

BMJ Open Investigating differences in dietary patterns among a small cross-sectional study of young and old Pacific peoples in NZ using exploratory factor analysis: a feasibility study

Ridvan Tupai-Firestone,¹ Soo Cheng,¹ Joseph Kaholokula,² Barry Borman,¹ Lis Ellison-Loschmann¹

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¹Centre for Public Health Research, Massey University, Wellington, New Zealand

²Department of Native Hawaiian Health, University of Hawaii, Honolulu, Hawaii, USA

Correspondence to

Dr Ridvan Tupai-Firestone;
r.t.firestone@massey.ac.nz

ABSTRACT

Objectives Obesity among Pasifika people living in New Zealand is a serious health problem with prevalence rates more than twice those of the general population (67% vs 33%, respectively). Due to the high risk of developing obesity for this population, we investigated diet quality of Pacific youth and their parents and grandparents. Therefore, we examined the dietary diversity of 30 youth and their parents and grandparents (n=34) to *identify whether there are generational differences in dietary patterns* and investigate the relationship between acculturation and dietary patterns.

Methods The *study design* of the overarching study was cross-sectional. Face-to-face interviews were conducted with Pasifika youth, parents and grandparents to investigate dietary diversity, that included both nutritious and discretionary food items and food groups over a 7 day period. *Study setting* was located in 2 large urban cities, New Zealand. Exploratory factor analyses were used to calculate food scores (means) from individual food items based on proportions consumed over the week, and weights were applied to calculate a standardised food score. The relationship between the level of acculturation and deprivation with dietary patterns was also assessed.

Results Three distinctive dietary patterns across all participants were identified from our analyses. Healthy diet, processed diet and mixed diet. Mean food scores indicated statistically significant differences between the dietary patterns for older and younger generations. Older generations showed greater diversity in food items consumed, as well as eating primarily a 'healthy diet'. The younger generation was more likely to consume a 'processed diet'. There was significant association between acculturation and deprivation with the distinctive dietary patterns.

Conclusion Our investigation highlighted generational differences in consuming a limited range of food items. Identified dietary components may, in part, be explained by specific acculturation modes (assimilation and marginalised) and high socioeconomic deprivation among this particular study population.

Strengths and limitations of this study

- The study data were obtained through a questionnaire carried out by face-to-face interviews. The youth were trained to obtain dietary diet from their parent and grandparent. They were accompanied by the research assistant during data collection.
- This study provides important insights of differences in food types consumed between the younger and older Pacific generation.
- Exploratory factor analyses was used to examine dietary data between groups, providing robust findings.
- A major limitation is the small sample size of the study; however, this is a feasibility study, and the results are limited to the study participants.
- The use of the dietary diversity questionnaire is based on a limited sampling frame of food group diversity over a 7-day period; therefore, it may not be completely representative of all food items and food groups that may have been consumed by the different age generations.

INTRODUCTION

Pacific peoples in New Zealand (NZ) are at greater risk of developing long-term conditions such as prediabetes, diabetes¹⁻³ and cardiovascular disease⁴ due to obesity, defined as having a body mass index (BMI) >30 kg/m². The prevalence of obesity (67% in adults aged 15+ years) in Pacific peoples is twice that in the general population (33%).⁵ Obesity has been viewed as a result of the changing westernised environmental pressures,⁶ leading to an energy expenditure/energy storage mismatch that operates through dietary behaviours.^{6 7} Often modernised dietary patterns, characterised by high energy dense and palatable food,⁸ and eating habits, such as having more access to less healthy snacks and food,^{9 10} explain the weight gain.¹¹

The findings from the NZ national nutritional survey on Pacific peoples reported similar patterns of energy, micro-nutrient intake, dietary supplement use and dietary habits (eg, consumption of breakfast and other food types, fruit and vegetable intake and salt intake), compared with the general population.¹²

Obesity rates continue to rise for all young people aged 15–24 years, with the highest increase among young Pacific peoples (up by 50% between 2007 and 2012).¹³ Previous NZ research has documented the impact of family meals on the dietary quality of young people¹⁴ and found that eating family meals together had an overall positive effect on the home food environment¹⁵ and that it encouraged the availability of more healthy food.¹⁰ Results from the Youth '12 Survey highlighted similar findings that shared family meals were associated with positive outcomes for young people, which were accentuated for those living in the lower deprivation neighbourhoods (66%), compared with those in the higher deprivation areas (58%).¹⁶ However, the survey results do not provide any clues as to the obesity-related mechanisms to further understanding about why young people continue to eat unhealthily. It has also been shown that young people experiencing poverty, irrespective of living in either low deprivation or more affluent neighbourhoods, does not explain overweight and obesity issues for young people.¹⁷ Little research has focused on understanding the Pacific concept of socialisation and food as inter-related activities, and there is increasing recognition of the importance of this if obesity prevention strategies are to be effective.¹⁸

In 2014, we investigated obesity-related health issues among 30 Pacific youth from the Wellington and Auckland regions of NZ in the pilot study, '*Chewing the facts on fat! What does that say about me?*'. The methodology and scope of the study has been published elsewhere.¹⁹ As part of that study, we also examined Pacific youths' diet and eating habits as it relates to obesity development. In particular, we explored dietary diversity as a form of investigating diet quality, which could be useful in identifying dietary component needs and provide insights to guide development of intervention strategies to improve diet quality and health outcomes for young Pacific peoples. The aim of the current paper is to examine the intergenerational dietary patterns among 30 young Pacific adults aged 15–24 years, and 34 parents and grandparents, from Wellington and Auckland regions.

