Is There Regional Variation in the SF-36 Scores of Canadian Adults?

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ABSTRACT

Background: Canadian normative data for the Medical Outcomes Study 36-item short form (SF-36) have recently been published. However, there is evidence from other countries to suggest that regional variation in health-related quality of life (HRQOL) may exist. We therefore examined the SF-36 data from nine Canadian centres for evidence of systematic differences.

Methods: Bayesian hierarchical modelling was used to compare the differences in the eight SF-36 domains and the two summary component scores within each of the age and gender strata across the nine sites.

Results: Five domains and the two summary component scores showed little clinically important variation. Other than a small number of exceptions, there was little overall evidence of HRQOL differences across most domains and across most sites.

Interpretation: Our finding of only a few small differences suggests that there is no need to develop region-specific Canadian normative data for the SF-36 health survey.

La traduction du résumé se trouve à la fin de l'article.

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The Medical Outcomes Study 36-item short form (SF-36)[1,2] health survey has proven to be useful for comparing the relative burden of different diseases, as well as the efficacy of treatment interventions on quality of life.[3] Moreover, it is increasingly being used in clinical trials research, reflecting a shift away from research that had a more narrow focus on clinical indicators such as morbidity and mortality, to a broader assessment of patient functioning and well-being.[4]

The recent publication of Canadian normative data for the SF-36 health survey[5] has allowed researchers and health care professionals to compare SF-36 data they have collected to age- and/or gender-appropriate norms. While this marks a substantial improvement over comparisons with US normative data,[1] there is also evidence to suggest that there may be regional variation in SF-36 scores in some countries.[6] Within Canada, where both an English and a French version of the SF-36[7] have been used, there may also be differences according to language of form completion.[8]

The initiation of data collection for the Canadian Multicentre Osteoporosis Study (CaMos) in 1996 provided the opportunity to develop the age- and sex-adjusted norms for Canadians.[5] Since these data were collected at nine centres across Canada, they can also be used to assess differences between the nine cities and surrounding regions. This will provide an opportunity to validate and confirm the usefulness of the normative data within all regions of Canada, as well as address the question of whether those living in various parts of Canada have similar health-related quality of life.

METHODS

The Canadian Multicentre Osteoporosis Study (CaMos) is a prospective cohort study of 9,423 non-institutionalized randomly selected males and females aged 25 years and older. The sample is drawn from a 50-km radius of nine Canadian cities: Vancouver, Calgary, Saskatoon, Hamilton, Toronto, Kingston, Quebec City, Halifax and St. John's. Details of the study's purpose, methodology and sampling framework are presented elsewhere.[5,9] Ethical approval for the study was obtained through the Review Boards of

each participating centre, as well as at the coordinating centre in Montreal.

The SF-36 contains 36 items which, when scored, yield 8 domains, including physical functioning, role physical, role emotional, bodily pain, vitality, social functioning, mental health, and general health perceptions. A detailed description of these domains is available elsewhere.[1,5] Summary scores for a Physical Component and a Mental Component can also be derived.[2] All domains are scored on a scale from 0 to 100, with 100 representing the best possible health state.

The data were scored by means of the Medical Outcomes Trust scoring methodology.[1,2] The data were age- and sex-standardized to the Canadian population by weighting the total means based on the underlying population for each of the nine centres, using Statistics Canada data.[10,11] The normative data[5] (means, standard deviations, 95% confidence intervals, and percent at floor and ceiling) were generated for the entire sample, by gender, by age groups (10-year increments) and for each of the nine centres.

A preliminary and descriptive analysis of these data, without taking into account the age and sex stratifications, indicated that there were some differences between the centres in some, though not all, domains. However, given that the developers of the SF-36 consider a clinically and socially meaningful difference to be a minimum of five points,[1] few of the differences were meaningful. Moreover, it is necessary to examine these differences within each of the two gender and six age strata, for each of the eight domains and two summary scores, for each of the nine centres.

We used a Bayesian hierarchical model to evaluate regional differences. Results are reported as posterior mean differences with 95% credible intervals (Bayesian analogues to frequentist confidence intervals). In contrast with other methods, these models also allow for the direct calculation of the probability of a clinically important difference, which we also report. A separate model was created for each combination of sex, age group and SF-36 domain, resulting in a total of 2 x 6 x 10 = 120 models. Each of these hierarchical models consists of three stages, described in detail in Appendix A.

