Appendix 1

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INSIGHT

Validation of the General Nutrition Knowledge Questionnaire in an Australian community sample

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Abstract

Aim: To validate the General Nutrition Knowledge Questionnaire developed by Parmenter and Wardle (1999) in an Australian community sample. This questionnaire differs from previous assessments of knowledge because it incorporates a broad range of nutrition concepts, including knowledge of dietary recommendations, healthy food choices, nutrient sources and some diet–disease relationships.

Methods: The original questionnaire was developed in the UK, and thus modified to suit the current *Dietary Guidelines for Australians* and current public health nutrition recommendations. A total of 156 people, of which 116 were community members, completed the questionnaire (113 items). As an indication of concurrent validity, a subsample of nutrition and dietetic students were included (n = 40). As a measure of test–retest reliability, a subsample (n = 57), including students and community members, answered the questionnaire on two occasions, two weeks apart.

Results: Both overall internal reliability of the questionnaire items (Cronbach's alpha = 0.92) and test–retest reliability (r = 0.87) were high. The nutrition and dietetic students, hypothesised to have higher knowledge levels, scored consistently higher than the general community sample, indicating good concurrent validity.

Conclusion: A test of a modified version of the General Nutrition Knowledge Questionnaire found it to be a valid and reliable measure of nutrition knowledge, appropriate for use in a section of the Australian community. The validated tool may be used in the future for the comprehensive assessment of general nutrition knowledge; however, further testing in differing sections of Australian society may be warranted.

Key words: Australia, nutrition knowledge, questionnaire, validation.

INTRODUCTION

Knowledge is one of the several factors required to change behaviour, although the influence of nutrition knowledge on food-related behaviours has not received consistent support from scientific literature.[1] Some research studies have found significant associations, of varying strengths, between higher nutrition knowledge and 'healthier' food intake.[2–4] However, weaker results have prompted doubt regarding the relevance of knowledge in this behavioural domain.[2] This relationship, however, may have been prematurely rejected as a result of methodological issues rather than theoretical weakness.

There are two main issues in the measurement of nutrition knowledge. First, the conceptualisation of nutrition knowledge is often considered to be one-dimensional; however, nutrition knowledge is a multifactorial construct and more complex to define. For example, many past questionnaires have chosen to focus only on specific areas of knowledge such as that related to dietary fat or fibre.[5,6] Second, the accuracy of tools used to measure knowledge is questionable when they are seldom assessed for reliability and validity.

Parmenter and Wardle (1999) attempted to overcome some of these measurement issues by focusing on the validation process in the development of their questionnaire to measure general nutrition knowledge.[7] Their questionnaire—referred to as the General Nutrition Knowledge Questionnaire (GNKQ)—was developed from a large pool of items covering a range of different nutrition concepts, including understanding nutrition-related terminology, awareness of current dietary recommendations, knowledge of food sources related to nutrients, the use of dietary information to make dietary choices and the awareness of diet–disease relationships. The questionnaire successfully demonstrated concurrent validity and test–retest reliability above the acceptable level.[7]

While the GNKQ proved to be a comprehensive and valid assessment of general nutrition knowledge in the UK

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sample, validity cannot be assumed in a sample outside of the original study sample. The questionnaire was originally validated in a sample of UK students who tend to be more educated, within a certain age bracket and also do not represent the average population of the UK; therefore, validity would need to be determined again for the general population. Validity would also need to be determined to access the appropriateness of the tool for use in other mixed demographic community samples. In addition, there are a number of items related specifically to UK nutrition recommendations and common food choices, which may or may not be as common in other settings. Therefore, estimates of validity and reliability in one sample may not always be accurate for another.

The purpose of the present paper was to measure the suitability of a modified 'Australian' version of the GNKQ—adapted from the original by Parmenter and Wardle (1999)—as a tool to measure general nutrition knowledge in an Australian community sample. The objectives of this work were to determine the accuracy (validity) and feasibility (reliability) of using the modified GNKQ questionnaire in an Australian sample.

METHODS

Study sample

The sample consisted of community members, aged 18 years and over, who volunteered to participate in the study. Participants were attending established social or non-health-related extra curricular groups at three community facilities within the Adelaide metropolitan area (n = 96). Other community members attending a Public Hospital Community Open Day (n = 20), held in February 2006, also volunteered to complete the questionnaire. To compare how the questionnaire performed in nutrition-educated and non-nutrition-educated sample groups, an additional sample of third year nutrition and dietetics students (n = 40) were recruited from a local university.

Ethical approval

The present study was granted ethical approval by the Social and Behavioural Research Ethics Committee at Flinders University, South Australia and all participants gave informed consent.

