

A B S T R A C T

This study used cross-sectional data from the 1994/95 National Population Health Survey (NPHS) in Canada. The objective of the study was to examine the relationship between several established correlates of health status in the general population and the Health Utilities Index (HUI), a multi-dimensional, preference-based measure of health status. Analyses were carried out separately for the English-speaking (n=9,853) and French-speaking (n=1,519) respondents. The index correlated strongly with self-ratings of health status and functional disability and varied as expected according to age, sex, and income. Subjects classified to different categories of chronic conditions reported different levels of health, as predicted. The HUI was also associated with the use of drugs and recent history of hospitalization. No major differences in the findings were observed between the two cultural groups. The results should be treated with caution due to the cross-sectional design and other methodological limitations of the study.

A B R É G É

Cette étude est basée sur un échantillon de données provenant de l'Enquête nationale sur la santé de la population de 1994-95 au Canada. L'enquête avait pour objectif d'examiner la relation entre divers corrélats acceptés pour l'état de santé de la population en général et de l'Indice de l'état de santé (IES) qui est une mesure multidimensionnelle de l'état de santé basée sur la préférence. Les analyses étaient effectuées séparément pour les personnes interrogées anglophones (n = 9 853) et francophones (n = 1 519). L'indice correspondait nettement aux auto-évaluations de l'état de la santé et de l'invalidité fonctionnelle et, conformément aux attentes, différait d'après l'âge, le sexe et le revenu. Comme prévu, les sujets classés dans des catégories différentes d'états chroniques signalaient des degrés de santé différents. L'IES était également associé à l'usage de médicaments et aux hospitalisations récentes. Aucune différence majeure n'a été constatée entre les deux groupes culturels. Les résultats devraient être traités avec prudence étant donné qu'ils étaient basés sur un échantillon et que l'étude avait d'autres restrictions méthodologiques.

Measuring Population Health: Correlates of the Health Utilities Index Among English and French Canadians

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In the last two decades, there has been a growing interest in the application of multidimensional, preference-based health indices in evaluating population health and assessing the impact of health services.¹⁻³ Preference-based measures are intended to reflect people's preferences for different health states on a scale where 0 indicates being dead and 1 indicates being in perfect health.⁴ Examples of such indices include the Quality of Well-Being,⁵ the EQ-5D (EuroQol)⁶ and the Health Utilities Index (HUI).^{7,8}

The HUI has been developed by Torrance and colleagues at McMaster University. Previous versions of the index (Mark 1 and 2) were designed for clinical studies in children with specific health problems.⁹⁻¹¹ The current Mark 3 system is a generic measure of health status which provides the description of an individual's functional health based on eight attributes: vision, hearing, speech, mobility, dexterity, cognition, emotion, and pain/discomfort, with 5 or 6 levels per attribute⁸ (Appendix). With respect to each attribute, a person is first classified into an appropriate level of function. Each level of function is associated with a different preference score, derived from a community sample. To combine the attribute-specific preferences into an overall health utility score, a

mathematical formula (scoring function) is used. The formula is based on a multiplicative model of interactions between the attributes, derived from multi-attribute utility theory.^{3,8}

The HUI can be used as an outcome measure in clinical studies or a population health index. Some properties of the index in patients with specific conditions have been examined.¹²⁻¹⁵ The test-retest reliability of the HUI in a general population sample was studied by Boyle et al.¹⁶ Grootendorst et al.¹⁷ assessed the proxy-subject agreement for the emotion and pain dimensions. Gold et al.¹⁸ investigated the predictive validity of a health index derived from the National Health and Examination Survey in the US, mapped into the four-dimensional HUI.

Since 1990, the HUI has been implemented in several surveys in Canada, including the Ontario Health Survey,¹⁹ the General Social Survey,²⁰ and the National Population Health Survey (NPHS).²¹ The index has been applied to calculate the health-adjusted life expectancy in Canada²² and Ontario,²³ to study the effect of socioeconomic factors on health,²⁴ and to provide the average health utilities for persons reporting various chronic conditions.²⁵ Descriptive data on mean HUI scores by province, age, sex, and income were included in the 1999 Statistical Report on the Health of Canadians.²⁶

Despite a wide range of applications, relatively little is known about the correlates of the HUI in the English-speaking and French-speaking populations in Canada. Our first objective was to describe the relationship between the HUI and more traditional measures of health status, such as self-reported health and functional disability.

