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The construct validity of the Health Utilities Index Mark 3 in assessing mental health in population health surveys

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Abstract

Purpose—To examine the construct validity of the Health Utilities Index Mark 3 (HUI3) by exploring relationships among several well-recognized measures of mental health, the K6 and the Composite International Diagnostic Interview (CIDI), and the HUI3 in a large, nationally representative sample of community-dwelling subjects. Known-group comparisons were also included in the validation process.

Methods—We specified a priori hypotheses about the expected degree of association between the measures. Correlation coefficients of <0.1 were defined as negligible, 0.1 to <0.3 as small, 0.3 to <0.5 as medium, and 0.5 as large. Data from the Statistics Canada National Population Health Survey (NPHS) Cycle 2 (1996/97) for respondents 20 years of age or older ($n = 66,435$) were used to test the a priori hypotheses.

Results—In 58.1% of cases, predictions of association were correct. Predictions were off by one category in 38.9% of cases and a priori predictions were off by two categories in 3.0% of cases.

Conclusions—Our results provide evidence supporting the cross-sectional construct validity of the HUI3 emotion and HUI3 in a nationally representative sample of the community-dwelling population. The results also provide further evidence of the cross-sectional construct validity of the HUI3 in assessing population health.

Keywords

Mental health; K6; CIDI; Health Utilities Index; Population health

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Conflict of interest It should be noted that David Feeny has a proprietary interest in Health Utilities Incorporated, Dundas, Ontario, Canada. HUInc. distributes copyrighted Health Utilities Index (HUI) materials and provides methodological advice on the use of the HUI. It should also be noted that HUInc. received no payments for the use of the Health Utilities Index Mark 3 in the study reported here. None of the other authors declare any conflict of interest.

Introduction

Much of the evidence of the construct validity of generic preference-based measures such as the EQ-5D [1] and the Health Utilities Index (HUI) [2, 3] is based on data from clinical studies. Further, there is relatively little information about relationships among mental health measures, such as the K6 [4–7] and the Composite International Diagnostic Interview (CIDI) [5, 8], and preference-based measures used to assess population health. This paper explores the construct validity of the HUI3 and, in particular, HUI3 emotion scores by examining the relationships among the K6, the CIDI, the HUI3 [9], and other measures in a large, nationally representative sample of community-dwelling subjects.

Construct validity is a key criterion in evaluating the performance of measures of health-related quality of life (HRQL) [10–13]. In assessing HRQL measures, construct validity involves the accumulation over time of evidence on how well a measure performs in a variety of settings and applications. The process of validation involves using theory about the nature of the constructs being examined to specify a priori hypotheses about the direction of the relationship among measures and degree of association that one expects to observe. An example of convergent validity would be a high degree of expected association between two measures of mental health. An example of discriminative or divergent validity would involve an expectation of a lack of a relationship between a measure of mental health and a measure of visual functioning [11]. Similarly, using a known-groups approach, one might expect that mental health scores and the number of chronic conditions that a subject has to be related, while mental health would not be associated with food allergies. The approach taken in this study with respect to convergent validity is to treat the K6 and CIDI as criterion measures and assess the extent to which variations in the K6 and CIDI are systematically associated with HUI3 emotion scores.

Methods

Data

The data used to assess the construct validity of these measures were taken from the Statistics Canada National Population Health Survey (NPHS) Cycle 2 (1996/97) of community-dwelling subjects [14, 15]. The target population of the NPHS is persons aged 12 years or older residing in the ten Canadian provinces and the three territories, excluding persons living on Indian Reserves and Crown Lands, residents of health institutions, full-time members of the Canadian Forces living on bases, and persons in some remote areas. Cycle 2 of the NPHS included the K6, a short-form of the CIDI, the HUI3, self-reported chronic conditions, information on smoking and the consumption of alcoholic beverages, body mass index (BMI), and standard socio-demographic characteristics. The response rate was 82.6%. The analyses reported in this paper are based on information from the NPHS for respondents 20 years of age or older ($n = 66,435$). The study was approved by the Institutional Review Board of Portland State University.