TABLE I

Sample Size, Gender and Age by Centre

Centre	Sample Size	Percent Female	Mean Age (SD) Males	Mean Age (SD) Females
St. John's	1034	70.2	59.8 (14.8)	63.3 (12.9)
Halifax	1052	70.4	61.1 (13.7)	63.8 (12.1)
Quebec City	1133	70.5	60.1 (14.8)	62.2 (13.5)
Kingston	1075	69.6	60.4 (14.7)	63.5 (13.1)
Toronto	900	67.2	59.8 (13.3)	61.3 (12.1)
Hamilton	1068	69.1	59.9 (15.0)	63.6 (12.8)
Saskatoon	1031	69.2	59.8 (14.1)	63.7 (12.2)
Calgary	1065	69.6	59.3 (14.8)	63.5 (12.6)
Vancouver	1065	68.4	58.7 (15.1)	62.4 (13.0)

TABLE II

Relative Ranking by Centre and Domain, and Maximum Between-Centre Differences

Centre	PF	RP	BP	GH	VT	SF	RE	MH	PCS	MCS
St. John's	6	1	1	8	2	2	1	3	4	1
Halifax	7	8	7	5	7	4	5	4	7	4
Quebec City	5	5	9	2	1	5	2	9	5	7
Kingston	8	6	5	6	5	1	3	1	8	2
Toronto	1	4	3	3	3	6	8	6	3	8
Hamilton	9	9	8	9	8	8	7	7	9	6
Saskatoon	3	7	6	7	6	3	4	2	6	3
Calgary	4	2	2	1	4	7	6	5	2	5
Vancouver	2	3	4	4	9	9	9	8	1	9
Maximum Difference (age and sex categories combined)	4.2	11.1	5.4	4.8	3.9	4.5	11.1	6.0	2.6	3.1
Maximum Difference (adjusted for age and sex)	3.7	38.4	4.0	2.8	14.7	3.1	19.0	4.6	2.6	3.0

PF = Physical Function, RP = Role Physical, BP = Bodily Pain, GH = General Health Perceptions, VT = Vitality, SF = Social Functioning, RE = Role Emotional, MH = Mental Health, PCS = Physical Component Score, MCS = Mental Component Score
A ranking of 1 represents the highest (best) score, while a ranking of 9 represents the lowest (poorest) score.
Maximum difference refers to the maximum calculated difference within each domain. The first maximum difference is based on the average per centre without adjusting for age and sex. The second maximum difference is calculated within each age/sex combination for each domain and is therefore the more accurate of the two.

RESULTS

Data were collected between January of 1996 and September of 1997. The entire sample consisted of 9,423 participants, with a mean age of 62.1 years and a standard deviation (SD) of 13.4 years. There were 2,884 men (mean age 59.9, SD 14.5 years, range 25-97 years), and 6,539 women (mean age 63.0, SD 12.8 years, range 25-103 years). Table I indicates that each centre was well represented, and the age and gender distributions were similar across the centres.

Table II contains the relative ranking attained by each of the centres on each of the domains of the SF-36, with age and sex combined within each region. This descriptive analysis was undertaken prior to completing the Bayesian hierarchical modelling. The highest (best) score is assigned a ranking of one, while the lowest (poorest) score is assigned a ranking of nine. For example, on the physical functioning domain, Toronto attained the highest score, while Hamilton had the poorest. Wide variation is apparent across all of the centres on all domains and summary scores of the SF-36.