Questionnaire refinement

A number of minor adjustments were made to the original version of the questionnaire prior to administrating it to the study sample. An additional three items were added to the original General Nutrition Knowledge Questionnaire,[7] to ensure that it was compatible with the *Food for Health Booklet*[8] (containing the *Dietary Guidelines for Australian Adults* and *The Australian Guide to Healthy Eating*, and henceforth called the *Dietary Guidelines for Australians*) and other key public health nutrition messages. To acknowledge that the Australian guidelines include a recommendation about dairy products, 'dairy products' as a food group was added to the section about knowledge of the recommendations in the *Dietary Guidelines for Australians*. Second, the original questionnaire contains one item referring to the recommended intake for fruits and vegetables. Given that the current Australian fruit and vegetable campaign—'Go for 2 and 5'[9]—separates out the guideline to be two serves of fruit and five serves of vegetables, this question was adjusted to be two separate items. Last, following an expert panel appraisal with seven registered dietitians of the "face" validity of the questionnaire items, that is, the questions relevant to the specific situation or context in which they were to be administered, one item, the common misperception of mushrooms as an appropriate substitute for red meat, was thought to be a worthy addition to the appropriate section.

The other modifications included substituting common UK food names or food items, not commonly used or consumed in Australia, with more familiar terminology for the general public. Examples include replacing the terms 'calories' with 'kilojoules', 'orange squash' with '35% orange juice', and 'luncheon meat' with 'lunch/sandwich meat'. The resulting self-administered questionnaire was 113 items, covering four areas of nutrition knowledge: knowledge of dietary recommendations (13 items), sources of nutrients (70 items), choosing everyday foods (10 items) and the diet–disease relationships (20 items).

The respondents answered on a range of different scales, such as 'more, same, less, don't know', 'yes, no, not sure', 'high, low, not sure', 'agree, disagree, not sure' or a choice of four different food options. The two items about recommended fruit and vegetable intake and the eight items about diet–disease relationships required written responses.

Data collection and analysis

The questionnaire was self-administered in small groups, and supervised by the first author. The raw data from each participant's responses were coded numerically and converted to a corrected score, as defined by Parmenter and Wardle.[7] Data were entered and analysed, by the first author, using SPSS 11.0 (SPSS Inc., Chicago, IL, USA).

A number of statistical tests were performed to assess reliability and validity of the questionnaire.

Internal reliability

Internal reliability refers to the extent to which the questionnaire is consistent within itself. That is, how consistently the questions within each section measure the knowledge constructs and overall nutrition knowledge. The Cronbach's alpha statistic indicates the consistency of responses to all items in the questionnaire.[10] Cronbach's alpha values range from 0 to 1, and a score of 0.7 or above is generally acceptable.[11]

Test–retest reliability

Test–retest reliability refers to a common method to determine reliability of a questionnaire that is to repeat the identical test on two separate occasions. The reliability coefficient is the correlation between the scores obtained by the same persons on the two administrations of the test.[10] In the present study, a subsample, including both students and community members, completed the questionnaire, on two occasions two weeks apart. These scores were compared and the Pearson's correlation coefficient (r) was used as an indicator of consistency. The correlation coefficients range from 0 to 1, and a high score indicates a more reliable scale.

Effects of nutrition education on questionnaire validity (concurrent validity)

Concurrent validity refers to whether a scale which purports to measure nutrition knowledge actually does measure nutrition knowledge. If the GNKQ is an accurate measure of nutrition knowledge, then people with a known higher level of nutrition education should score better on the questionnaire than those without previous nutrition education. *T*-tests were used to assess whether the group of third year university students studying nutrition had a significantly higher level of knowledge than those without education experience (significance level $P < 0.01$).

Comparisons between UK and Australian samples

Finally comparisons were made between the reliability and validity results of the original questionnaire, validated in the UK, and the results of the present study, using an Australian community sample.

RESULTS

Sample and distribution of scored data

Of the 156 people who participated, 90% were female, and their ages ranged from 18 to 74 years. Half the sample had tertiary qualifications, 13.5% had technical or trade qualifications and the others had completed high school or less (Table 1).

Scores ranged from 21 to 100 (out of a maximum 113) in the non-nutrition-educated community group and 41 to 100 in the nutrition-educated student group (hence there was no ceiling effect of the scale). The scores for knowledge of diet–disease relationships tended to be lower than those for the other sections. A histogram of knowledge scores would show a slight shift to the right (higher scores), as generally few people have 'zero' or no understanding about food and nutrition. The maximum scores for the groups were similar, but the minimum scores tended to be higher in the nutrition-educated sample compared with the community sample (Table 2).