Measures

K6—Non-specific psychological distress (K6) was assessed by six items on a five-point Likert-type scale [4], ranging from ‘all of the time’ to ‘none of the time.’ The respondents indicated the frequency in the past month that they had felt ‘so sad that nothing could cheer you up,’ ‘nervous,’ ‘restless or fidgety,’ ‘hopeless,’ ‘worthless,’ or ‘everything was an effort.’ The scale was used as a continuous measure ranging from 0 (no psychological distress) to 24 (highest level of psychological distress) and as a dichotomized measure (less than 13 vs. 13 and more). Following Kessler et al. [5], this cut-point is used to identify individuals with ‘serious mental illness.’

Short-Form CIDI—The CIDI was developed as a full structured diagnostic interview suitable for lay administration and covering the definitions and criteria used in the ICD-10 [16] and DSM-IV [17, 18]. The Short-Form CIDI was developed using data from the National Comorbidity Survey used to identify the smallest set of CIDI symptom questions that would reproduce estimates of diagnoses based on the full set of questions [5]. A score for depression is based on a subset of CIDI items [8]. Higher scores indicate higher levels of depression. This measure assesses the depression level for respondents who felt depressed or had lost interest in regular activities for two weeks or more during the past year. Respondents who reported feeling depressed or having lost interest for two weeks or more in a row are then asked the frequency at which they lost interest in most things, felt tired or low on energy all the time, gained or lost weight, had difficulty falling asleep, had trouble concentrating, felt down on themselves, or thought about death.

The 90% probability of caseness refers to the probability that the respondents would have been diagnosed as having experienced a major depressive episode in the past 12 months if they had completed the CIDI. This variable was dichotomized into 90% probability of having had a major depressive episode versus less than 90%.

The HUI3—The HUI3 is a preference-based measure of health status and HRQL [2, 3, 9]. The HUI3 includes eight attributes (dimensions) of health status: vision, hearing, speech, ambulation, dexterity, emotion, cognition, and pain and discomfort, with five or six levels per attribute. The levels range from severe disability (e.g., severe pain that prevents most activities) to no disability (e.g., free of pain and discomfort). The current health status of a subject is described by an eight-element vector, with one level for each attribute. The multiplicative multi-attribute scoring function is based on community preferences obtained from a random sample of the Canadian population [9]. Single-attribute utility scores range from 0.00 for the most severe level of disability for that attribute to 1.00 for no disability/normal. Overall HUI3 scores are on the conventional scale in which ranges from dead = 0.00 to perfect health = 1.00. The score for the all-worst HUI3 health state (every attribute at its highest level of disability) is -0.36; states with negative scores imply health states considered to be worse than dead.

Self-rated health (SRH)—Subjects rated their health as excellent, very good, good, fair, or poor.

Alcohol—Alcohol consumption was grouped into four categories: (1) never had a drink or did not drink in the last year; (2) one drink per day or less; (3) two drinks per day; and (4) three or more drinks per day.

Body mass index (BMI)—The BMI was based on self-reported weight and height data collected in the NPHS.

Restriction of activities—Respondents were asked if, because of any physical or mental condition or health problem, they needed help with preparing meals, running errands, doing everyday housework, doing heavy household chores, personal care, moving about inside the house, or personal finances. The range of restriction of activities varies from zero (no restriction) to six (maximum number of restrictions).

Chronic conditions—Respondents were asked whether they had been diagnosed with any of the following conditions lasting or expected to last six months or more: allergies, asthma, fibromyalgia, arthritis or rheumatism, back problems, high blood pressure, migraine headaches, diabetes, epilepsy, heart disease, cancer, stomach or intestinal ulcers, stroke,

urinary incontinence, bowel disorder, cataracts, glaucoma, thyroid condition, chronic fatigue, mood disorder, anxiety disorder, or chronic bronchitis. The number of chronic conditions for each subject was calculated.

Social support—Four questions on social support were administered to the survey subjects. Subjects were also asked about whether they had someone in whom they could confide, someone who made them feel loved and cared for, someone on whom they could count to help in a crisis, and someone on whom they could count for advice. Responses to the four questions were summed, with higher scores indicating higher levels of social support; scores ranged from 0 to 4.

