

ORIGINAL ARTICLE

Associations between diet quality and mental health in socially disadvantaged New Zealand adolescents

AA Kulkarni, BA Swinburn and J Utter

BACKGROUND/OBJECTIVES: To examine the relationship between diet quality and mental health in an ethnically diverse adolescent population in New Zealand.

SUBJECTS/METHODS: Cross-sectional, population-based study design. Data were available at baseline for 4249 students. Responses from self-reported dietary questionnaires were used to assess diet quality; healthy eating and unhealthy eating were assessed as two separate scales. Mental health was assessed by the emotional subscale of the PedsQL instrument.

RESULTS: Eating a healthy diet was significantly associated with better emotional health ($P < 0.001$) and eating an unhealthy diet was significantly associated with greater emotional distress ($P < 0.001$), after controlling for age, ethnicity and gender. The healthy and unhealthy eating scales were independently related to mental health scores.

CONCLUSIONS: These findings contribute to a growing body of literature that diet quality is associated with mental health in adolescents. Further research is warranted to determine whether improvements to the diets of adolescents can have meaningful improvements to mental well-being.

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INTRODUCTION

Adolescence is a critical time for physical and psychological growth, and promoting mental health during this period is essential to the health and well-being of adolescents. It is estimated that, each year, 20% of adolescents suffer from a mental health disorder.¹ Unipolar depression, the most prevalent mental health disorder, is the primary contributor to disability in this age group.² Depression has significant negative physical, emotional and social consequences during adolescence, in addition to continued implications for future quality of life.^{3,4}

Successful physical and mental development during adolescence is dependent on adequate nutritional intake; however, evidence demonstrates that the diet quality of young people has deteriorated significantly in recent decades.^{5–8} This decline in diet quality, in addition to an apparent parallel increase in the prevalence of adolescent depression,^{9–11} has led to an interest in the possible role of nutrition in the development or progression of depressive symptoms. Several studies in adult and adolescent populations have identified a significant cross-sectional relationship between diet quality and symptoms of depression.^{12–16} Notably, Oddy *et al.*¹⁵ found that young adolescents eating a Western-style diet were more likely to experience both externalizing and internalizing problem behaviors compared with their peers eating healthier diets. A limited number of prospective studies in adults have reported that diet quality is associated with symptoms of depression over time,^{17–19} and, to date, only three studies have examined this relationship in adolescents.^{12,20,21} Notably, a recent study published in *PLoS One* by Jacka *et al.*²⁰ reported that diet quality was associated with mental health symptoms in a large sample of Australia adolescents. In addition, the study reported that changes in diet quality were associated with changes in mental health; improvements in diet quality were associated with higher mental health scores at follow-up but not

vice versa. Of interest, two other adolescent studies did not observe any prospective relationships between diet quality and mental health.^{12,21} Additional research is necessary to further understand this relationship and its implications for mental health promotion in this age group.

Given the significance of both nutrition and mental health as public health concerns and the paucity of research examining the relationship between the two, the current study aims to contribute to this emerging field. As such, the aim of this study is to examine the relationship between diet quality and self-reported emotional health in a large, ethnically diverse adolescent population in Auckland, New Zealand.

SUBJECTS AND METHODS

Study design

This study used data derived from baseline and follow-up measurements of the New Zealand arm (Living 4 Life) of the Obesity Prevention in Communities (OPIC) project.^{22,23} OPIC primarily aimed to reduce adolescent obesity through building community capacity to promote healthy eating and physical activity. Six high schools from the South Auckland region participated in OPIC. This region is characterized with high ethnic diversity and has a large youth population. All participating schools had a large Pacific Island population and students were primarily from low socioeconomic areas; all schools were classified as decile 1 or 2, defined as a measure of neighborhood-level socioeconomic deprivation on a scale of 1 (most deprived) to 10 (least deprived).

Participants

Principals of the participating schools provided consent for school participation on behalf of the Boards of Trustees for each school. All students enrolled in year 9 through year 13 were eligible to participate. Students were required to be in attendance at school on the days measurements were collected. Baseline data were available for 4249

students (response rate of 63%). Ethics approval was granted by the University of Auckland Human Participants Ethics Committee and all participants and their parents gave consent for participation.