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ty. In previous surveys,²⁷⁻³³ these traditional measures have been associated with a number of variables, such as age, gender, socioeconomic status, presence of chronic conditions, and utilization of health services. We hypothesized that a similar pattern of relationships can be demonstrated for the HUI.

METHODS

Study population

The study used cross-sectional data from the National Population Health Survey (NPHS) conducted by Statistics Canada in 1994/95.²¹ The target population for the NPHS was household residents in all provinces, 12 years of age or older, with the principal exclusion of populations on Indian Reserves, Canadian Forces Bases and some remote areas in Quebec and Ontario. The household response rate was 88.7%.²¹ For the purpose of this analysis, we selected respondents who were born in Canada and spoke only English (n=9,853) or only French (n=1,519). We excluded respondents born in Canada who were bilingual or spoke other (unspecified) languages, as well as persons born outside Canada. The purpose of these exclusions was to ensure linguistic and cultural homogeneity of the two study populations and facilitate the evaluation of the English and French versions of the HUI.

Outcome variable

Because the HUI distribution was strongly skewed, the index was categorized into three levels of health. Respondents with an HUI greater than 0.946 were classified as healthy and those scoring less than 0.830 were classified as dysfunctional. These cut-points were based on the clinical judgement and consensus of the investigators. For example, a person who is near-sighted, yet fully healthy on all other attributes, receives a score of 0.947. A score of 0.830 is assigned to an individual who requires mechanical support for walking (e.g., a cane), but does not report any pain or other limitations. A person reporting difficulty in walking and pain that restricts at least some activities would obtain a score of 0.814 and would be considered dysfunctional.

Appendix	
Health Utilities Index Mark 3: Health Status Classification System	
<p>Vision</p> <p>1 Able to see well enough to read ordinary newspaper and recognize a friend on the other side of the street, without glasses or contact lenses</p> <p>2 Able to see well enough to read ordinary newspaper and recognize a friend on the other side of the street, but with glasses</p> <p>3 Able to read ordinary newspaper with or without glasses, but unable to recognize a friend on the other side of the street, even with glasses</p> <p>4 Able to recognize a friend on the other side of the street with or without glasses, but unable to read ordinary newspaper, even with glasses</p> <p>5 Unable to read ordinary newspaper and unable to recognize a friend on the other side of the street, even with glasses</p> <p>6 Unable to see at all</p> <p>Hearing</p> <p>1 Able to hear what is said in a group conversation with at least three other people, without a hearing aid</p> <p>2 Able to hear what is said in a conversation with one other person in a quiet room without a hearing aid, but requires a hearing aid to hear what is said in a group conversation with at least three other people</p> <p>3 Able to hear what is said in a conversation with one other person in a quiet room with a hearing aid and able to hear what is said in a group conversation with at least three other people with a hearing aid</p> <p>4 Able to hear what is said in a conversation with one other person in a quiet room without a hearing aid, but unable to hear what is said in a group conversation with at least three other people even with a hearing aid</p> <p>5 Able to hear what is said in a conversation with one other person in a quiet room with a hearing aid, but unable to hear what is said in a group conversation with at least three other people even with a hearing aid</p> <p>6 Unable to hear at all</p> <p>Speech</p> <p>1 Able to be understood completely when speaking with strangers or friends</p> <p>2 Able to be understood partially when speaking with strangers, but able to be understood completely when speaking with people who know the respondent well</p> <p>3 Able to be understood partially when speaking with strangers or people who know the respondent well</p> <p>4 Unable to be understood when speaking with strangers but able to be understood partially by people who know the respondent well</p> <p>5 Unable to be understood when speaking to other people (or unable to speak at all)</p> <p>Ambulation</p> <p>1 Able to walk around the neighbourhood without difficulty, and without walking equipment</p>	<p>2 Able to walk around the neighbourhood with difficulty, but does not require walking equipment or the help of another person</p> <p>3 Able to walk around the neighbourhood with walking equipment, but without the help of another person</p> <p>4 Able to walk only short distances with walking equipment and requires a wheelchair to get around the neighbourhood</p> <p>5 Unable to walk alone, even with walking equipment; able to walk short distances with the help of another person and requires a wheelchair to get around the neighbourhood</p> <p>6 Cannot walk at all</p> <p>Dexterity</p> <p>1 Full use of two hands and ten fingers</p> <p>2 Limitations in the use of hands or fingers, but does not require special tools or the help of another person</p> <p>3 Limitations in the use of hands or fingers, is independent with use of special tools</p> <p>4 Limitations in the use of hands or fingers, requires the help of another person for some tasks</p> <p>5 Limitations in the use of hands or fingers, requires the help of another person for most tasks</p> <p>6 Limitations in the use of hands or fingers, requires the help of another person for all tasks</p> <p>Emotion</p> <p>1 Happy and interested in life</p> <p>2 Somewhat happy</p> <p>3 Somewhat unhappy</p> <p>4 Very unhappy</p> <p>5 So unhappy that life is not worthwhile</p> <p>Cognition</p> <p>1 Able to remember most things, think clearly and solve day to day problems</p> <p>2 Able to remember most things, but has a little difficulty when trying to think and solve day to day problems</p> <p>3 Somewhat forgetful, but able to think clearly and solve day to day problems</p> <p>4 Somewhat forgetful and has a little difficulty when trying to think and solve day to day problems</p> <p>5 Very forgetful and has great difficulty when trying to think and solve day to day problems</p> <p>6 Unable to remember anything at all, and unable to think and solve day to day problems</p> <p>Pain</p> <p>1 Free of pain and discomfort</p> <p>2 Mild to moderate pain that prevents no activities</p> <p>3 Moderate pain that prevents a few activities</p> <p>4 Moderate to severe pain that prevents some activities</p> <p>5 Severe pain that prevents most activities</p>