Formulation of a priori hypotheses—Three of the four authors independently indicated the degree of association (correlation coefficient) among various measures that they expected in the data from the NPHS: negligible (<0.1), small (0.1 to <0.3), medium (0.3 to <0.5), or large (≥ 0.5) [19]. Each author specified 234 a priori hypotheses. The independent predictions were then compiled and the researchers met to compare predictions and come to a unified consensus about each of the 234 hypotheses. The multi-disciplinary team included an economist with expertise in population health and HRQL, a psychiatrist and biostatistician with expertise as a mental health clinician and population health researcher, and a public health specialist with expertise in psychosocial and population health. The 234 a priori hypotheses are presented in Table 1. The statistical analyses were conducted by an author who did not contribute any a priori hypotheses. The pairs included in the exercise included pairs expected to be related (convergent validity) (e.g., HUI3 emotion single-attribute utility score and K6) and pairs for which no relationship was expected (divergent validity) (e.g., BMI and HUI3 vision score).

Statistical analyses—Analyses based on information for respondents 20 years of age or older were weighted to be representative of the population of Canada. For correlations among continuous variables, weighted Pearson correlations (to account for the complex survey design of the NPHS) were computed; for correlations involving ordinal variables, point bi-serial correlations were computed. The *phi* coefficient was used when both variables were dichotomous [20]. Because we had specified predictions before conducting the analyses, no adjustment was made for multiple testing. Kappa, the chance-corrected agreement, was estimated to assess agreement between the predicted and observed degrees of association. The extent of agreement is interpreted according to standards suggested by Altman [21]: <0.20 , poor; 0.21 – 0.40 , fair; 0.41 – 0.60 , moderate; 0.61 – 0.80 , good; 0.81 – 1.00 , very good. To account for the design of the NPHS, Jackknife weights were used to estimate the standard errors of the correlations using SUDAAN statistical software (release 8.0; Research Triangle Institute, Research Triangle Park, NC).

Results

Basic descriptive data on the 66,435 respondents 20 years of age or older from Cycle 2 of the NPHS are given in Table 2. The mean HUI3 score of 0.91 indicates that, on average, respondents were quite healthy, with only mild disability. However, the range of overall HUI3 scores, 0.06 to 1.00, is substantial, indicating that some respondents are quite unhealthy. The same pattern is seen in various single-attribute HUI3 scores, K6, the Short-Form CIDI, the number of chronic conditions, and a number of other indicators of health status.

Initial agreement

In 23.1% of cases (54 out of 234), the independent predictions of all three authors were in agreement, agreement by two of the three occurred in 59.4% of cases (139), and disagreement among all three occurred in 17.5% of cases (41). During the meeting, consensus was readily achieved and a unified set of a priori predictions was specified.

A priori hypotheses and the observed degree of association are reported in Table 1. The accuracy of the a priori hypotheses is summarized in Table 3 and the observed correlations are reported in Table 4. In 58.1% of cases (136 of 234), the predictions were correct. Predictions were off by one category in 38.9% of cases (91), with a priori > observed in 27.8% of cases (65) and a priori < observed in 11.1% (26). A priori predictions were off by two categories in 3.0% of cases (7).

The Kappa statistics for the degree of agreement between the observed and predicted associations was 0.33, $P < 0.001$, indicating fair chance-corrected agreement.

Discussion

The paper presents evidence on the convergent and divergent validity of HUI3 emotion scores. The K6 and Short-Form CIDI were moderately correlated with HUI3 emotion single-attribute utility scores. In general, overall HUI3 scores were associated with known groups in the manner expected.

Success in predicting the degree of association depends on the validity and usefulness of the underlying theory used to derive the hypotheses, knowledge of the measures, and familiarity with the health status of the survey respondents. Over-prediction of the degree of association by one category was more frequent than under-prediction by one category. For instance, we had expected a stronger relationship between the K6 and the Short-Form CIDI, the K6 and social support, and the Short-Form CIDI and social support.

The results for the correlation between the K6 and social support are based on a previously used measure of social support that was replaced by the Medical Outcomes Study (MOS) Social Support Scale [22] in the NPHS in 1998/99 (Cycle 3). Statistics Canada adopted the MOS Social Support Scale because of less than satisfactory performance of the previous measure of social support, which may account for some of the unexpected results.

It is useful to compare the agreement between a priori and observed predictions in this study to results from clinical studies investigating construct validity. Blanchard et al. [23], in an investigation of the construct validity of the HUI and the Short-Form 36 in elective total hip arthroplasty, reported a success rate of 75%. Two studies [24, 25] of children with asthma and their caregivers reported success rates of 55.6 and 50%, respectively. A study of high-risk primary-care patients using the RAND-12 Health Status Inventory and HUI [26] reported a success rate of 50%. The high success rate in the hip study may be due, in part, to the fact that two of the five individuals who contributed a priori hypotheses treated the patients in the study.

