economic disadvantage, higher quality of life, healthier diets (higher healthy diet score and lower unhealthy diet score) ($p<0.05$). There was no significant difference between age, Indigenous and/or Torres Strait Islander origin, and physical activity assessed by the number of times participate in organised sport per week.

With regards to dietary-related behaviours, compared to urban students, rural students consumed less soft drink and less frequently, less takeaway and a higher proportion consumed breakfast ($p<0.05$, Table 2). When examining differences by gender, regardless of residential location, males had higher unhealthy diet scores and higher HRQoL compared to females ($p<0.01$). In rural students, males consumed more packaged snacks, more soft drink (and more frequently), more non-carbonated sweet drinks (and more frequently) and a higher proportion consumed breakfast compared to females ($p<0.05$). Similarly, in urban students, males consumed more soft drink, more non-carbonated sweet drinks, a higher proportion consumed breakfast and takeaway compared to females ($p<0.05$). Regardless of geographic location or gender, the proportion of students meeting daily minimum fruit and vegetable recommendations was similar.

To examine the association between diet score and HRQoL in all students combined, MLR was performed (Table 3). In the fully adjusted models, each unit increase in healthy diet score was associated with a 0.02 increase in HRQoL ($p<0.02$). Models for unhealthy diet scores showed that each unit increase in unhealthy diet was associated with a 0.01 decrease in HRQoL ($p<0.05$). The analysis conducted separately for geographic location (rural or urban) showed that among rural students each unit increase in unhealthy diet was associated with a 0.01 point reduction in HRQoL score ($p=0.002$); and among urban students a unit increase in healthy diet score was associated with a 0.02 point increase in HRQoL score ($p<0.001$).

Discussion

There is a significant gap in knowledge regarding adolescent HRQoL and diet quality in rural populations. The findings from this study indicate that compared to urban students, rural students have higher HRQoL and healthier dietary behaviours. In both urban and rural settings males consumed more energy-dense, nutrient-poor foods but reported better HRQoL compared to females. In all students combined, after adjustment for potential confounders, we found that increases in healthy diet scores were associated with increases in HRQoL, while increases in unhealthy diet scores were associated with decreases in HRQoL. In rural students examined alone, there was a decrease in HRQoL with increasing unhealthy diet score; and in urban students alone there was an increase in HRQoL with increasing healthy diet score. The study highlights geographic location and gender as possible factors associated with dietary behaviours and HRQoL.

HRQoL, dietary behaviours and diet scores by geographic location

The observed positive association between healthfulness of diet and HRQoL and negative association between an unhealthy diet and HRQoL are concordant with previous findings in other adolescent populations.[1, 6, 7, 9, 22] Greater fruit and vegetable consumption has also been shown to be associated with lower odds of mental disorders in Canadians[23] and

improved mental health status in Australian adolescents.[24] Conversely, unhealthy dietary patterns are associated with poorer mental health in children and adolescents,[10] consistent with our findings of poorer HRQoL with increased unhealthy diet scores. In our study, there was a low adherence to the Australian dietary guidelines, particularly for vegetable consumption regardless of geographic location. This finding has been previously reported in another adolescent population[1] and is of concern given the emerging evidence linking inadequate nutrition and poor diet quality (such as fast food, confectionary, animal foods) to mental health issues.[10]

Rural vs. urban students

This study revealed rural adolescents to have better HRQoL and healthier eating behaviours compared to their urban counterparts. There are few comparative studies of diet quality between rural and urban students, particularly in Australia, though non-metropolitan Australian students have reported more healthful behaviours (i.e. eating less fast foods, energy-dense nutrient poor snacks and sugar-sweetened beverages, meeting vegetable guidelines and not skipping breakfast) than metropolitan counterparts.[25, 26] Breakfast skipping has also been found to be more common in urban compared to suburban and rural children in the US.[27] In Scotland, rural students had more healthful behaviours (increased vegetable consumption and decreased sweets and crisps consumption); possibly due to growing their own vegetables and having few shops to purchase snacks from on the route home from school.[28]