TABLE I
Percent Distribution of Respondents and Mean HUI Scores According to the Independent Variables Included in the Analysis

Variable	English (N=9,853)		French (N=1,519)	
	Proportion (%)	Mean HUI	Proportion (%)	Mean HUI
Self-rated Health				
Excellent	23.9	0.949	26.7	0.946
Very good	39.4	0.924	32.0	0.932
Good	26.4	0.875	29.1	0.879
Fair	8.2	0.758	10.2	0.768
Poor	2.0	0.531	1.9	0.544
Help in ADL				
No	90.5	0.916	92.1	0.912
Yes	9.5	0.697	7.9	0.712
Activity Restriction				
No	76.9	0.930	81.2	0.926
Yes	23.1	0.781	18.8	0.767
Disability Days				
No	83.9	0.909	89.5	0.908
Yes	16.1	0.823	10.5	0.795
Age (years)				
<25	21.9	0.927	21.0	0.938
25-44	41.0	0.914	37.4	0.921
45-65	23.6	0.874	27.6	0.871
>65	13.4	0.826	14.0	0.817
Sex				
Male	49.7	0.906	44.5	0.902
Female	50.3	0.885	55.5	0.891
Education				
College/University	27.0	0.913	18.8	0.919
Some post-secondary	23.8	0.895	15.8	0.910
High school	16.1	0.903	13.1	0.913
Less than high school	33.1	0.878	52.3	0.880
Income Adequacy*				
Highest	17.6	0.926	7.6	0.921
Upper middle	37.8	0.905	33.4	0.913
Middle	28.8	0.888	36.1	0.894
Lower middle	10.8	0.853	16.3	0.872
Lowest	5.0	0.851	6.6	0.851
Chronic Conditions†				
None	41.6	0.934	53.6	0.935
Mild	13.3	0.931	10.0	0.921
Moderate	18.1	0.891	14.0	0.881
Severe	22.0	0.808	17.2	0.791
Other	5.0	0.878	5.2	0.832
In Hospital Last Year				
No	90.5	0.903	90.5	0.901
Yes	9.5	0.825	9.5	0.847
Drug Utilization				
0 in last month	20.1	0.939	29.4	0.936
0 in last 2 days	33.9	0.925	30.3	0.917
1 in last 2 days	24.6	0.897	19.2	0.897
>1 in last 2 days	21.4	0.806	21.1	0.813

* Income adequacy levels were derived by Statistics Canada based on household income and household size.