The magnitude of the maximum difference between centres (e.g., the difference between the centre scoring the highest and the centre scoring the lowest) is close to or below the five points identified as clinically and socially relevant by the developers.[1,2] The exceptions are the role physical and role emotional domains, where there was a difference of 11.1 points between the highest (St. John's in both cases) and the lowest (Hamilton and Vancouver, respectively) scoring centres prior to assessing the age and gender stratifications. While these data are interesting, they must be treated with caution because they do not take into account the age and gender stratifications. As a

TABLE III

Mean Differences and Probability of a Clinically Important Effect

Women		Centre								
Domain	Centre and Age Group	Vancouver	Calgary	Saskatoon	Hamilton	Toronto	Kingston	Quebec City	Halifax	St. John's
Role	St. John's	13.5 99.7	11.5 99.1	9.5 95.2	15.0 99.8	10.7 98.2	11.9 99.1	14.0 99.6	9.7 95.7	–
Physical	55-64	(7.4, 19.7)	(6.1, 17.5)	(4.2, 14.8)	(8.5, 21.6)	(5.4, 16.1)	(6.1, 17.9)	(7.6, 20.4)	(4.3, 15.1)	–
Role	St. John's	11.8 98.1	12.5 98.8	12.6 98.7	17.4 99.6	7.8 83.5	14.7 99.4	10.2 96.4	9.2 93.1	–
Physical	65-74	(5.5, 18.2)	(6.3, 18.6)	(6.3, 18.6)	(10.2, 24.4)	(2.1, 13.4)	(7.9, 21.4)	(4.5, 15.8)	(3.5, 14.7)	–
Role	St. John's	25.6 100.0	38.4 100.0	32.0 100.0	29.4 100.0	31.2 100.0	23.3 100.0	12.0 95.9	28.9 100.0	–
Physical	75 +	(16.7, 34.4)	(29.2, 47.5)	(23.6, 40.6)	(20.8, 37.5)	(21.8, 40.8)	(15.0, 31.5)	(4.0, 19.9)	(20.4, 37.3)	–
Role	Quebec City	13.5 97.2	26.3 100.0	19.9 100.0	17.4 99.6	19.2 99.8	11.3 91.9	–	16.8 99.5	-12.0 95.9
Physical	75 +	(4.6, 22.4)	(17.2, 35.8)	(10.9, 29.1)	(8.4, 26.4)	(9.6, 29.2)	(2.5, 20.0)	–	(8.1, 25.5)	(-19.9, -4.0)
Vitality	Quebec City	8.5 95.6	11.4 99.8	10.2 99.5	12.2 99.9	9.8 99.1	14.7 100.0	–	9.4 98.2	8.5 95.6
	75 +	(4.5, 12.5)	(7.3, 15.5)	(6.3, 14.4)	(7.7, 16.7)	(5.8, 14.1)	(9.8, 19.4)	–	(5.3, 13.7)	(4.5, 12.8)
Role	Calgary	-8.4 79.9	–	-11.7 94.7	-2.7 29.2	-3.9 39.4	-10.5 91.2	-10.0 89.0	-5.2 51.3	-19.0 100.0
Emotional	75 +	(-16.7, -0.8)	–	(-19.7, -3.8)	(-10.4, 4.6)	(-12.1, 3.9)	(-18.5, -2.9)	(-18.2, -2.5)	(-12.9, 1.9)	(-27.1, -10.5)
Role	St. John's	10.6 96.3	19.0 100.0	7.4 80.3	16.3 99.9	15.2 99.5	8.5 87.8	9.1 91.5	13.8 99.6	–
Emotional	75 +	(4.4, 17.2)	(10.5, 27.0)	(1.9, 13.0)	(9.3, 23.1)	(7.9, 23.0)	(3.0, 14.1)	(3.2, 15.0)	(7.2, 20.6)	–

Men		Centre								
Domain	Centre and Age Group	Vancouver	Calgary	Saskatoon	Hamilton	Toronto	Kingston	Quebec City	Halifax	St. John's
Role	St. John's	22.7 96.4	29.7 96.6	20.0 96.2	27.3 96.5	21.4 96.3	16.8 95.7	11.7 89.1	23.1 96.5	–
Physical	75+	(1.8, 35.2)	(2.4, 43.6)	(1.8, 31.6)	(2.2, 40.6)	(1.8, 34.2)	(1.6, 27.4)	(0.4, 21.9)	(2.0, 35.2)	–
Role	Quebec City	11.0 81.6	18.0 94.3	8.3 71.3	15.6 92.2	9.7 76.5	5.0 52.2	–	11.5 83.5	-11.7 10.9
Physical	75 +	(-1.2, 23.8)	(1.0, 32.0)	(-3.0, 20.3)	(0.7, 29.3)	(-2.0, 22.9)	(-5.4, 16.3)	–	(-0.5, 24.3)	(-21.9, -0.4)

The first row within each cell represents mean differences (centre in row – centre in column) AND the probability of a clinically important effect, that is, the probability that the difference between centres is greater than or equal to five points; the second row within each cell contains the 95% credible regions for mean differences.

result, effects in one direction in one age and gender group may cancel opposite effects in other strata. However, even when examining the maximum between-site differences within all age and gender categories within each domain, there were still only three domains (role physical at 38.4, role emotional at 19.0 and vitality at 14.7) in which the largest between-centre comparison exceeded five points (Table II, last row).