Measures

Mental health. Mental health was assessed using the emotional functioning subscale of the Pediatric Quality of Life (PedsQL) instrument. The PedsQL is an assessment of health-related quality of life, designed and validated for use in child and adolescent populations.^{24,25} The emotional functioning subscale is a measure of depressive symptoms in children and adolescents and is the sum of scores on five questions related to fear, sadness, anger, somatic troubles and anxiety. Each question is scored on a 5-point scale, with responses ranging from 0 (never a problem) to 4 (almost always a problem). Overall scores are derived by reverse scoring and transforming items to a 0–100 scale, where 0=100, 1=75, 2=50, 3=25, 4=0. Higher mean scores represent better emotional health. The PedsQL has demonstrated high internal validity and has high convergence with other self-reported measures of depression in adolescents, including the Children's Depression Inventory and the Child Behavior Checklist.^{24,25}

Dietary assessment. Dietary intake was assessed by using a questionnaire designed for the OPIC study. Two separate scales were created to evaluate healthy and unhealthy eating behaviors by assessing correlation among responses to items related to dietary intake. A significant correlation was found between nine items assessing healthy eating behaviors. Healthy eating behaviors included: eating breakfast, mid-morning snack and lunch; eating breakfast, mid-morning snack and lunch at home; eating fruits and vegetables; and eating dinner as a family (Cronbach's alpha coefficient = 0.697). A significant correlation was also found among six items assessing unhealthy eating behaviors. Unhealthy eating behaviors included: consuming soft drinks; takeaways; unhealthy snacks (for example, biscuits, potato chips and instant noodles); fried or high-fat foods (for example, French fries and pies); sweet foods (for example, chocolates, lollies and ice cream); and purchasing snacks from takeaways or convenience shops (Cronbach's alpha coefficient = 0.732). Student responses were standardized and averaged, and four categories of healthy and unhealthy eating behaviors were created based on quartiles of eating score distribution (that is, quartile 1 to quartile 4).

Sociodemographic variables. Data on age, ethnicity and gender were collected through self-report. Student responses for age were collapsed into five categories: 12–13, 14, 15, 16 and 17 or over. Data on ethnicity were collapsed into four primary ethnic groups (Pacific, Maori, European and Asian or other) from twelve response options.

Statistical analyses

All data analyses were conducted using SAS version 9.3 (Cary, NC, USA).

The correlation between healthy eating and unhealthy eating was assessed to identify if there was a significant overlap in participants with high healthy eating scores and low unhealthy eating scores, and vice versa. There was very low, significant correlation between the two variables (Pearson's correlation coefficient = -0.173; $P < 0.001$).

The bivariate relationships between the dietary indicators and mental health were described by estimating the mean mental health score (with a 95% confidence interval) at each quartile of the dietary indicator. Multiple regression models were then tested to determine whether the relationships between healthy eating and mental health, and unhealthy eating and mental health were statistically significant, when age, sex and ethnicity were treated as covariates. In addition, a multiple regression model was tested to determine whether the independent relationships between healthy eating and mental health, and unhealthy eating and mental health were statistically significant when included in the model simultaneously, and age, sex and ethnicity were treated as confounders. All findings were considered statistically significant at $P < 0.05$.

RESULTS

Table 1 reports the demographic characteristics of the study sample. In total, 4249 students completed the baseline questionnaires. Slightly more females than males participated and the mean age was 15.2 (range 12–20 years). The study population was

ethnically diverse. A large percentage of the study population was Pacific Island, followed by Maori, Asian and European students.

The mean mental health score for the total population was 75.6. Females reported significantly poorer mental health than males (77.2 males; 74.2 females).

Mental health scores appeared to decline with age, although few differences reached statistical significance. Likewise, there were few differences in mental health scores by ethnicity, although the Asian young people reported lower mental health scores than Maori young people (77.8 Maori; 71.9 Asian).

There were no significant differences in dietary indicators by gender. However, there were significant differences between age and ethnic groups. Younger students were more likely to be in the highest quartile for healthy eating than older students; and older students were more likely to be in the lowest quartile for healthy eating than younger students, suggesting that healthy eating declines over the adolescent years. European students were most likely to be in the highest quartiles of healthy eating, followed by Asian, Maori students and Pacific students (data not shown).

Figure 1 displays the relationship between healthy eating and mental health. There was a significant, positive relationship across quartiles of healthy eating and mental health, adjusting for age, ethnicity and gender ($P < 0.0001$): quartile 1, β (s.e.) = 5.43 (0.47); quartile 2, β (s.e.) = 3.53 (0.83); quartile 3, β (s.e.) = 1.91 (0.46); quartile 4, β (s.e.) = 0 (0).