While the associations support the hypothesis that diet quality drives HRQoL, there were slightly differential relationships observed between diet and HRQoL in rural and urban students. Therefore, qualitative studies to explore influences on HRQoL and diet in rural and urban contexts may shed more light. Influences could include cultural differences that may influence attitudes and behaviours; the physical and built environment – i.e. access and availability to healthy and unhealthy foods; food environments (including the quality within schools); and access to health services.[28]

HRQoL and dietary behaviours by gender

Adolescent males in this study reported higher HRQoL and unhealthy dietary behaviours compared to females. Males have previously reported higher HRQoL compared to their female counterparts[3, 30] possibly due to the female puberty process, coping mechanisms, social demands, beauty ideals.[30] Adolescent males reporting poorer dietary behaviours is supported by Savige et.al (2007) who reveal Australian adolescent males were less likely to have a healthy dietary pattern to females.[25] Previous studies have also supported the current finding of males being less likely to skip breakfast with the suggestion that the common behaviour of frequent snacking could reduce hunger at meal times, particularly at breakfast due to late night snacking.[26]

Implications

The exact mechanism responsible for association between diet quality and HRQoL is yet to be determined. Based upon recent suggestions proposed for beneficial associations between the Mediterrean diet and HRQoL; and healthy diet quality on mental health; we postulate that a healthy diet (i.e. high fibre, fruit, vegetable, dairy, wholegrains, fish, lean red meat, olive oils) will be rich in nutrients (e.g. folate, magnesium, B group vitamins) and be able to modulate inflammation, immune system functioning and redox state; improve metabolic activity; synthesis and transport neurotransmitters (e.g. serotonin).[9, 31] These mechanisms require further investigation. The crux of the finding in this study (i.e. diet quality is associated with HRQoL in adolescents) emphasises the importance of establishing health promoting behaviours in this population to decrease risk of poor mental health and chronic disease.

Strengths and limitations

To our knowledge, this is the first study to examine the relationship between diet quality and HRQoL in rural Victorian adolescents compared to urban counterparts. The study has a relatively large sample size from the general population and uses a validated Australian HRQoL instrument.[18] We acknowledge several study limitations. The participant response rate (27%) is somewhat lower compared to other studies[32] and may limit generalisability.

The self-report survey has potential for recall and social desirability bias. The cross-sectional study design precludes determination of causality. While the approach to categorising diet quality was relatively simple excluding specific information regarding meal composition,[9] previous sensitivity analyses using fruit and vegetables alone produced almost identical results.[9] Whilst statistically significant and in the direction hypothesised, the relative size of the beta coefficients are modest. However, the substantial measurement error that is a common feature of dietary assessment can seriously attenuate the power of epidemiological studies to estimate the association of diet with disease outcomes.[33] Moreover, while diet did not account for a large proportion of the variance in HRQoL in this study, even small effects sizes may be of substantial relevance at the population level given that diet is an exposure for the entire population.[34]

Conclusion

This study highlights the importance of diet as a correlate of HRQoL and suggests that HRQoL and some dietary behaviours are better in rural compared to urban students. Dietary modification may offer a target to improve HRQoL and general well-being; and consequently the prevention and treatment of adolescent health problems. The fact that the existing evidence suggests that diet is a modifiable risk factor for mental ill health, as well as somatic disease adds to the impetus for changes from individual to policy level to drive long term sustainable changes in the food system.[35] Inequities in health outcomes and treatment in rural settings when compared with urban counterparts further strengthens the need for targeted responses in both rural and urban communities, and the consideration of gender.

Acknowledgements

We gratefully acknowledge the funding support for this study from the Windermere Foundation. We acknowledge the assistance of research assistants involved in collecting data in the field, input from Boyd Swinburn, and the assistance and support of the project officers from each of the five school-based 'Go for your life' Health Promoting Communities: Being Active and Eating Well (HPC:BAEW) projects. The HPC:BAEW projects and their