It is important to interpret the results reported here in light of several study limitations. In this study, observed and a priori predictions were in agreement in 58.1% of the 234 a priori predictions. Given the use of four categories for the degree of association (ignoring predictions about the direction of the relationship), guessing at random would be expected to be correct in approximately 25% of cases. Nonetheless, the Kappa statistics indicate that the agreement observed is unlikely to be due to chance.

The results presented in this article were derived from data from a nationally representative sample of community-dwelling subjects in Canada and may not generalize to institutionalized populations or non-Western developed country settings. The results reported here support the validity of HUI3 emotion (and the HUI3) in the context of assessing population health. Of course, reliability and responsiveness are also important measurement properties. Evidence on reliability and responsiveness for the HUI3 is found in [2, 3, 27].

The results reported here support the cross-sectional construct validity of the HUI3 emotion scale. HUI3 emotion demonstrated convergent validity with well-established measures of mental health in population health surveys, the K6 and the Short-Form CIDI, in a nationally representative sample of community-dwelling persons and provide further evidence of the cross-sectional construct validity of the HUI3 in assessing population health. Our results provide evidence that these instruments measure what they purport to measure. Evidence on construct validity is important to support that inferences based on these measures about mental and overall population health and trends therein over time are likely to be valid. Vasiliadis et al. [28] provide further evidence of the construct validity of HUI3 emotion using data from the 2002/2003 Joint Canada United States Health Survey. Respondents with moderate or severe emotional health burdens according to HUI3 emotion were more than twice as likely to use healthcare services for mental health reasons compared with respondents with no or mild emotional health burdens.

Additional investigations of the cross-sectional, and in particular the longitudinal, construct validity of the K6, Short-Form CIDI, and the HUI3 are needed. Further exploration of the determinants of mental health and the relative usefulness of the K6, Short-Form CIDI, and HUI3 emotion in understanding the determinants of mental health in population health studies would also be useful.

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List of abbreviations

BMI	Body mass index
CCHS	Canadian Community Health Survey
CIDI	Composite International Diagnostic Interview
EQ-5D	EuroQol five-dimension health utility instrument
HRQL	Health-related quality of life
HUI3	Health Utilities Index Mark 3
K6	Six-item measure of non-specific psychological distress
MOS	Medical Outcomes Study
NPHS	National Population Health Survey