METHOD

From a pilot study of 30 young Pacific adults aged 15–24 years in Wellington and Auckland, NZ, we investigated the social cultural determinants of the obesogenic environment. The study was conducted in two phases, and the original study methodology has been previously published,¹⁹ which described the recruitment, questionnaire data and the social demography of the participants, from phase 1. This paper presents data mainly from phase 2, obtained from young Pacific peoples who were

trained to interview and obtain information from one Pacific parent and one Pacific grandparent to examine and compare older generation's dietary habits with those of the Pacific youth group (phase 1) using the Pasifika dietary diversity questionnaire (described below). As Pacific peoples are not a homogenous group, we will refer to them as Pasifika, defined as a collective group of people representing the different Pacific Island nations and their respective languages, social cultural realities and protocols.

Patient involvement

Patients were not involved in the planning or design of the study.

Demography

Basic descriptive data were obtained from the parent and grandparent as per the protocol (face to face) described in phase 1 of the study,¹⁹ including measured weight and height, from which BMI was determined. We used the international standard cut-offs in defining obesity.²⁰ BMI was analysed as a continuous variable, with a BMI of $\geq 30 \text{ kg/m}^2$ and $25\text{--}29.9 \text{ kg/m}^2$ defined as being obese and overweight, respectively.²¹ Waist-to-hip circumference was also measured, from which the waist-hip ratio (WHR) was determined to provide a measure of central adiposity to indicate associated risk of incident cardiovascular events.²² The waist-to-height ratio (WtHR) was also calculated, as an adjunct measure of central obesity, which is less prone to measurement error than WHR.^{23 24} Deprivation was assessed using the NZDep2013 measure,²⁵ a small area-based measure of deprivation derived from the 2013 Census, which uses nine variables (benefit income, employment, household income, communication, transport, support, qualifications, living space and home ownership) from the Census to place small area blocks on a deprivation scale from 1 to 10 with 10 representing the most deprived 10% of NZ areas, while 1 represents the 10% least deprived areas. For analyses, deprivation was categorised into quintiles combining deciles 1–2, 3–4, 5–6, 7–8 and 9–10. Ethnicity was defined according to standard NZ Census data²⁶ and self-identified by each participant; however, for participation in the project, parents and grandparents needed to be self-identifiable as being of Pacific ethnicity. Where possible, the participants were also invited to record any physician-diagnosed conditions to highlight the presence of morbidity.

Dietary diversity

The Pacific dietary diversity questionnaire was compiled by the research team to assess the scope of individual foods and food groups in Pacific peoples' diets. The dietary diversity questionnaire aims to capture the 'range of food' that people consume over a 7-day period and not to measure quantity of food items like the 'food frequency questionnaire'. This type of assessment has been used among other indigenous groups successfully, and it has been proven to be effective than a quantitative assessment

of describing the quality of the diet.^{27–32} This questionnaire was pretested among an independent community group of Pasifika youth (n=30) from Wellington, and it was adapted to include common food that would be consumed by Pasifika people in NZ (eg, povi masima [salted meat]).

Data on different individual foods and food groups that were consumed over a 7-day period (reference period) were collected and recorded (dichotomised: yes/no) by the Pacific youth who were participants in phase 1 and were trained by the research team at a single day workshop. The training involved familiarising and understanding the questionnaire and prompts. Following the training day, each youth arranged and organised a face-to-face interview (accompanied by a research assistant), with a parent and grandparent. The questionnaire included both nutritious and discretionary food and food groups to encapsulate the diversity of food groups and of food items. The questionnaire data produced a total of 26 food groups (15 nutritious and 11 discretionary) specifically consumed by the study participants. However, using exploratory factor analyses (EFA) (see below) in order to create meaningful summary patterns that describe types of diet, we had refined the food groups down to 13, as determined by the total percentage of items consumed within a food grouping, per person. The groupings are: group 1: meats, poultry and fish diversity; group 2: dairy products diversity; group 3: bread, cereals and starchy vegetable diversity; group 4: legumes and nut diversity; group 5: fruit diversity; group 6: vegetable diversity; group 7: oil and fat diversity; group 8: drinks diversity; group 9: alcohol diversity; group 10: sauces, spreads and flavouring diversity; group 11: sweets and sweet snacks diversity; group 12: savoury snacks diversity; and group 13: take away food diversity.

Eating habits and meal patterns, food choices and related cultural and social influences were also investigated, but the results are not presented here.

We also included a measure of acculturation using a tool developed by coauthor JK and his colleagues³³ to examine affiliation to traditional or mainstream culture. The tool was used in this project to examine metabolic health outcomes in relation to the participants' affiliation with their Pacific heritage and or mainstream culture. This has been described in detail previously,¹⁹ and the responses were grouped based on a summation of the following categories: *integrated* (high affiliation with Pacific heritage and mainstream culture); *tradition* (high affiliation with Pacific heritage only); *assimilated* (high affiliation with mainstream culture only); and *marginalised* (low affiliation with both Pacific heritage and mainstream culture).

Data analysis

Descriptive data of the parent/grandparent characteristics (ie, sex, ethnicity, education, diagnosed comorbidities, deprivation, body weight anthropometrics and

acculturation mode affiliation) were analysed by distribution proportions.

EFA was used for analysis of the 13 food data groups (described above). With this approach, we originally intended to identify dietary patterns between three generational groups. Due to small numbers in the older generational group, the parents and grandparents were combined to form a single group ('old'), which was compared with the youth responses ('young') obtained from phase 1. Each dietary pattern was allocated weights for each food group, which were used to calculate a standardised mean score for each dietary pattern. EFA analysis was conducted in SAS for Windows V.9.1 (SAS Institute, Cary, NC, USA), and each factor was rotated and compared (promax and varimax) to identify and improve interpretability of each factor loading. Parallel analyses and scree plots were also used to check for data interpretability. Each of the dietary pattern scores was standardised to have a mean of zero and a variance of one. Each participant was assigned a score for each dietary pattern, since a typical person's diet may include characteristics of more than one pattern. Thus, the dietary pattern scores are a constant measure of how closely the participant's diet matches each type of diet. Based on the EFA of all the participants' dietary intake, standardised scores above 0.3 (ie, threshold) for any given food grouping indicated a strong propensity matched to a particular dietary pattern. Thus, we have identified three distinctive dietary pattern groups (from 65 potential dietary groups). Our selection of the three-factor loadings was confirmed by parallel analyses. Negative scores are indicative of participants 'less likely' to consume dietary patterns.