† Severe conditions included arthritis, heart disease, diabetes, chronic bronchitis/emphysema, cancer, stroke, and Alzheimer disease. Moderate conditions included asthma, back problems, migraine, epilepsy, ulcer, cataracts, and glaucoma. Mild conditions included food and other allergies, hypertension, incontinence, sinusitis, and acne. Unspecified conditions were classified as 'other'. Respondents with multiple conditions were classified according to the most severe condition.

Chronic conditions

The NPHS inquired about the presence of 20 chronic conditions. These conditions were *a priori* classified by the investigators into three levels of expected average impact on functional health: mild, moderate, and severe (Table I). Although there is a spectrum of severity for each condition, some conditions may be expected to be associated with lower levels of health than oth-

ers.^{18,30} For example, we hypothesized that stroke, Alzheimer's disease or arthritis would generally have a greater impact on functional health than allergies or hypertension, even after adjusting for age.

Statistical methods

All analyses were performed with SAS. Separate analyses were carried out in representative samples of English-speaking and

French-speaking Canadians. The mean HUI score was calculated for all levels of the independent variables. Relationships between the HUI and other measures of health status were reported as the proportion of subjects classified as dysfunctional (HUI<0.830) or healthy (HUI>0.946). Statistical modelling with several independent variables was performed using multiple logistic regression.³⁴ The results from logistic regression are reported as odds ratios. All analyses used re-scaled sample weights (actual weight divided by mean weight) that preserved the original size of each group.

RESULTS

Overall, 55.3% of English Canadians and 52.9% of French Canadians were classified as healthy, whereas 16.4% and 18.1%, respectively, were classified as dysfunctional. French Canadians reported slightly fewer restrictions in activities, lower levels of education and income, fewer chronic conditions, and less medication use (Table I).

The association between the HUI and self-reported health was strong in both cultural groups. Among the English-speaking respondents who reported excellent health, only 4.3% were classified as dysfunctional, and 75.1% were classified as healthy (Table II). Of those reporting poor health, the corresponding proportions were 84.7% and 4.7%, respectively. Among the French-speaking respondents who said that their health was poor, 95.7% were classified as dysfunctional.

The proportion of subjects with an HUI<0.830 was significantly higher among those reporting a limitation in activity or disability days in the previous month, whereas the proportion with an HUI>0.946 was significantly lower. For example, among those who needed help with activities of daily living, 64.9% of English-speaking respondents and 63.7% of French-speaking respondents were dysfunctional, whereas 16.2% and 14.7%, respectively, were healthy.

Sociodemographic variables

In a multiple logistic regression model with age, sex, education, and income as

independent variables, the relative odds of being dysfunctional in the English-speaking population were 2.5 in the age group 45-64 and 4.6 in those aged 65+, compared with subjects less than 25 years of age (Table III). In the French-speaking population, the corresponding odds ratios were 4.3 and 8.5, respectively. Females were more likely to be classified as dysfunctional than males. Education was only weakly related to the HUI. Income adequacy, on the other hand, was strongly associated with the index. The odds ratios among those in the lowest income category, relative to the highest, were 2.8 and 4.5 in the English-speaking and French-speaking populations, respectively. The corresponding odds ratios of being healthy were 0.41 and 0.54.

Chronic conditions

Subjects reporting chronic conditions were more likely to be classified as dysfunctional, and less likely to be classified as healthy, than those not reporting any conditions, after adjustment for age, sex, education and income (Table IV). Compared with persons with no conditions, the relative odds of dysfunction in the English-speaking population ranged from 1.1 in persons reporting "mild" conditions to 6.6 in those reporting "severe" conditions. In the French-speaking population, the corresponding odds ratios ranged from 1.8 to 8.8.

Health service utilization

Hospitalization in the previous year correlated with the HUI in both groups, as expected (Table IV). The use of drugs was also strongly associated with the index. Compared to non-users, the adjusted odds ratio in English-speaking Canadians was 2.5 for subjects using one drug in the last 2 days and 7.7 for those using two or more drugs. The corresponding odds ratios in French-speaking Canadians were 2.6 and 5.4, respectively.