Table 1. Demographic characteristics of sample

	n	Percent	Mean PedsQL score
Total	4249	100.0	75.6
Gender			
Male	2020	47.5	77.2 (CI 75.9–78.4)
Female	2229	52.5	74.2 (CI 72.8–75.6)
Age			
12–13	1427	33.6	77.4 (CI 75.4–79.4)
14	938	22.1	75.6 (CI 72.9–78.3)
15	727	17.1	75.4 (CI 74.8–75.0)
16	639	15.0	74.7 (CI 72.0–77.4)
17 or over	518	12.2	72.3 (CI 68.8–75.8)
Ethnicity			
Maori	839	19.8	77.8 (CI 76.0–79.6)
Pacific	2502	59.0	76.0 (CI 74.8–77.1)
European	447	10.6	73.2 (CI 69.8–76.6)
Asian	449	10.6	71.9 (CI 68.0–75.9)

Abbreviations: CI, confidence interval; PedsQL, Pediatric Quality of Life.

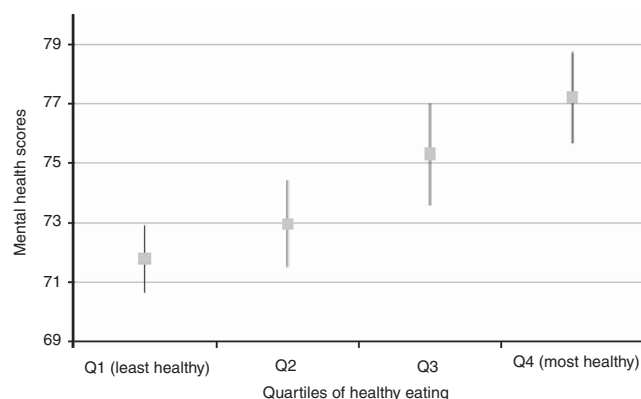


Figure 1. Relationship between healthy eating and mental health adjusting for age, gender and ethnicity.

Likewise, there was a significant, negative relationship across quartiles of unhealthy eating and mental health, adjusting for age, ethnicity and gender ($P < 0.0001$): quartile 1, β (s.e.) = -3.34 (0.28); quartile 2, β (s.e.) = -3.09 (1.13); quartile 3, β (s.e.) = -0.93 (0.64); quartile 4, β (s.e.) = 0 (0) (Figure 2).

Last, a third regression model was generated to determine whether the independent effects of healthy eating on mental health were confounded by unhealthy eating and vice versa. When both healthy eating and unhealthy eating were included in the same model, adjusting for age, ethnicity and gender, healthy eating was still positively associated with mental health scores ($P < 0.0001$) and unhealthy eating was associated with poorer mental health scores ($P < 0.0001$).

DISCUSSION

The current study identified a significant, dose-dependent, cross-sectional relationship between both healthy and unhealthy eating and mental health symptoms in a large, ethnically diverse population of adolescents. Moreover, the relationship between healthy diet and mental health remained even when accounting for unhealthy eating (and vice versa). Independent effects of healthy and unhealthy diets on mental health suggest that both increased intake of healthy food and decreased intake of unhealthy food may positively influence adolescent mental health, as an increase in one of these behaviors is not necessarily indicative of a decrease in the other.

Our findings are consistent with previous cross-sectional studies of diet and mental health among adolescents.^{15,16,20,26} For example, Weng *et al.*¹⁶ found that diets high in unhealthy foods, such as processed meats and high fat snacks, and low in fruits and vegetables were associated with increased likelihood of psychological symptoms in Chinese adolescents. Likewise, diets high in fruits, vegetables and whole grains were associated with a decreased likelihood of psychological symptoms. Similarly, Jacka *et al.*¹² reported that unhealthy diets high in fast food and unhealthy snacks were associated with mental health problems in an ethnically diverse adolescent sample in East London.

Of interest, we found substantial differences in mental health between the highest and lowest quartiles of healthy and unhealthy eating. Specifically, differences of 3.3 points and 5.4 points were observed between the highest and lowest quartiles of healthy and unhealthy eating, respectively. This compares with differences in PedsQL emotional scores between healthy adolescents and those with gastrointestinal disease (5.38 reduction), cardiac disease (5.55 reduction) end-stage renal disease (4.17 reduction) and obesity (3.80 reduction).^{27,28} The higher point difference between quartiles of unhealthy eating suggests a

stronger relationship between unhealthy eating and mental health. However, it may also reflect measurement challenges in assessing healthy and unhealthy eating.