SRH

Self-rated health

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Table 1

A priori and observed associations

	HUB overall	K6	K6, cut-off 13+	HUI3 cognition	HUI3 emotion	HUI3 pain	HUI3 vision	SRH	Alcohol use	BMI	CIDI Short-Form	90% probability of depression	Social support
HUI3 overall	<i>1.00</i>												
K6	<i>S/M</i>	<i>1.00</i>											
K6, cut-off 13 +	S	L	<i>1.00</i>										
HUI3 cognition	<i>S/M</i>	S	S	<i>1.00</i>									
HUI3 emotion	<i>M/L</i>	M	M	<i>1.00</i>									
HUI3 pain	<u><i>S/L</i></u>	S	S	<i>N/S</i>	S	<i>1.00</i>							
HUI3 vision	<u><i>N/M</i></u>	N	N	<i>N/S</i>	N	<i>1.00</i>							
SRH	<i>L/M</i>	M	<i>M/S</i>	S	S	<i>S/M</i>	<i>N/S</i>	<i>1.00</i>					
Alcohol use	<i>N/S</i>	<i>S/N</i>	N	<i>N/S</i>	N	<i>N/S</i>	N	<i>1.00</i>					
BMI	<i>S/N</i>	N	N	N	N	N	N	<i>N/S</i>	1.00				
CIDI Short-Form	S	<i>L/M</i>	M	S	M	S	N	S	N	N	<i>1.00</i>		
90% probability of depression	S	<i>L/M</i>	<i>L/M</i>	S	<u><i>L/S</i></u>	S	N	<i>M/S</i>	N	N	L	<i>1.00</i>	
Social support	<i>N/S</i>	S	<i>S/N</i>	<i>N/S</i>	S	N	N	S	<i>S/N</i>	N	<i>S/N</i>	<i>S/N</i>	<i>1.00</i>
Restriction of activity	<i>M/L</i>	S	S	S	S	M	S	M	<i>N/S</i>	<i>S/N</i>	<i>S/N</i>	<i>S/N</i>	<i>S/N</i>
No. of chronic conditions	M	S	S	S	S	M	<i>N/S</i>	M	N	S	S	S	<i>S/N</i>
Heart disease	<i>M/S</i>	<i>S/N</i>	N	<i>N/S</i>	<i>M/N</i>	S	N	S	N	<i>S/N</i>	<i>S/N</i>	<i>S/N</i>	<i>S/N</i>
Diabetes	S	<i>S/N</i>	N	N	<i>S/N</i>	S	N	S	N	<i>M/S</i>	<i>S/N</i>	<i>S/N</i>	<i>S/N</i>
Arthritis	<i>S/M</i>	<i>S/N</i>	N	<i>N/S</i>	<i>S/N</i>	M	<i>N/S</i>	S	N	<i>S/N</i>	<i>S/N</i>	<i>S/N</i>	<i>S/N</i>
Epilepsy	N	N	N	N	N	N	N	N	N	N	N	N	N
Chronic bronchitis	S	S	<i>S/N</i>	N	<i>S/N</i>	<i>N/S</i>	N	S	N	<i>S/N</i>	<i>S/N</i>	<i>S/N</i>	<i>S/N</i>
Effects of stroke	<i>M/S</i>	<i>S/N</i>	<i>S/N</i>	<i>M/S</i>	<i>S/N</i>	<i>S/N</i>	N	<i>M/S</i>	N	<i>S/N</i>	<i>S/N</i>	<i>S/N</i>	<i>S/N</i>
Cataract	S	N	N	<i>N/S</i>	N	<i>M/S</i>	<i>M/S</i>	S	N	N	N	N	N
Food allergy	N	N	N	N	N	N	N	N	N	N	N	N	N
Age	M	<i>S/N</i>	<i>S/N</i>	<i>M/S</i>	<i>S/N</i>	S	S	<i>M/S</i>	S	S	<i>S/N</i>	<i>S/N</i>	S
Gender	<i>S/N</i>	<i>S/N</i>	<i>S/N</i>	N	<i>S/N</i>	N	N	<i>S/N</i>	<u><i>M/N</i></u>	S	<i>S/N</i>	<u><i>M/N</i></u>	<u><i>M/N</i></u>

N = negligible association, correlation <0.1; S = small degree of association, correlation 0.1 to <0.30; M = medium degree of association, correlation 0.30 to <0.5; L = large degree of association, correlation 0.5
Bold = a perfect match between a priori and observed; italics = a difference of one category in which a priori < observed; bold italics = a difference of one category in which a priori > observed; underline = a difference of two categories in which a priori < observed; double underline = a difference of two categories in which a priori > observed

Table 2

Description of community-dwelling subjects aged 20 years or older from Cycle 2 of the National Population Health Survey (NPHS) 1996/97

	%	95% confidence interval (CI)
Male	48.9	(48.08–49.73)
Age 20–14 years	54.3	(53.47–55.10)
Age 45–64 years	29.7	(28.95–30.45)
Age 65+ years	16.0	(15.46–16.58)
Education <12 years	23.2	(22.54–23.93)
K6, cut-off 13+	1.7	(1.46–1.92)
90% probability of depression	4.2	(3.89–4.52)
Food allergy	6.7	(6.33–7.11)
Heart disease	4.4	(4.13–4.71)
Diabetes	3.6	(3.34–3.94)
Arthritis	15.8	(15.29–16.40)
Epilepsy	0.7	(0.52–0.82)
Chronic bronchitis	3.0	(2.75–3.27)
Effects of stroke	1.0	(0.88–1.15)
Cataract	3.1	(2.85–3.35)
	Mean	Standard error (SE)
HUI3 overall (range: 0.061–1)	0.91	0.001
K6 (range: 0–24)	2.31	0.029
HUI3 cognition (range: 0.32–1)	0.97	0.001
HUI3 emotion (range: 0–1)	0.98	0.001
HUI3 pain (range: 0–1)	0.93	0.001
HUI3 vision (range: 0.38–1)	0.96	0.001
SRH (range: 0–4)	2.68	0.008
alcohol use (range: 0–3)	0.86	0.005
BMI (range: 13.2–57.9)	25.52	0.039
CIDI (range: 0–8)	0.33	0.011
Social support (range: 0–4)	3.77	0.007
Restriction of activity (range: 0–6)	0.28	0.007
No. of chronic conditions (range: 0–15)	1.34	0.012