From our univariate logistic regression analyses (data not presented here), we identified potential independent factors that may explain differences in dietary scores between the young and old participants. Therefore, multivariate logistic regression was applied to further examine the association between participant's dietary patterns and those variables. (acculturation status, sex, treatment for comorbidities such as asthma, high blood pressure, heart troubles, diabetes, stroke, thyroid problems, psychological problems and sleep problems).

RESULTS

Demographics of the old and young participant groups

Table 1 highlights the main characteristics of the young and old generation groups that participated in the study. In addition to the 30 young people, a total of 34 parents and grandparents (ie, old group) took part in phase 2 of the study. There were no significant differences between the young and old gender groups. The average age of the parent's group was 50.2 years old and for the grandparent's group 72.2 years old (for both sexes). Education background showed that the more than half (52.9%) of the old group had postschool qualifications; the majority (80%) of the young group had any school qualification. Thus, education status was non-remarkable

Table 1 Distribution of participant characteristics

	Proportion (%) or mean (SD) by young and old						P value†
	Total		Young		Old		
	64 (n)		30 (n)		34 (n)		
Gender							
Male	19	29.7	11	36.7	8	23.5	
Female	45	70.3	19	63.3	26	76.5	0.251
Ethnicity							
NZ European	6	9.4	5	16.7	1	2.9	0.091
Maori	2	3.1	1	3.3	1	2.9	1.000
Samoan	30	46.9	14	46.7	16	47.1	1.000
Cook Island Maori	3	4.7	3	10.0	0	0.0	0.097
Tongan	15	23.4	7	23.3	8	23.5	0.985
Niuean	6	9.4	4	13.3	2	5.9	0.407
Tokelauan	10	15.6	5	16.7	5	14.7	1.000
Tahitian	1	1.6	1	3.3	0	0.0	0.469
Kiribatian	1	1.6	0	0.0	1	2.9	1.000
Fijian	5	7.8	3	10.0	2	5.9	0.659
Chinese	6	9.4	5	16.7	1	2.9	0.091
Education							
Any school qualification	45	70.3	24	80.0	21	61.8	0.111
Postschool qualification	30	46.9	12	40.0	18	52.9	0.301
NZDep2013							
1–2	4	6.4	2	6.7	2	6.1	
3–4	7	11.1	4	13.3	3	9.1	
5–6	5	7.9	1	3.3	4	12.1	
7–8	16	25.4	9	30.0	7	21.2	
9–10	31	49.2	14	46.7	17	51.5	0.673
Missing	1						
Comorbidities							
Asthma	16	25.0	6	20.0	10	29.4	0.386
High blood pressure	19	29.7	0	0.0	19	55.9	<0.0001**
Diabetes	11	17.2	0	0.0	11	32.4	0.0006**
Other conditions	17	26.6	4	13.3	13	38.2	0.024*
Metabolic syndrome conditions	22	34.4	0	0.0	22	64.7	<0.0001**
Acculturation							
Integrated	49	76.6	24	80.0	25	73.5	
Traditional	8	12.5	2	6.7	6	17.7	
Assimilated	4	6.3	3	10.0	1	2.9	
Marginalised	3	4.7	1	3.3	2	5.9	0.462
Anthropometrics							
Age	64	40.6 (22.1)	30	19.5 (2.4)	34	59.3 (12.7)	<0.0001**
Weight (kg)	64	92.9 (20.6)	30	90.5 (18.3)	34	94.9 (22.5)	0.399
Height (cm)	62	166.1 (10.9)	29	170.4 (10.2)	33	162.2 (10.2)	0.002*
BMI (kg/m ²)	62	33.7 (7.5)	29	31.0 (6.9)	33	36.1 (7.2)	0.006*
Waist-to-hip ratio	59	0.9 (0.11)	26	0.84 (0.05)	33	0.94 (0.13)	0.0002**
Waist-to-height ratio	58	0.62 (0.10)	25	0.56 (0.09)	33	0.66 (0.08)	<0.0001**

NZDep2013=quintiles: 1 (lowest deprivation) to 5 (highest deprivation).

*p values <0.05; **p values <0.001.

† χ^2 .

‡Test.

BMI, body mass index.

with no significant differences between the two groups. The participants self-identified across a range of ethnic groupings including different Pacific Island nations, such as Samoa, Tonga and Tokelau representing the dominant Pacific ethnic affiliations. Other ethnic groups included: Māori, Chinese and NZ European. This is an indicator of the growing ‘diversity’ of intermixing between Pacific and other ethnic groups. However, the important thing to note, is that the participants continue to self-identify and affiliate strongly with their Pacific culture and values. The majority of the young (80%) and old (73%) groups assessed their acculturation mode as being ‘integrated’, illustrating that both groups have an *equally* high affiliation with both Pacific and mainstream cultures, although this was not statistically significant. The old group rated their affiliation with living a more ‘traditional’ (17.7%) lifestyle, compared with the young group (6.7%), suggesting young people have less involvement within the Pacific community and other wider activities, at the time of the study. When examining socioeconomic position using the NZ Deprivation (2013) scale, comparing the old and young groups, those living in the ‘least deprived’ (NZDep 1–2) areas, with those living the ‘most deprived’ (NZDep 9–10) areas, there were no differences between each group. For this study, the majority of both young (46.7%) and old (51.5%) participants lived the highest deprived areas of the region.