Table 1 Demographic characteristics of the study population

Characteristics	*Total sample (n = 156)* *n (%)*
Previous nutrition education	
Non-nutrition education	116 (74.4)
Nutrition educated	40 (25.6)
Gender	
Female	141 (90.4)
Male	15 (9.6)
Age (years)	
18–24	36 (23.1)
25–34	38 (24.4)
35–44	31 (19.9)
45–54	19 (12.2)
55–64	22 (14.1)
65–74	10 (6.4)
Martial status	
Single	44 (28.2)
Married/living as married	101 (64.7)
Other	11 (7.0)
Culture	
Australian	114 (73.0)
British/English	8 (5.1)
Scottish/Welsh	
Chinese	13 (8.3)
Australian and British	11 (7.1)
Other	10 (6.2)
Education level	
Some high school or less	15 (9.6)
Completed high school	42 (26.9)
Tech or trade qualification	21 (13.5)
Tertiary degree	78 (50.0)
Primary employment status	
Employed full time	27 (17.3)
Employed part time	42 (26.9)
Student	39 (25.0)
Home maker	29 (18.6)
Other	19 (12.2)

Concurrent validity

The nutrition-educated group scored consistently higher than the community members on all sections of knowledge (Table 2). The mean of the nutrition-educated group, 84.72 (SD = 13.11) was 12 points higher than that of the community members, 72.42 (SD = 13.51). The differences between the two groups were significantly different across all sections of the questionnaire ($P < 0.01$).

Internal reliability

The internal reliability (Table 3) for the whole scale, and for some of the individual sections (sources of nutrients and diet–disease relationships) was very high. For two other sections, reliability was moderate (see *Discussion*).

Table 2 Mean and range of correct scores obtained from the two sample groups who completed the modified GNKQ

	Nutrition-educated student sample (n = 40)				*Community Sample (n = 116)*				*Difference between group means*	
Knowledge components (no. of items)	*Min*	*Max*	*Mean*	*SD*	*Min*	*Max*	*Mean*	*SD*	*Mean difference*	*P-value*
Dietary recommendations (13)	2	12	10.12	1.95	4	12	8.89	1.56	1.24	0.000
Sources of nutrients (70)	23	66	54.27	9.32	15	67	47.45	9.22	6.83	0.000
Choosing everyday foods (10)	3	10	7.62	1.55	1	10	6.66	1.97	0.96	0.006
Diet–disease relationships (20)	5	17	12.70	2.66	0	16	9.42	2.95	3.28	0.000
Nutrition knowledge score (113)	41	100	84.72	13.11	21	100	72.42	13.51	12.30	0.000

GNKQ = General Nutrition Knowledge Questionnaire.

Table 3 Internal reliability and Pearson's correlation coefficients for the knowledge components, in the original UK sample and the Australian sample

	UK study sample (n = 168) Parmenter and Wardle (1999)		*Australian sample (n = 156) Current study (2006)*	
Knowledge components	*Internal reliability*	*Correlation coefficient*	*Internal reliability*	*Correlation coefficient*
Dietary recommendations	0.70	0.80	0.53	0.37
Sources of nutrients	0.95	0.94	0.88	0.85
Choosing everyday foods	0.76	0.87	0.55	0.75
Diet–disease relationships	0.94	0.97	0.73	0.74
Nutrition Knowledge Score	0.97	0.98	0.92	0.87

Table 4 Pearson's correlation coefficients for test–retest reliability in the community sample and the nutrition-educated sample groups

	Pearson's correlation coefficient		
Knowledge components (no. of items)	*Nutrition-educated sample (n = 33) r*	*Community sample (n = 24) r*	*Overall sample (n = 57) r*
Dietary recommendations (13)	0.44	0.21	0.37*
Sources of nutrients (70)	0.88**	0.84**	0.85**
Choosing everyday foods (10)	0.80**	0.72**	0.75**
Diet–disease relationships (20)	0.73**	0.69**	0.74**
Nutrition knowledge score (113)	0.88**	0.86**	0.87**

*$P < 0.005$; **$P < 0.001$.

Test–retest reliability

An opportunistic subsample of the community group (n = 24) from one community centre and part of the nutrition-educated university student sample (n = 33) completed the questionnaire on two occasions. The Pearson's correlation coefficients for overall questionnaire was high (r = 0.87, $P < 0.001$). The correlation coefficient was lowest for the section on knowledge of dietary recommendations (r = 0.37) and highest for food sources of nutrients (0.85). The average reliability coefficients for the community sample (r = 0.86, $P < 0.001$, range 0.21–0.84) and nutrition-educated group (r = 0.88, $P < 0.001$, range 0.44–0.88) were high (Table 4).

Comparison between the UK and Australian samples

Table 3 presents the internal reliability and test–retest reliability measures from the original sample used in the validation study by Parmenter and Wardle (1999) and the validation results from this Australian sample. Despite the variation across each knowledge section, the Cronbach's alpha values for the overall score were relatively similar for the two samples. The test–retest correlation coefficients were high for both the UK and Australian samples overall, for the nutrition knowledge score, and across three knowledge sections, but only moderate for one section.