evaluation were funded by the Department of Health and Department of Planning and Community Development, State Government of Victoria (note the views in this paper do not necessarily represent those of the Department of Health). Data collection was supported by the Department of Education and Early Childhood Development. KB was funded by the Windermere Foundation. FJ has received Grant/Research support from the Brain and Behaviour Research Institute, the National Health and Medical Research Council (NHMRC), Australian Rotary Health, the Geelong Medical Research Foundation, the Ian Potter Foundation, Eli Lilly, the Meat and Livestock Board and The University of Melbourne and has been a paid speaker for Sanofi-Synthelabo, Janssen Cilag, Servier, Pfizer, Health Ed, Network Nutrition, Angelini Farmaceutica, and Eli Lilly. SA is supported by funding from an Australian National Health and Medical Research Council/ Australian National Heart Foundation Career Development Fellowship (APP1045836). SA is a researcher on the US National Institutes of Health grant titled Systems Science to Guide Whole-of-Community Childhood Obesity Interventions (1R01HL115485-01A1) and a researcher within a NHMRC Centre for Research Excellence in Obesity Policy and Food Systems (APP1041020). At the time of the study LG was partly funded by an NHMRC capacity building grant and LG and EW were supported by the Jack Brockhoff Foundation.

Conflict of interest

KB, SA, PK, LG, EW, ADS declare no conflict of interest. FJ has received Grant/Research support from the Brain and Behaviour Research Institute, the National Health and Medical Research Council (NHMRC), Australian Rotary Health, the Geelong Medical Research Foundation, the Ian Potter Foundation, Eli Lilly, the Meat and Livestock Board and The University of Melbourne and has been a paid speaker for Sanofi-Synthelabo, Janssen Cilag, Servier, Pfizer, Health Ed, Network Nutrition,Angelini Farmaceutica, and Eli Lilly.

Role of funding source

The funders played no role in the study design; the collection, management, analysis, and interpretation of the data; or in manuscript preparation.

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	Total rural	Total urban	p
	n= 722	n= 422	

Table 1: Study characteristics of adolescents, stratified by geographic location (rural and urban)

Gender (male)	46.0%	59.2%	p<0.001
Age	14.55 (1.52) Range 11.77-18.52	14.77 (1.51) Range 12.06-18.91	ns
Newly arrived			
Australian born	99.2%	85.1%	p<0.001
Arrived 5-10 years ago	0.5%	5.2%	
Arrived < 5 years ago	0.3%	9.7%	
Indigenous and/or Torres Strait Islander origin			
Yes	1.9%	1.9%	ns
No	98.1%	98.1%	
Level of disadvantage†			
1 high disadvantage	30.6%	42.2%	p<0.001
2	56.7%	8.8%	
3	3.1%	32.0%	
4 low disadvantage	9.7%	17.0%	
AQoL	0.89 (0.13)	0.87 (0.14)	p<0.02
Healthy diet score	2.38 (0.97)	2.17 (1.05)	p<0.001
Unhealthy diet score	17.48 (5.95)	18.66 (6.68)	p<0.002
Physical activity (number of times participate in organized sport per week)	2.70 (2.18)	2.89 (2.93)	ns

Note: statistical analysis conducted rural vs urban

Statistical analysis: chi2 for categorical data, ttest for continuous data

† SES categorized into quartiles, based on SEIFA; Mean (SD); ns: not significant

Table 2: AQoL, diet score and dietary score components of rural compared to urban students

	RURAL			URBAN		
	Total	**Male**	**Female**	**Total**	**Male**	**Female**
	n=722	n=332 , 46.0%	n= 390, 56.0%	n= 422	n= 250, 59.2%	n= 172, 40.8%
	Mean (SE)	**Mean (SE)**	**Mean (SE)**	**Mean (SE)**	**Mean (SE)**	**Mean (SE)**
AQoL	0.89 (0.01)*	0.90 (0.01)**	0.87 (0.01)	0.87 (0.01)	0.87 (0.01)*	0.86 (0.01)
Healthy diet score	2.38 (0.97)*	2.32 (0.90)	2.42 (1.03)	2.17 (1.05)	2.15 (1.06)	2.20 (1.05)
Unhealthy diet score	17.48 (5.95)*	19.05 (6.12)**	16.16 (5.47)	18.66 (6.68)	17.36 (5.86)*	19.55 (7.07)
Fruit (serves yesterday)	1.65 ± 0.04	1.58 ± 0.06	1.71 ± 0.05	1.67 ± 0.05	1.65 ± 0.07	1.71 ± 0.08
Vegetable (serves yesterday)	2.17 ± 0.05	2.21 ± 0.07	2.14 ± 0.07	2.02 ± 0.06	2.02 ± 0.08	2.02 ± 0.10
Packaged snacks (serves yesterday)	1.54 ± 0.05	1.77 ± 0.08*	1.35 ± 0.06	1.56 ± 0.07	1.64 ± 0.10	1.45 ± 0.11
Soft drink (total ml yesterday)	206.20 ± 13.88*	286.44 ± 24.89*	138.31 ± 13.71	298.99 ± 23.90	361.70 ± 36.78**	207.85 ± 22.47
Usual soft drink (days per week)	2.06 ± 0.07*	2.47 ± 0.10*	1.71 ± 0.80	2.67 ± 0.09	2.82 ± 0.12	2.46 ± 0.15
Non-carbonated sweet drinks (total ml yesterday)	387.12 ± 17.09	474.10 ± 29.34*	313.08 ± 18.65	400.41 ± 25.90	456.00 ± 38.39**	319.62 ± 29.44
Usual non-carbonated sweet drinks (days per week)	3.44 ± 0.09	3.73 ± 0.13**	3.19 ± 0.11	3.26 ± 0.11	3.43 ± 0.15	3.02 ± 0.16