DISCUSSION

Subjective measures of health status, such as disability reports and self-ratings of health, have often been implemented in population surveys. The HUI offers a dif-

TABLE II
Proportion of Respondents Classified as Dysfunctional (HUI<0.830) or Healthy (HUI>0.946), by Self-rated Health, Help in Activities of Daily Living, Restrictions in Activities, and Disability Days

	English		French	
	Dysfunctional (%)	Healthy (%)	Dysfunctional (%)	Healthy (%)
Self-rated Health				
Excellent	4.3	75.1	4.9	73.5
Very good	8.2	61.5	6.4	60.2
Good	22.2	45.5	23.0	42.5
Fair	55.2	19.0	60.3	15.9
Poor	84.7	4.7	95.7	0.0
Help in ADL				
No	11.3	59.4	14.2	56.2
Yes	64.9	16.2	63.7	14.7
Activity Restrictions				
No	7.4	63.6	9.2	60.2
Yes	46.4	27.8	56.5	21.5
Disability Days				
No	13.2	58.2	14.9	54.6
Yes	33.2	40.1	45.1	38.5

TABLE III
Effect of Age, Sex, Income and Education on the Relative Odds of Being Classified as Dysfunctional (HUI<0.830) or Healthy (HUI>0.946)

	English		French	
	Dysfunctional OR (95% CI)	Healthy OR (95% CI)	Dysfunctional OR (95% CI)	Healthy OR (95% CI)
Age (years)				
<25	1.00	1.00	1.00	1.00
25-44	1.6 (1.3, 1.9)	0.8 (0.7, 0.9)	2.2 (1.3, 3.7)	0.8 (0.6, 1.1)
45-64	2.5 (2.1, 3.1)	0.5 (0.5, 0.6)	4.3 (2.6, 7.2)	0.5 (0.3, 0.6)
≥65	4.6 (3.8, 5.6)	0.3 (0.3, 0.4)	8.5 (5.1, 14.8)	0.3 (0.2, 0.4)
Sex				
Male	1.00	1.00	1.00	1.00
Female	1.4 (1.3, 1.6)	1.0 (0.9, 1.0)	1.3 (1.0, 1.7)	0.9 (0.7, 1.1)
Education				
College/University	1.00	1.00	1.00	1.00
Some post-secondary	1.3 (1.1, 1.6)	0.7 (0.7, 0.8)	1.3 (0.8, 2.2)	0.8 (0.5, 1.1)
High school	1.0 (0.9, 1.3)	0.9 (0.8, 1.0)	0.8 (0.5, 1.5)	0.8 (0.5, 1.1)
Less than high school	1.5 (1.3, 1.8)	0.7 (0.6, 0.8)	1.4 (0.9, 2.1)	0.8 (0.5, 1.0)
Income Adequacy				
Highest	1.00	1.00	1.00	1.00
Upper middle	1.3 (1.2, 1.6)	0.8 (0.7, 0.9)	1.5 (0.8, 3.5)	0.9 (0.6, 1.3)
Middle	1.7 (1.4, 2.0)	0.6 (0.5, 0.7)	2.0 (1.0, 4.5)	0.7 (0.5, 1.1)
Lower middle	2.6 (2.1, 3.2)	0.5 (0.4, 0.6)	2.4 (1.1, 5.5)	0.7 (0.4, 1.1)
Lowest	2.8 (2.2, 3.7)	0.4 (0.3, 0.5)	4.5 (2.0, 10.9)	0.5 (0.3, 1.0)

Odds ratios were obtained from a multiple logistic regression model with age, sex, education and income as independent variables.

ferent perspective, whereby health is seen as a combination of eight suitably weighted attributes: vision, hearing, speech, ambulation, dexterity, emotion, cognition, and pain/discomfort. Although compelling arguments have been put forward for a wider use of such indices,¹⁻³ questions are being raised about their measurement properties and interpretation.³⁵⁻³⁷

In this cross-sectional study, the HUI correlated strongly with more traditional measures of health status. Furthermore, a number of established correlates of self-reported health and functional disability displayed a similar pattern of relationships with the HUI. Age, income, type of chron-

ic condition, and use of drugs demonstrated a clear gradient in health status. Education was only weakly associated with the index, after controlling for income, age and sex. The effect of gender was relatively small, in agreement with other studies.^{38,39} Our results are essentially consistent with those obtained recently by Kind et al. in the UK using the QE-5D questionnaire.⁴⁰ In that study, age, education, employment, and smoking behaviour remained significant predictors of health status in an analysis of variance model.