The hierarchical modelling indicates that there are very few clinically meaningful between-centre differences, when comparing those within the same age and gender stratification, in the domains of physical functioning, bodily pain, general health perception, social functioning, mental health, and the physical and mental component summary scores. Table III presents data (by domain, age group and centre) in which meaningful differences were found. Two domains, vitality and role emotional, showed some potentially meaningful between-centre differences in females aged 75+. For vitality, the 75+ females from Quebec City scored higher than their counterparts, with mean differences ranging from 8.5 (as compared to Vancouver) to 14.7 (Kingston). For role emotional, the 75+ females from St. John's scored somewhat higher than their counterparts in other centres, with mean differences ranging from 7.4 (Saskatoon) to 19.0 (Calgary). Females 75+ from Calgary scored somewhat lower than their peers, with mean differences ranging from -2.7 (Hamilton) to -19.0 (St. John's).

For the final domain, role physical, there were some between-centre differences for males aged 75+. Those from St. John's and to a lesser extent those from Quebec City scored higher than their counterparts at other sites. For St. John's, the differences ranged from 11.7 (Quebec City) to 29.7 (Calgary), and for Quebec City, the differences ranged from 5.0 (Kingston) to 18.0 (Calgary). St. John's women in the age groups 55-64 years and 65-74 years scored higher on the role physical domain than the other sites. For the age group 55-64 years, differences ranged from 9.5 (Saskatoon) to 15.0 (Hamilton), while for the age group 65-74 years, they ranged from 7.8 (Toronto) to 17.4 (Hamilton). For the age group of 75+, women from St. John's and from Quebec City scored somewhat higher than the other centres. For St. John's, differences ranged from 12.0 (Quebec City) to 38.4 (Calgary), while for Quebec City, the differences ranged from 11.3 (Kingston) to 26.3 (Calgary). It should be noted, however, that where sizeable between-site differences are noted, the credible regions are quite wide.

DISCUSSION

The question of quality-of-life variation between Canadian cities and the surrounding regions needs to be addressed to identify whether regional normative data need to be developed, or whether the Canadian normative data[5] are valid for use across Canada. While the centres can be ranked in terms of their scores, Table II indicates that there is wide variation across the domains and the summary scores in terms of the relative ranking of each centre. Looking across the many comparisons made, there were very few differences that reached clinical importance, so that overall there appears to be no strong need for region-specific norms over most domains.

Given that the hierarchical modelling examined between-site differences on the basis of nine sites, six age groups and two gender groups for eight SF-36 domains and two summary scores, the absence of between-centre variation other than that identified in Table III is noteworthy. The data therefore suggest that the Canadian SF-36 normative data already published[5] can be used for most comparative purposes. Since many comparisons were done, some differences may have arisen due to chance variations alone. In general, hierarchical modelling reduces the probability of such chance findings, by borrowing strength from all regions to estimate the domain means from each individual region. Nevertheless, chance remains a possible explanation for some of the differences reported in Table III.

One limitation of our study is that although the CaMos participants were randomly selected, not everyone invited decided to participate. Therefore, the results apply only to those who participated (or would have participated had they been invited), who may differ from the Canadians who did not (or would not) participate. It is therefore possible that the regions do vary but we did not find this because only certain people were interested in participating. Our data also do not allow us to fully investigate rural regions, since each of our study centres was based in an urban area. Although the 50-km region around each urban centre included surrounding rural areas, it remains possible that differences between rural regions in Canada exist that are not captured by our data.