Regarding the known comorbidities, these were evident primarily in the old group, and in particular, high blood pressure (59.9%) and diabetes (32.4%), with both conditions showing statistically significant differences between the young and old groups. Of note, other conditions (gout, low blood pressure, leg ulcer, arthritis, eczema, allergies) demonstrated significant differences between the old and young. In addition, we combined several conditions (high blood pressure, heart trouble and diabetes) that form part of the metabolic syndrome.^{34–36} This condition indicated a significant statistical difference.

Means and SD for the anthropometric measures comparing both groups illustrated that, on average, the old group were heavier (94.9 kg), compared with the young (90.5 kg) group. Across both groups, the average BMI was 33.7 kg/m² (7.5 kg), and the old group showed a higher BMI (36.6 kg/m²) compared with the young (31.0 kg/m²). Nonetheless, the average BMI data indicated that the study participants were significantly obese. Moreover, central fatness as measured by the WHR and WtHR ratios, the old group showed a very high WHR ratio (mean: 0.94; 0.13), and for the young group, the average WHR ratio was 0.84 (0.05). According to the WHO, this is indicative of a higher than normal risk of developing heart disease and other serious conditions.³⁷ Both young and old groups attained an overall average (WtHR) of 0.62 (0.10), as a measure of body fat distribution,³⁸ and the scores are indicative of being at high risk of developing disease morbidities such as heart attack and stroke²³ but not of any new disease diagnoses, like diabetes.³⁹

Using EFA, standardised scores above 0.3 for any given food grouping were matched to a particular dietary pattern, and we identified three-factor loaded patterns (table 2). The patterns provided a reasonable summary of dietary patterns with the scree plot elbow being at approximately 3 and the three factors cumulatively explaining 28% of the variance in dietary intake data, resulting in interpretable dietary patterns. The following are suitable descriptions of the three dietary patterns: (1) dietary pattern 1: ‘healthy food’: characterised by moderate-to-high intake of proteins/meats, fruits and vegetables; (2) dietary pattern 2: ‘processed food’: characterised by high intake of sweets, snacks, takeaways and sugary beverages; and (3) dietary pattern 3: ‘mixed food’: characterised by limited healthy and more processed food group intake. Of particular note, the high intake (ie, ≥70% per food item checked) of sugary beverages (eg, soft drinks, juice and tea), alcohol (eg, beer, wine and kava) and dairy

Table 2 Food grouping factor loadings for all participants by dietary pattern

Food items	Healthy diet	Processed diet	Mixed diet
Group 1: meat, poultry, fish diversity	0.63	0.17	0.39
Group 2: dairy products diversity	0.38	0.19	0.68
Group 3: bread, cereals and starchy vegetable diversity	0.74	0.36	0.21
Group 4: legume and nut diversity	0.59	0.09	0.27
Group 5: fruit diversity	0.92	0.16	0.16
Group 6: vegetable diversity	0.76	0.14	0.32
Group 7: oil and fat diversity	0.38	0.28	0.47
Group 8: drinks diversity	0.30	0.44	0.57
Group 9: alcohol diversity	0.19	0.07	0.46
Group 10: sauces, spreads and flavouring diversity	0.61	0.41	0.48
Group 11: sweets and sweet snacks diversity	0.16	0.63	0.56
Group 12: savoury snacks diversity	0.22	0.97	0.05
Group 13: take away food diversity	0.18	0.64	0.42

Table 3 Comparing young versus old dietary patterns (7-day measure)

Food groups	Young Phase 1, n=30		Old Phase 2, n=34		P value*
	Mean (%)	SD	Mean (%)	SD	
Group 1: Meat, poultry, fish diversity	38.27	15.63	52.72	21.36	0.003
Group 2: Dairy products diversity	33.70	14.29	31.04	20.15	0.550
Group 3: Bread, cereals starchy vegetable diversity	40.42	17.31	49.17	17.00	0.046
Group 4: Legume and nut diversity	28.14	19.29	34.96	23.39	0.212
Group 5: Fruit diversity	31.11	21.75	48.04	25.40	0.006
Group 6: Vegetable diversity	38.65	17.72	53.26	23.45	0.007
Group 7: Oil and fat diversity	43.70	17.00	49.01	20.85	0.272
Group 8: Drinks diversity	46.22	19.57	41.17	19.86	0.311
Group 9: Alcohol diversity	7.92	16.57	8.09	14.06	0.964
Group 10: Sauces, spreads and flavouring diversity	39.84	15.18	44.65	20.22	0.292
Group 11: Sweets and sweet snacks diversity	50.83	22.88	48.04	28.21	0.668
Group 12: Savoury snacks diversity	41.67	20.86	40.59	29.02	0.864
Group 13: Take away food diversity	44.05	20.47	38.44	25.66	0.342
Dietary patterns, by mean scores (%)					
Healthy dietary pattern	36.07	14.93	47.13	17.90	0.010
Processed dietary pattern	45.51	19.16	42.36	24.38	0.570
Mixed dietary pattern	32.88	13.28	32.33	14.72	0.875
Dietary patterns, by standardised scores					
Healthy dietary pattern	-0.26	0.90	0.23	1.04	0.052
Processed dietary pattern	-0.04	0.93	0.03	1.07	0.789
Mixed dietary pattern	-0.09	0.94	0.08	1.06	0.496

*Based on means score and two-sample t-test.

food (eg, ice cream, cheese and dairy food) consumption marks this dietary pattern as being remarkably different from the other two patterns.

Table 3 compares the dietary patterns of the young and old generation using the mean scores and two-sample t tests (p value). It showed there were statistically significant dietary differences between these two groups, predominantly in food groupings 1, 3, 5 and 6. The types of food items young people consumed in very high proportions (ie, >80% consumption) over a 7-day period were: group 1 (meat, poultry and fish diversity): beef (87%), chicken (87%) and eggs (83%); group 3 (bread, cereals and starchy vegetable diversity): white/brown bread (100%), rice (90%) and potatoes (80%); group 5 (fruit diversity): banana (100%); and group 6 (vegetable diversity): onions (93%), carrots (96.7%), lettuce (83%), garlic (80%), broccoli (80%) and tomatoes (80%).