	%	%	%	%	%	%
Breakfast (yes)	87.5%*	90.9%**	84.5%	78.6%	82.7.%**	72.7%
Takeaway						
< 2-3 times a month	68.0%*	66.9%	69.0%	54.5%	50.4%***	60.5%
> once a week	32.0%	33.1%	31.0%	45.5%	49.6%	39.5%
Met fruit recommendations (2 serves)	52.8%	51.1%	54.2%	52.1%	50.8%	54.1%
Met vegetable recommendations (5 serves females, 5.5 serves males)	6.4%	5.0%	7.6%	4.7%	4.8%	4.7%

Note: statistical analysis was conducted on total rural versus total urban, and subsequently on data stratified by gender in rural and urban samples separately.

*p<0.001; **p<0.01; ***p<0.05

One serve of fruit was defined as one apple, banana or orange, or two mandarins, or a cup of diced fruit or fruit salad. A serve of vegetables was defined as ½ cup cooked vegetables or one cup of salad vegetables. Packaged snacks are referred to as energy dense nutrient poor (EDNP) snacks and included items such as potato chips, muesli bars, roll-ups (fruit straps), twisties, cheezels. Soft drinks were defined as non-diet, carbonated beverages and included energy drinks. Non-carbonated sweet drinks included cordial, fruit juice, fruit or sports drinks. Cordial is a flavoured sugar syrup (concentrate) added to water to make a sweet drink. Sports drinks included flavoured drinks containing carbohydrates (glucose), electrolytes and other supplements (vitamins and minerals).

Table 3: MLR for association between HRQoL, healthy diet score, unhealthy diet score and geographic location

	Model 1			Model 2		
	B coef (SE)	**95% CI**	**p**	**B coef (SE)**	**95% CI**	**p**
	Rural and urban n=1123			**Rural and urban** n=1034		
Healthy diet score (ref: score of 0)	0.02 (0.01)	0.00, 0.03	0.018	0.02 (0.01)	0.00, 0.03	0.016
Unhealthy diet score (ref: score of 0)	-0.01 (0.00)	-0.00, 0.00	0.044	-0.01 (0.00)	-0.00, 0.00	0.044

		Rural alone n=706			**Rural alone** n=618	
Healthy diet score (ref: score of 0)	0.01 (0.01)	-0.01, 0.03	ns	0.01 (0.01)	-0.01, 0.03	ns
Unhealthy diet score (ref: score of 0)	-0.01 (0.00)	-0.00, 0.00	0.040	-0.01 (0.00)	-0.00, 0.00	0.002
		Urban alone n=415			**Urban alone** n=405	
Healthy diet score (ref: score of 0)	0.03 (0.00)	0.01, 0.04	0.003	0.02 (0.00)	0.02, 0.03	<0.001
Unhealthy diet score (ref: score of 0)	-0.00 (0.00)	-0.00, 0.00	ns	-0.00 (0.00)	-0.00, 0.00	ns

Regression coefficients represent differences in total AQoL score compared with reference group (ref). All models adjusted for clustering by school (n=19). Model 2 was adjusted for gender, age, level of disadvantage and BMI. ns:not significant