Table 3

Accuracy of a priori predictions

	<i>n</i>	%
Exactly correct	136	58.1
Off by one category		
A priori > observed	65	27.8
A priori < observed	26	11.1
Off by two categories		
A priori > observed	4	1.7
A priori < observed	3	1.3
Off by three categories	0	
Total	234	

Table 4

Observed associations

	HUI3 overall	K6	K6, cut-off 13+	HUI3 cognition	HUI3 emotion	HUI3 pain	HUI3 vision	SRH	Alcohol use	BMI	CIDI Short-Form	90% probability of depression	Social support
HUI3 overall	1.00												
K6	-0.37	1.00											
K6, cut-off 13+	-0.25	0.54	1.00										
HUI3 cognition	0.42	-0.29	-0.20	1.00									
HUI3 emotion	0.51	-0.46	-0.42	0.31	1.00								
HUI3 pain	0.82	-0.26	-0.18	0.21	0.23	1.00							
HUI3 vision	0.32	-0.04	-0.02	0.10	0.07	0.10	1.00						
SRH	0.49	-0.30	-0.19	0.24	0.28	0.41	0.14	1.00					
Alcohol use	-0.13	-0.03	-0.04	-0.10	-0.07	-0.10	-0.05	-0.14	1.00				
BMI	-0.08	-0.03	-0.01	-0.02	0.00	-0.08	-0.04	-0.14	0.02	1.00			
CIDI Short-Form	-0.22	0.41	0.36	-0.17	-0.31	-0.16	0.01	-0.16	0.00	-0.01	1.00		
90% probability of depression	-0.21	0.39	0.35	-0.16	-0.29	-0.14	0.01	-0.15	0.00	0.00	0.93	1.00	
Social support	0.14	-0.15	-0.09	0.10	0.19	0.07	0.05	0.11	-0.07	-0.04	-0.08	-0.08	1.00
Restriction of activity	-0.57	0.19	0.11	-0.29	-0.23	-0.47	-0.20	-0.37	0.15	0.04	0.09	0.08	-0.04
No. of chronic conditions	-0.41	0.19	0.11	-0.18	-0.16	-0.35	-0.15	-0.40	0.09	0.12	0.12	0.11	-0.05
Heart disease	-0.20	0.03	0.02	-0.10	-0.07	-0.15	-0.09	-0.23	0.07	0.05	0.01	0.02	-0.03
Diabetes	-0.14	0.04	0.04	-0.07	-0.06	-0.10	-0.07	-0.18	0.08	0.12	0.02	0.02	-0.03
Arthritis	-0.34	0.09	0.05	-0.12	-0.08	-0.30	-0.13	-0.29	0.09	0.00	0.00	0.00	-0.02
Epilepsy	-0.04	0.04	0.03	-0.04	-0.04	-0.02	0.00	-0.04	0.04	0.00	0.00	0.00	-0.02
Chronic bronchitis	-0.15	0.10	0.06	-0.07	-0.08	-0.13	-0.04	-0.17	0.03	0.03	0.07	0.06	-0.04
Effects of stroke	-0.16	0.03	0.01	-0.13	-0.07	-0.08	-0.08	-0.11	0.06	0.02	0.00	0.00	-0.02
Cataract	-0.19	0.02	0.02	-0.10	-0.05	-0.12	-0.18	-0.15	0.08	0.02	0.00	-0.01	-0.02
Food allergy	-0.05	0.05	0.01	-0.02	-0.01	-0.05	-0.01	-0.05	0.00	-0.01	0.03	0.03	0.00
Age	-0.31	-0.07	0.00	-0.12	-0.01	-0.16	-0.25	-0.27	0.16	0.19	-0.06	-0.06	-0.10
Gender	-0.05	0.09	0.03	-0.02	0.00	-0.03	-0.06	-0.03	0.04	-0.18	0.06	0.06	0.08

Non-significant correlations are in bold