The old generation demonstrated somewhat more variety in the items they consumed (on average) per food grouping. These were: group 1 (meat, poultry and fish diversity): chicken whole/thighs/drumstick (94%), eggs (94%), fresh white fish (eg, hoki and snapper) (91%) and chicken wings (82%); group 3 (bread, cereals and starchy vegetable diversity): white/brown bread (100%), rice

(88%) and taro (88%); group 5 (fruit diversity): banana (100%), apple (88%) and orange (85%); and group 6 (vegetable diversity): onions (94%), lettuce (85%), garlic (85%), cabbage (82%) and cauliflower (80%), as indicated by listing the individual food items.

There were also differences between the two old generations (ie, parent vs grandparent) (data not shown) by: group 9 (alcohol diversity): examples of items consumed included wine and kava. The median score for parents was 0.65 and for grandparents was 0.28 (p value=0.004); and group 11 (sweets and sweet snacks diversity): examples of items consumed included plain biscuits, cakes and chocolates. The median score was 0.65 for parents and 0.28 for grandparents (p value=0.033). This indicates that the parent generation consumes statistically significantly more alcohol and high sugar snacks than the grandparents.

Additionally, based on 'percentage dietary patterns scores', there was a significant difference (p value=0.010) between the young and old groups for the 'healthy dietary pattern', with the older group showing a higher percentage intake of this dietary pattern. Based on the 'standardised dietary pattern scores', comparing the young and old groups, there was a trend for significance (p value=0.052). The

Table 4 Multivariate analyses examining dietary factor patterns and demographic characteristics

Variable (number)	Factor 1: healthy diet			Factor 2: processed diet			Factor 3: mixed diet		
	RCE	95% CI	P value	RCE	95% CI	P value	RCE	95% CI	P value
Phase									
Old (30)			Ref			Ref			Ref
Young (34)	0.05	-0.81 to 0.92	0.904	0.09	-0.86 to 1.04	0.850	0.12	-0.70 to 0.95	0.762
Gender									
Male (19)			Ref			Ref			Ref
Female (45)	-0.02	-0.58 to 0.54	0.941	-0.14	-0.64 to 0.36	0.575	-0.19	-0.74 to 0.37	0.504
Acculturation									
Integrated (49)			Ref			Ref			Ref
Traditional (8)	-0.65	-1.15 to 0.15	0.013*	-0.36	-0.86 to 0.14	0.155	-0.62	-1.14 to 0.09	0.021*
Assimilated (4)	-0.88	-1.47 to 0.29	0.004	-1.06	-1.57 to 0.55	0.0001**	-1.03	-1.59 to 0.47	0.0006**
Marginalised (3)	-1.30	-2.27 to 0.33	0.010*	-1.23	-2.17 to 0.29	0.011*	-1.31	-2.13 to 0.49	0.002*
NZDep13 (quintiles)									
1-2 (4)			Ref			Ref			Ref
3-4 (7)	0.39	0.08 to 0.69	0.013*	0.45	0.25 to 0.65	<0.0001**	0.48	0.17 to 0.79	0.003*
5-6 (5)	0.96	0.14 to 1.78	0.022*	0.94	0.28 to 1.60	0.006**	0.82	-0.06 to 1.69	0.067
7-8 (16)	1.26	0.81 to 1.71	<0.0001**	1.10	0.66 to 1.54	<0.0001**	1.08	0.67 to 1.47	<0.0001**
9-10 (31)	1.00	0.65 to 1.32	<0.0001**	0.97	0.66 to 1.28	<0.0001**	0.90	0.57 to 1.23	<0.0001**
BMI (n) (SD)									
62	0.015	0.01	0.226	0.013	0.01	0.302	0.01	0.01	0.140
Age									
64	0.012	0.01	0.240	-0.00	0.01	0.952	0.00	0.00	0.797

P value= χ^2 test.

*p<0.05; **p<0.001.

BMI, body mass index; RCE, regression coefficient estimate; P value=chisquare test.

scores indicated that the young group were less likely to consume a healthy dietary pattern than the old group.

We carried out univariate analyses (data not presented here) and identified certain characteristics that contributed to the difference in dietary pattern scores. Therefore, table 4 illustrates a multivariate regression model using standardised regression coefficients to measure the strength of independent relationships of (known relationships and statistically significant) variables identified from earlier analyses. The key independent variables shown to have a positive influence on the dietary patterns were predominantly *acculturation*, particularly 'assimilation' and 'marginalised' modes, and high *socioeconomic deprivation*, particularly quintiles 7-8 and 9-10. After controlling for other variables, trending for significance for BMI had dissolved, and age indicated no relationship for processed and mixed dietary patterns.

DISCUSSION

In a sample of 30 Pasifika youths and 34 older Pasifika adults (parents and grandparents), we identified three distinctive dietary pattern groups: healthy diet, processed diet and mixed diet. In relation to these dietary patterns, there were three major findings. First, although the mixed

dietary pattern contained 8 of the total 13 food groups, it had the highest average consumption of dairy products, sweetened beverages and alcohol intake, potentially making it the unhealthiest of the three dietary patterns. Although the questionnaire did not measure the 'actual' amounts, frequency or average volume of drinks per week of the sweetened and alcohol beverages, it has been well established that alcohol is the second most energy dense macronutrient⁴⁰ and favours fat storage resulting in weight gain.³⁷ Similarly, sugar-sweetened beverages and fast food were more available within the home environment. A recent study reported 58% of Pacific children consume high amounts of fizzy drinks compared with non-Pacific children (15%). Moreover, Pacific youth consumed high (29%) and moderate (45%) amounts (ie, 1-3 times a week) of soft drinks in the past week compared with 25% of children who were considered to be low consumers.⁴¹ Data from the NZ Youth Survey 2012 revealed that in the previous 7 days⁴² youth residing in the highest deprivation decile were almost four times more likely to consume four or more energy drinks, three times more likely to eat fast food at least four times a week and five times more likely to eat other take-aways at least four times. This is compounded by social marketing targeting the younger generation as their main

customers due to their spending power, purchasing influence, as emergent behaviours of adult customers.⁴³ With the advent of online advertising and shopping and mobile media, public health policy and researchers are lagging well behind in being aware of and understanding the potential impact of the latest and continuously developing advertising techniques used on children and youth. More work and comprehensive monitoring are needed in this space.⁴⁴