DISCUSSION

The aim of the present paper was to assess the validity and reliability of a modified nutrition knowledge questionnaire for use in an Australian sample.

The range of scores suggests that individuals vary substantially along the nutrition knowledge continuum. Following the analysis of data, the group known to have more training and exposure to nutrition information (those studying nutrition) had the higher mean scores, demonstrating that the modified GNKQ has the ability to distinguish between sample groups with different levels of nutrition knowledge. The present study recruited individuals studying to be nutrition educators, and still clear differences were found between this group and those hypothesised to have a lower knowledge level. Given these initial findings, using this tool may identify groups with even greater nutrition knowledge than third year nutrition students, for example, qualified dietitians, or conversely those with very little nutrition understanding. Its ability to differentiate between groups of different knowledge is important for use in the future.

The reliability of the final instrument was high overall; however, it lacked consistency in some of the knowledge sections. The internal reliability measure was highest for the sources of nutrients section which had 70 items. Theoretically, reliability coefficients increase as the number of items increase[12] and, accordingly, the coefficient for the overall knowledge score (113 items) was high. The overall test–retest coefficients for the nutrition knowledge score for both groups, as well as the sample as a whole, were high, which indicates the questionnaire measures nutrition knowledge consistently over time from one testing occasion to another.

The internal reliability and validity measures reported in the original paper were generally higher than those reported for this mixed demographic Australian sample. The UK sample was more homogenous in nature—made up of younger, more educated individuals attending university, which may partially explain the stronger statistical results.

Participants had a limited understanding of the diet–disease relationships, and this was shown consistently over time, in the retest subsample, indicating that the GNKQ was measuring poor scores consistently for this section. This was not the case for the results of the section about dietary recommendations; they were consistently weakest. The test–retest correlation coefficient was noticeably lowest for this section, and the internal reliability was also weak. The original questionnaire was validated in 1999, arguably prior to the low-carbohydrate high-protein diet trend. Since then, media coverage of this trend has peaked and, consequently, this dietary information may be foremost in the public's mind. It is possible that the weaker results in this area are a reflection of the confusion created by such media attention. Compared with new diet fashions, the information contained in the *Dietary Guidelines for Australians* have not received widespread publicity, and their content may have been overshadowed by the more recent publicised dietary fads. This existing public uncertainty may partially explain the lower test–retest coefficients and weaker statistical results in general.

There are a few limitations of this research, mainly regarding the sample selection. The sample was based on convenience and not chosen primarily to represent the Australian community as a whole. As a result of the nature of the community groups that the sample was selected from, the majority was female.

A positive aspect of the majority of this sample being female is that a potential confounding variable, gender, was controlled. The proportion of women in the student and community samples were relatively similar, thus comparisons could be made between groups without controlling for gender. Furthermore, women are still considered to be the 'gatekeepers' of the household food supply, and therefore are important in any food-related study. Clearly, future studies involving men and women are still important. The sample was also overrepresentative of people with a tertiary education, 50% compared with 20% nationally.[13] Further work is being conducted to investigate the influence of socioeconomic status on nutrition knowledge in an Australian population.

Despite these sampling limitations, the one overriding benefit of this sample, and one of the major objectives in repeating this validation process, is that this validation process involved community members. Lower test–retest reliability in the community group may suggest that they are less familiar with testing situations, and this is more likely to reflect reliability in the wider community. As mentioned earlier, the sample used by Parmenter and Wardle (1999) was homogenous in nature, in that it consisted of university students, and this was one of the primary barriers identified in assuming the validity of this questionnaire for use in a community sample.

Despite being a relatively long questionnaire (113 items), the majority of participants were able to complete it within 15 minutes. Ideally, a questionnaire should be valid, reliable and of a low burden to the participants; however, this can prove difficult in a complex domain such as nutrition. In the present study, the knowledge questionnaire was the only questionnaire administered; however, if it were to be used in conjunction with a number of other tools, then further work may be required to reduce the number of items in the questionnaire while maintaining the questionnaire's validity and reliability. Future work could reduce the overall number of items by factor analysis, or, depending on the research question, subscales (e.g. diet–disease relationships) could be used.

CONCLUSION

Acknowledging the sampling limitations, and reviewing the results of this validation exercise, the General Nutrition Knowledge Questionnaire developed by Parmenter and Wardle and modified for use in Australia, is valid and reliable for use in a community sample and in groups with more advanced nutrition knowledge. This questionnaire is a useful tool for the comprehensive assessment of general nutrition

knowledge and differentiates between groups of different knowledge levels. The challenge of future research is to reduce the participant burden by shortening the questionnaire, while retaining its validity and reliability. Such a tool would allow nutrition knowledge to be assessed more readily and consistently, and thus facilitate our understanding of the complex relationship between nutrition knowledge and food intake behaviour.

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