In conclusion, our finding of only a few small differences within a few age groups within three centres suggests that there is no need to develop region-specific Canadian normative data for the SF-36 health survey. However, the few differences we did find should be kept in mind when comparing role physical scores of women aged 55 years and older in St. John's to Canadian normative data, and for three domains when assessing women aged 75 years and over in St. John's and Quebec City. For men, caution needs to be used when assessing the role physical scores of men aged 75 years and over in Quebec City and St. John's. Other than this minor variation, it appears that those living in various Canadian cities and their surrounding areas have similar health-related quality of life.

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RÉSUMÉ

Contexte : Les données normatives canadiennes s'appliquant à la version abrégée du questionnaire sur l'évolution médicale comportant 36 questions (SF-36) ont été publiées récemment. Toutefois, les données recueillies dans d'autres pays suggèrent qu'il peut exister des variations régionales au niveau de la qualité de vie reliée à l'état de santé (HRQOL). Nous avons donc étudié les données du SF-36 provenant de neuf centres canadiens pour démontrer les différences systématiques.

Méthodes : Un modèle hiérarchique bayésien a été utilisé pour comparer les différences entre les résultats des huit domaines du SF-36 et des deux composantes sommaires pour chaque strate d'âge et de sexe, et ce, pour les neuf centres.

Résultats : Les résultats de cinq domaines et des deux composantes sommaires démontraient des différences peu significatives cliniquement. Outre de rares exceptions, il y avait peu d'évidence de variations du HRQOL entre la plupart des domaines et des centres.

Interprétation : Les résultats obtenus, ne démontrant que de légères différences, suggèrent qu'il n'est pas nécessaire d'établir des données normatives spécifiques aux régions du Canada pour le questionnaire de santé SF-36.

Appendix A

The Three Stages in the Development of the Hierarchical Models

At the first stage, the SF-36 domain score for each subject within each individual region is assumed to follow a normal distribution with mean μ_i and variance σ^2_i. That is,

$$x_{ij} \sim N(\mu_i, \sigma^2_i),$$

where x_{ij} represents the SF-36 domain score for the j^{th} subject in the i^{th} region. Next, at the second stage, the means across regions are considered to follow a normal distribution,

$$\mu_i \sim N(\theta, \tau^2),$$

where θ represents the overall mean SF-36 domain value across all regions, and τ^2 represents the region-to-region variance in the means, μ_i. Therefore, if τ^2 is small, there is little regional variation for this domain of the SF-36, with larger values indicating more regional variation. Posterior distributions of all unknown quantities are estimated essentially using information from the data alone, since noninformative or "diffuse" prior distributions were used throughout. Specifically, we used normal priors with a very large variance of 1000 for all unknown means, so that the prior curve is roughly flat over the region where there is appreciable likelihood. As is standard in the BUGS software we used, priors over variances are rather specified as priors over the precision, which is defined to be the reciprocal of the variance. Therefore, small prior precision values correspond to large prior variances. We used a gamma(4,8) prior distribution over the precision corresponding to σ^2_i, roughly corresponding to a range for the precision of 0 to 1, or a range for the variance of 1 to close to infinity. Similarly, we used a gamma(4,2) prior distribution over the precision corresponding to τ^2, roughly corresponding to a range for the precision of 0 to 4, or a range for the variance of 0.25 to close to infinity. These prior distributions form the third stage of our hierarchical model.

From the posterior distributions of the region-specific means, μ_i, we can directly calculate the probability that the mean domain value of any one region is greater than the mean value on that domain in any other region. Since a difference of less than 5 points is generally considered to be of little clinical importance,[1] we calculated the probabilities that one region differs by at least this amount compared to any other region. Therefore, our model allows us to estimate the probability of a clinically important difference between any two regions in any domain.

An exact analytic solution for this complex model is impossible. Inferences were therefore carried out using the Gibbs sampler, a Markov chain Monte Carlo approach to numerical integration, wherein random samples from the marginal distribution of each parameter of interest are generated by intensive computer calculations. We used samples of size 5000 or greater for each parameter, in order to provide a high degree of accuracy in the final estimates. The criterion of Raftery and Lewis[12] was used to ensure convergence and estimate the number of iterations required. After ensuring convergence, empirical summary statistics can be formed and used to make inferences about the true values of the quantities of interest. This computation work was carried out using BUGS software.[13]

Appendix B

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