Second, there were major significant differences reported from [table 3](#) between the young and old in relation to the four food groups: (1: meat, poultry and fish; 2: breads, cereal and starchy vegetables; 3: fruit diversity; and 4: vegetable diversity). More specifically, the old generation ate a greater range of items from each food group than the young generation. Furthermore, dietary patterns between the two groups also differed. The mean food scores for the old group being primarily characterised by the 'Healthy diet', in contrast with the younger generation who were more likely to consume a 'Processed diet'. Multiple factors may influence eating behaviours and food choices between young and old. For instance, the idea that eating family meals promotes togetherness and is positively associated with overall well-being within the home food environment is an important factor. However, a NZ-based research study reported no significant relationship between the frequency of family meals and the availability of high sugar/high fat snack foods and fast food. In fact, adolescents who regularly ate with their family were just as likely to consume less healthy snack food. Parental education and family work schedules were regarded as potential explanatory factors for the lack of association.¹⁰ For our study, all of our youth lived at home with their parents, and although we did not specifically collect data on the home food environment, we have previously reported data on this study groups' purchasing behaviour. That is, the youth purchased savoury and sweet snack food from specific shops in their local neighbourhoods spending up to \$24 over a 7-day period.¹⁹ It is likely that this behaviour is contributing to the difference in dietary diversity between the two generational groups. Food purchasing and eating behaviours outside of the home environment is a tremendously influential force, particularly in regards to the obesogenic environment.⁴⁵ More understanding around the impact of health education and health promotion messages targeting healthy eating is needed to make mindful decisions and subsequent behavioural changes to support vulnerable communities for the sake of healthier living. However, by comparing standardised food scores, the difference between young and old (particularly for the healthy dietary pattern) trended towards significance (p value=0.052), and it is likely that other factors may explain the difference rather than just the food types consumed between the two generation groups.

Finally, from our multivariate regression analyses, we found that *acculturation* (categorised affiliation with Pasifika and mainstream cultures) and *socioeconomic position* (NZ Deprivation) played a significant role in

influencing dietary patterns. For acculturation, those who described themselves as being 'assimilated' (ie, a high degree of affiliation with NZ's mainstream culture) and 'marginalised' (ie, a low affiliation with both Pacific heritage and mainstream culture) were significantly less likely to exhibit characteristics of these dietary pattern groups, based on their high negative coefficients. Although they were significant negative relationships for 'traditional', 'assimilation' and 'marginalised' modes across all dietary patterns, it was more marked (high negative coefficients) for those who affiliated with the 'marginalised' mode for healthy diet (regression coefficient estimate [RCE]: -1.30), processed diet (RCE: -1.23) and mixed diet (RCE:-1.31), compared with those identified as being 'integrated' with both Pacific heritage and mainstream culture. Similarly, those who aligned with the 'assimilation' mode also indicated significantly high negative relationships with processed diet (RCE: -1.06) and mixed diet (RCE: -1.03). However, this finding needs to be interpreted with caution (ie, the wide CIs) because of the small number of participants for this specific analyses. Nonetheless, this finding suggests that the 'assimilated' and 'marginalised' groups have different behaviours that may be protective for their overall health (eg, they may do more physical activity and eat more healthily), compared with the majority of this sample (who were 'integrated'). There are studies that suggest greater acculturation increases the risk of obesity among indigenous groups.⁴⁶⁻⁴⁸ Some studies suggest that the obesogenic environments of host countries promote weight gain among migrants that significantly increase over 10-15 years postmigration, by which time migrants' obesity rates match or become greater than that of the host population.⁴⁹ The impact of the relationship between acculturation and obesity continues to remain unclear, however, there is a need for validated and comprehensive acculturation scales to be used between studies to enable comparability of results.^{33 50}

Socioeconomic deprivation as measured using the NZ Deprivation scale also highlighted strong positive relationship with the three dietary patterns. In particular, those people residing in the high-to-highest deprived areas (quintiles 7-8 and 9-10) had strong positive relationships, compared with those living in the least deprived areas (quintile 1-2), where the coefficients were closer to 0. This finding is not new but provides added support to the knowledge-base that high deprivation plays an important role in financial and economic barriers to have access to good quality food (particularly for processed and mixed dietary patterns).⁵¹ However, for those living in the high-to-highest deprived areas, showing a positively strong relationship (quintile 7-8 RCE: 1.26 and quintile 9-10 RCE: 1.00) to a 'healthy diet' maybe reflective of some people instigating the efforts to improve behaviours and preparing and eating food at home, rather than purchasing meals and snacks prepared away from the home, that are higher in fat and saturated fat and contain less nutritional value.⁵¹

Study limitations

A major limitation of the study is the sample size that restricts our ability to make any definitive inferences of the observed dietary patterns described above. As this is a feasibility study, these patterns reflect the behaviours of the study participants and cannot be generalised to Pasifika youth and adults in general. In addition, the Pacific-focused dietary diversity questionnaire was developed, including both nutritious and discretionary foods and food groups to capture diversity (food groups) and variety (food items) and does not measure quantity and so we cannot be definitive about the defined dietary patterns, which is also reflective of the study participants. The EFA analyses allowed us to examine the highest and lowest variety of food groups that were consumed, and this provided important insight in identifying which dietary components needs to be addressed, and it could guide intervention strategies to improve diet quality to improve health outcomes. Furthermore, we are cognizant that the data collected from the limited sampling frame of food group diversity over a 7-day period may not be completely representative of all food items and food groups that may have been consumed by the different age generations. Finally, although the study highlighted behavioural patterns of diet, the study also showed 'no relationship' between the dietary patterns and obesity-related parameters (BMI, WHR and WtHR) and poor health, and this may be due to limited sample size, as other studies have shown clear associative links.