The findings presented in this study have important implications for adolescent health. It is widely recognized that a poor diet is associated with increased risk of diseases such as diabetes and heart disease. However, the prevalence of many nutrition-related chronic conditions is low in adolescent populations as these diseases typically emerge during adulthood. However, there is a high prevalence of mental health disorders in this age group and the prevalence of mental health symptoms appears to have increased in the past two decades.^{9–11} This increase parallels a global decline in the quality of adolescent diets (that is, increased intake of snacks, fast food, sweets and fried foods, and decreased intake of fruits and vegetables),^{5–8} suggesting that diet may have substantial immediate implications for the mental health and well-being of adolescents.

Strengths and limitations

The current study had several notable strengths including a large sample size comprised of multiple ethnicities and the use of a well-validated instrument of emotional health. However, there are a few limitations that warrant consideration in interpreting these findings.

First, the study was not representative of the population and we were unable to collect data on the students not participating. It is possible that students who did not participate experience greater mental health issues and/or dietary problems that may influence the findings of this study. However, it is likely that the non-responders would affect the strength, not the direction, of the findings. Likewise, our study had inadequate data on socioeconomic status. That said, all participating schools had similar area-level socioeconomic deprivation classifications (decile 1 or 2), thus mitigating the potential for confounding by socioeconomic status.

This study also lacked data related to familial factors (for example, family functioning, conflict and cohesion) and other health behaviors (for example, overall activity levels and substance use) that may be independently associated with both mental health and diet quality.^{29–33} However, previous studies on the diet and depression relationship in adolescents have adjusted for factors related to family environments, such as family conflict, family structure, family management and family functioning, and did not find these factors to have a significant confounding effect on the relationship between diet quality and depressive symptoms.^{15,26}

Last, it may be hypothesized that our findings may be confounded by overweight/obesity, as obesity is associated with both poor diet and depression in cross-sectional studies. However, the role of obesity in the diet–mental health relationship is unclear; it is likely to be on the causal pathway between diet and mental health rather than explaining both. One longitudinal study³⁴ reported that adolescent obesity predicted adult depression, but several others have reported that adolescent depression causes later-onset obesity.^{35–37} Moreover, a previous study of New Zealand adolescents found that there was no relationship between severe obesity among young people and mental well-being.³⁸

Improving adolescent mental health is a recognized global public health priority. Understanding the more immediate consequences of unhealthy diet on mental health during adolescence increases the urgency in addressing policy change to promote healthy diet. Policies that promote healthy school environments, for example, can limit access to unhealthy food and increase access to healthier options. Widespread access to low-nutrition, competitive foods, such as those sold in vending machines or school canteens, can lead to increased intake of total

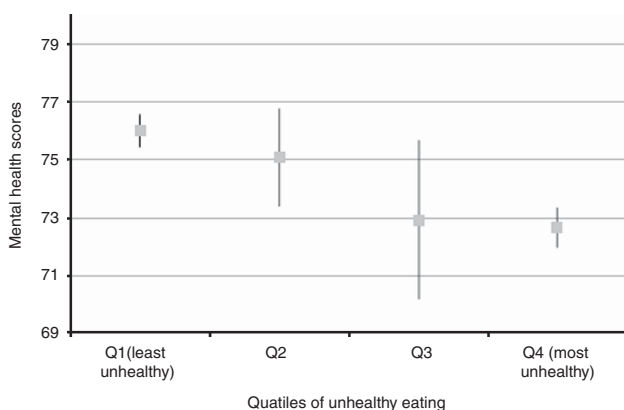


Figure 2. Relationship between unhealthy eating and mental health adjusting for age, gender and ethnicity.

calories, sugar and fat, and decreased consumption of nutritious foods.^{39–43} Several studies have demonstrated the effectiveness of school policies that limit or restrict access to low-nutrition foods in decreasing consumption of these foods.^{44,45}

In addition, policies addressing the marketing of food products to adolescents may limit the consumption of fast foods, soft drink and other unhealthy foods. Food marketing has strong potential to influence dietary behavior; unfortunately, a significant amount of marketing directed toward adolescents promotes low-nutrition, calorie-dense foods.^{46–50} Powell et al.,⁴⁹ for example, reported that 89% of television food product advertisements viewed by adolescents were for foods high in fat, sugar or sodium. Policies that limit or restrict the marketing of low-nutrition food products may decrease the consumption of unhealthy foods and may simultaneously encourage the marketing of healthier alternatives.

In conclusion, we found significant relationships between diet quality and mental health. These findings are consistent with previous studies; however, additional research is required to examine the causal role of diet in mental health.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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