A recent report by Mittmann et al.²⁵ showed that individuals with different chronic conditions have different mean

TABLE IV
Effect of Chronic Conditions, History of Hospitalization, and Use of Drugs on the Relative Odds of Being Classified as Dysfunctional (HUI<0.830) or Healthy (HUI>0.946)

	English		French	
	Dysfunctional OR (95% CI)	Healthy OR (95% CI)	Dysfunctional OR (95% CI)	Healthy OR (95% CI)
Chronic condition				
None	1.00	1.00	1.00	1.00
Mild	1.1 (0.8, 1.4)	0.9 (0.8, 1.0)	1.8 (0.9, 3.2)	0.7 (0.5, 1.0)
Moderate	3.2 (2.6, 3.8)	0.6 (0.5, 0.7)	4.4 (2.9, 6.9)	0.6 (0.4, 0.8)
Severe	6.6 (5.6, 7.9)	0.3 (0.3, 0.4)	8.8 (5.8, 13.5)	0.3 (0.2, 0.4)
Other	3.8 (2.9, 4.9)	0.5 (0.4, 0.6)	7.7 (4.3, 13.7)	0.3 (0.2, 0.4)
In hospital last year				
No	1.00	1.00	1.00	1.00
Yes	2.4 (2.1, 2.9)	0.7 (0.6, 0.8)	1.7 (1.1, 2.6)	0.7 (0.5, 1.0)
Drug use				
0 in last month	1.00	1.00	1.00	1.00
0 in last 2 days	1.6 (1.3, 2.0)	0.7 (0.6, 0.7)	1.1 (0.7, 1.8)	0.6 (0.5, 0.8)
1 in last 2 days	2.5 (2.0, 3.2)	0.5 (0.5, 0.6)	2.6 (1.6, 4.1)	0.4 (0.3, 0.6)
>1 in last 2 days	7.7 (6.2, 9.5)	0.3 (0.2, 0.3)	5.4 (3.5, 8.6)	0.3 (0.2, 0.4)

Odds ratios are adjusted for age, sex, education and income in a multiple logistic regression model.

HUI scores, although their results were based on small numbers and may have been confounded by comorbidity, age, and other factors. In our study, an *a priori* classification according to the *expected* impact on functional health produced groups of conditions with predictably different HUI scores, after adjusting for age, sex, and socioeconomic status. This suggests that the index may be useful in assessing the burden of common chronic conditions at the population level.

Our study had several limitations. Although the NPHS implemented the Mark 3 version of the HUI questionnaire, the scores are based on the Mark 2 utility weights, which were originally developed to study clinical outcomes in children. Therefore, these scores are considered preliminary and approximate.⁴¹ New weights, derived specifically for the HUI Mark 3,⁴² were not available at the time of this analysis. However, as different weights tend to produce scores that are highly correlated, it is unlikely that improvements in the weighting system would significantly change the conclusions from this study.

A limitation of survey data was that all independent variables were based on self-reports or proxy reports. In particular, no clinical data to confirm the diagnosis were available. Furthermore, because of the cross-sectional design of the study, we were unable to assess the predictive validity of the index or its sensitivity to changes in health status over time. It should also be noted that we used the summary index only

and did not analyze the individual attributes. Finally, we have not made any corrections for the effect of sampling design on the variance of the estimated parameters.

In conclusion, both the English and French versions of the HUI have been shown to discriminate between various groups of respondents that, based on previous studies, may be expected to differ in their health status. The results should be treated with caution because of the limitations inherent in this type of analysis. Further analyses of the index are needed to confirm its predictive validity and sensitivity to change.

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