CONCLUSION

Our investigation of the food consumed by young and old Pacific people allowed us to identify three distinctive dietary patterns based on the high food scores. There was an intergenerational difference in dietary patterns, with the younger generation tending to consume a more limited diet, compared with the old group. The older generation consumed more diversity in their food groups and a healthier dietary pattern. These patterns may be related to the social cultural aspects of obesity in relation to dietary habits, such as the young generation who are opting to eat more high fat, high sugar snacks outside of the home food environment. There was a strong negative relationship between the level of acculturation and dietary patterns, and a strong positive relationship of dietary patterns among those living in the high-to-highest deprivation areas. Our findings provide added social cultural insights that could guide improved health promotion strategies to increase health outcomes of young and older Pacific family members. In particular, improvements in highlighting more healthy food group options, encourage food diversity within the home and social environments and enhance access to health education about food items for the whole family.

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Contributors RTT-F designed the study and drafted the manuscript. JK, BB and LE-L help informed the study design and JK assisted in interpretation of the acculturation tool. SC analysed the data. All authors read and approved the final manuscript.

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REFERENCES

- Coppell KJ, Mann JI, Williams SM, *et al.* Prevalence of diagnosed and undiagnosed diabetes and prediabetes in New Zealand: findings from the 2008/09 Adult Nutrition Survey. *N Z Med J* 2013;126:23–42.
- Foliaki S, Pearce N. Prevalence and causes of diabetes in Pacific people. *Pac Health Dialog* 2003;10:90–8.
- The role of advertising and promotion in the marketing of tobacco products. *Preventing tobacco use among young people: a report of the surgeon general*. Washington, DC: US Government Printing Office, 1994.
- Sundborn G, Metcalf PA, Gentles D, *et al.* Overweight and obesity prevalence among adult Pacific peoples and Europeans in the Diabetes Heart and Health Study (DHAHS) 2002–2003, Auckland New Zealand. *N Z Med J* 2010;123:30–42.
- Ministry of Health. Annual Update of Key Results 2014/15: New Zealand Health Survey Wellington: Ministry of Health. 2015 <http://www.health.govt.nz/publication/annual-update-key-results-2014-15-new-zealand-health-survey>
- Swinburn B, Sacks G, Vandevijvere S, *et al.* INFORMAS (International Network for Food and Obesity/non-communicable diseases Research, Monitoring and Action Support): overview and key principles. *Obes Rev* 2013;14:1–12.
- Hill JO. Understanding and addressing the epidemic of obesity: an energy balance perspective. *Endocr Rev* 2006;27:750–61.
- New Zealand Medical Association. *Policy briefing tackling obesity, NZMA calls for action on obesity*. Wellington: NZ Medical Association, 2014.
- Utter J, Scragg R, Schaaf D, *et al.* Nutrition and physical activity behaviours among Māori, Pacific and NZ European children: identifying opportunities for population-based interventions. *Aust N Z J Public Health* 2006;30:50–6.
- Utter J, Scragg R, Schaaf D, *et al.* Relationships between frequency of family meals, BMI and nutritional aspects of the home food environment among New Zealand adolescents. *Int J Behav Nutr Phys Act* 2008;5:50.
- Ministry of Health. Physical Activity Statement Wellington: Ministry of Health. 2010 <http://www.health.govt.nz/our-work/preventative-health-wellness/physical-activity>.
- Ministry of Health. *A focus on Pacific nutrition: findings from the 2008/2009 New Zealand Adult Nutrition Survey*. Wellington: Ministry of Health, 2012.
- Clark T, Fleming T, Bullen P, *et al.* Health and well-being of secondary school students in New Zealand: trends between 2001, 2007 and 2012. *J Paediatr Child Health* 2013;49:925–34.
- Utter J, Denny S, Grant S, *et al.* *Eating together at mealtimes: the role of family meals in the health and wellbeing of young people in new zealand*. Wellington: Families Commission, 2011.

15. Fulkerson JA, Kubik MY, Story M, *et al.* Are there nutritional and other benefits associated with family meals among at-risk youth? *J Adolesc Health* 2009;45:389–95.
16. Clark TC, Fleming T, Bullen P, *et al.* *Youth'12 Overview: The health and wellbeing of New Zealand secondary school students in 2012.* Auckland: The University of Auckland, 2013.
17. Denny S, Lewycka S, Utter J, *et al.* The association between socioeconomic deprivation and secondary school students' health: findings from a latent class analysis of a national adolescent health survey. *Int J Equity Health* 2016;15:109.
18. Fotu KF, Millar L, Mavoia H, *et al.* Outcome results for the Ma'alaha Youth Project, a Tongan community-based obesity prevention programme for adolescents. *Obes Rev* 2011;12(Suppl 2):41–50.
19. Tupai-Firestone R, Tuisano H, Manukia M, *et al.* Understanding Pasifika youth and the obesogenic environment, Auckland and Wellington, New Zealand. *N Z Med J* 2016;129:23–35.
20. World Health Organisation. Obesity and overweight. 2012 <http://www.who.int/mediacentre/factsheets/fs311/en/index.html>
21. Cole TJ, Bellizzi MC, Flegal KM, *et al.* Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 2000;320:1240–3.
22. de Koning L, Merchant AT, Pogue J, *et al.* Waist circumference and waist-to-hip ratio as predictors of cardiovascular events: meta-regression analysis of prospective studies. *Eur Heart J* 2007;28:850–6.
23. Ashwell M, Gunn P, Gibson S. Waist-to-height ratio is a better screening tool than waist circumference and BMI for adult cardiometabolic risk factors: systematic review and meta-analysis. *Obes Rev* 2012;13:275–86.
24. World Health Organisation. *Waist circumference and waist-hip ratio: report of a WHO expert consultation.* Geneva: WHO, 2011:8–11.
25. Atkinson J, Salmond C, Crampton P. *NZDep2013 index of deprivation.* Wellington: University of Otago, 2014.
26. Statistics New Zealand. *Census 2013 Wellington: Statistics New Zealand.* 2013 <http://www.stats.govt.nz/Census/2013-census/profile-and-summary-reports/quickstats-culture-identity/pacific-peoples.aspx>.
27. Arimond M, Ruel MT. Dietary diversity is associated with child nutritional status: evidence from 11 demographic and health surveys. *J Nutr* 2004;134:2579–85.
28. Hatloy A, Torheim LE, Oshaug A. Food variety--a good indicator of nutritional adequacy of the diet? A case study from an urban area in Mali, West Africa. *Eur J Clin Nutr* 1998;52:891–8.
29. Oldewage-Theron W, Kruger R. Dietary diversity and adequacy of women caregivers in a peri-urban informal settlement in South Africa. *Nutrition* 2011;27:420–7.
30. Oldewage-Theron WH, Kruger R. Food variety and dietary diversity as indicators of the dietary adequacy and health status of an elderly population in Sharpeville, South Africa. *J Nutr Elder* 2008;27:101–33.
31. Oldewage Theron WH, Kruger R. Impact of food aid on food variety and dietary diversity of an elderly community in Sharpeville, South Africa. *J Nutr Health Aging* 2009;13:300–8.
32. Steyn NP, Nel JH, Nantel G, *et al.* Food variety and dietary diversity scores in children: are they good indicators of dietary adequacy? *Public Health Nutr* 2006;9:644–50.
33. Kaholokula JK, Nacapoy AH, Grandinetti A, *et al.* Association between acculturation modes and type 2 diabetes among Native Hawaiians. *Diabetes Care* 2008;31:698–700.
34. Brewer N, Wright CS, Travier N, *et al.* A New Zealand linkage study examining the associations between A1C concentration and mortality. *Diabetes Care* 2008;31:1144–9.
35. Green JG, Johnson NA, Sachinwalla T, *et al.* Low-carbohydrate diet does not affect intramyocellular lipid concentration or insulin sensitivity in lean, physically fit men when protein intake is elevated. *Metabolism* 2010;59:1633–41.
36. Green JG, Johnson NA, Sachinwalla T, *et al.* Moderate-intensity endurance exercise prevents short-term starvation-induced intramyocellular lipid accumulation but not insulin resistance. *Metabolism* 2011;60:1051–7.
37. Zurlo F, Lillioja S, Esposito-Del Puente A, *et al.* Low ratio of fat to carbohydrate oxidation as predictor of weight gain: study of 24-h RQ. *Am J Physiol* 1990;259(5 Pt 1):E650–7.
38. Lee CM, Huxley RR, Wildman RP, *et al.* Indices of abdominal obesity are better discriminators of cardiovascular risk factors than BMI: a meta-analysis. *J Clin Epidemiol* 2008;61:646–53.
39. Kuo RJ, Wu YH, Chen LK. Inability of waist-to-height ratio to predict new onset diabetes mellitus among older adults in Taiwan: a five-year observational cohort study. *Arch Gerontol Geriatr* 2011;53:e1–4.
40. Prentice AM. Alcohol and obesity. *Int J Obes Relat Metab Disord* 1995;19(Suppl 5):S44–50.
41. Sundborn G, Utter J, Teevale T, *et al.* Carbonated beverages consumption among New Zealand youth and associations with BMI and waist circumference. *Pac Health Dialog* 2014;20:81–6.
42. Group AHR. *The Health and Wellbeing of New Zealand Secondary School Students in 2012: Youth'12 Prevalence Tables.* Auckland: University of Auckland, 2013.
43. Story M, French S. Food advertising and marketing directed at children and adolescents in the US. *Int J Behav Nutr Phys Act* 2004;1:3.
44. Rideout R. *Advertising to children and teens: current practices.* San Francisco: Common Sense Media Research Brief, 2014.
45. Rush E, Reed P, McLennan S, *et al.* A school-based obesity control programme: Project Energize. Two-year outcomes. *Br J Nutr* 2012;107:581–7.
46. Garcia L, Gold EB, Wang L, *et al.* The relation of acculturation to overweight, obesity, pre-diabetes and diabetes among U.S. Mexican-American women and men. *Ethn Dis* 2012;22:58–64.
47. Franzini L, Ribble JC, Keddie AM. Understanding the Hispanic paradox. *Ethn Dis* 2001;11:496–518.
48. Smith NR, Kelly YJ, Nazroo JY. The effects of acculturation on obesity rates in ethnic minorities in England: evidence from the Health Survey for England. *Eur J Public Health* 2012;22:508–13.
49. Delavari M, Sønderlund AL, Swinburn B, *et al.* Acculturation and obesity among migrant populations in high income countries--a systematic review. *BMC Public Health* 2013;13:458–69.
50. Kaholokula JK, Grandinetti A, Keller S, *et al.* Association between perceived racism and physiological stress indices in Native Hawaiians. *J Behav Med* 2012;35:27–37.
51. Utter J, Denny S, Robinson E, *et al.* Food security concerns among young people: impact on eating behaviors and weight status. *J Hunger Environ Nutr* 2012;7:101–11.