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The Minneapolis-Manchester Quality of Life Instrument: Reliability and Validity of the Adult Form in Cancer Survivors

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Abstract

Purpose—Childhood cancer survivors are at risk for deficits in health-related quality of life (HRQL) as they age. Youth (8–12 years) and adolescent (13–20 years) versions of the Minneapolis-Manchester Quality of Life Instrument (MMQL) have been developed to address survivor-specific issues and are currently in use; the MMQL-Adult Form has now been developed to assess HRQL in childhood cancer survivors aged 21 to 55 years.

Methods—The MMQL-Adult Form was administered to 499 adults: 65 cancer patients on-therapy, 107 off-therapy, and 327 healthy controls. Forty-four percent of patients were under 30 years old at cancer diagnosis. Principal components analysis was performed. We evaluated internal consistency reliability, stability (re-administration of the MMQL-Adult Form 2 weeks later), construct validity (concurrent administration of the SF-36), and known-groups validity (score comparisons across the three groups).

Results—Principal components analysis resulted in retention of 44 items across six scales: social functioning, physical functioning, cognitive functioning, outlook on life, body image, and psychological functioning. Internal consistency (Cronbach's α) was 0.80–0.90 for individual scales and 0.95 overall. Strong intraclass correlations (0.98 overall) indicated high stability. The

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COMPLIANCE WITH ETHICAL STANDARDS

Conflict of interest

The authors declare that they have no conflict of interest.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent

Informed consent was obtained from all individual participants included in the study.

MMQL-Adult Form distinguished between known groups; healthy controls scored better than patients on four of six scales. The MMQL-Adult Form scales correlated highly with similar SF-36 scales, demonstrating construct validity.

Conclusions—The MMQL-Adult Form is a reliable and valid self-report instrument for measuring multidimensional HRQL in cancer survivors. Development of this instrument ensures availability of a tool enabling cross-sectional and longitudinal assessment of HRQL in childhood cancer survivors as they age.

Keywords

cancer; oncology; quality of life; psychometrics; childhood cancer survivors

BACKGROUND

Long-term survival after childhood cancer has become an increasingly likely outcome; 5-year survival in children with cancer diagnosed before age 20 now exceeds 80% [1]. The population of childhood cancer survivors in the United States is estimated to be over 400,000, 72% of whom are 20 years of age or older [1]. Childhood cancer survivors have an extraordinarily high prevalence of chronic health conditions [2–4]; in fact, over half of childhood cancer survivors have at least one severe/life-threatening complications by age 50 [5], necessitating increasing attention to health-related quality of life (HRQL) among childhood cancer survivors as they age [6–8].

A number of self-report instruments exist to measure HRQL in adults, but there are significant limitations to their utility in adult survivors of childhood cancer. The SF-36 [9] is among the most widely-used HRQL tools, but because it is a generic instrument, it fails to address some specific concerns of cancer survivors, such as cognitive functioning. Cancer-specific tools for measuring HRQL in adult cancer patients (e.g., European Organization for Research and Treatment of Cancer Quality of Life Questionnaire [EORTC QLQ-C30] [10], Functional Assessment of Cancer Therapy-General [FACT-G] [11], Functional Living Index-Cancer [FLIC] [12]) address issues faced by those receiving active treatment (e.g., nausea, coping with illness and treatment) and are well-suited for use in clinical trials. However, portions of these instruments are less likely to be relevant to cancer survivors who have completed treatment, sometimes decades ago, and face a different set of challenges [13]. Instruments developed for adult cancer survivors (e.g., Quality of Life-Cancer Survivors [QOL-CS] [14], Quality of Life in Adult Cancer Survivors [QLACS] [15]) have been shown to have poor construct validity in young adult survivors of childhood cancer [16,17], likely because they were developed for survivors of adult-onset cancer, rather than childhood cancer, and were validated in older adults (e.g., the mean age of participants in the QLACS validation was 71 years). The Impact of Cancer-Childhood Survivor (IOC-CS) Scale was developed to measure the impact of childhood cancer in young adult survivors on areas missing from existing HRQL instruments [18,19]. Subscales include life challenges, body and health, thinking and memory problems, socializing, and relationship concerns. However, the IOC-CS is not a comprehensive stand-alone HRQL instrument and is intended to supplement other instruments.

We have developed the Minneapolis-Manchester Quality of Life Instrument-Adult Form (MMQL-Adult Form) to address a critical need for a comprehensive, multidimensional self-report instrument to assess HRQL in adult survivors of childhood cancer. Other versions of the MMQL, the Youth Form (for ages 8 to 12) [20] and the Adolescent Form (for ages 13 to 20) [21], have been previously validated and are currently in use [22–38]. The three versions of the MMQL contain developmentally appropriate yet common domains, allowing for assessment of longitudinal trends in HRQL among childhood cancer survivors as they mature and transition from one age group to the next. The development and validation of the MMQL-Adult Form is addressed here.

METHODS

Instrument development

The MMQL-Adult Form was created by adapting the MMQL-Adolescent Form for an older population. Similar to the Adolescent Form, the Adult Form examines multidimensional HRQL, including physical, social, psychological, and cognitive functioning, in the context of cancer, its treatment, and the sequelae of both. The Adolescent Form included 93 items (prior to item reduction) addressing issues identified by patients, parents, and medical staff in a focus group and open interviews [21]. The research team reviewed all items for relevance to the adult population. Twelve items relating to body development, family relations, school, and dating were excluded because they were not age-appropriate for the adult population (Table 1), resulting in retention of 81 items. Most items were constructed using a four- or five-point response scale, with one yes/no item. Scores for each item were converted to a five-point scale and reversed when appropriate, with higher scores indicating better HRQL. To validate the MMQL-Adult Form, we first performed principal components analysis for item reduction and instrument refinement. We then assessed the instrument's internal consistency reliability, test-retest reliability/stability, known-groups validity, and construct validity.

Participants and procedure

Participants were English-speaking adults between the ages of 21 and 55 years, and were drawn from three populations: cancer patients currently receiving therapy (“on-therapy”), cancer patients after completion of therapy (“off-therapy”), and healthy controls. The study was approved by City of Hope's institutional review board. Participants provided written informed consent in accordance with the Declaration of Helsinki.

Participants with cancer were drawn from two patient populations at City of Hope: patients on therapy for at least 6 weeks and patients off therapy for at least 4 months. For the on-therapy group, consecutive patients were approached. For the off-therapy group, we randomly selected a sample of patients from a list of all eligible patients. To minimize respondent burden, patients were randomly assigned to either the validation or the test-retest arm of the study. Patients on the validation arm completed the MMQL-Adult Form and the SF-36 concurrently, while those on the test-retest arm completed the MMQL-Adult Form on two occasions approximately two weeks apart. The questionnaires were self-administered and completed in clinic or by mail.

Normative data were constructed by enrolling healthy adults who had no history of cancer or other chronic illness from throughout the United States recruited using internet bulletin boards such as craigslist.org. Healthy controls were frequency-matched to patients on sex, age, and education. The questionnaire was completed by mail. Healthy controls also completed an eligibility checklist by mail to ensure they met eligibility criteria; participants with cancer or chronic health conditions such as diabetes, high blood pressure, chronic bronchitis, kidney disease, heart failure, heart attack, epilepsy, Alzheimer's disease, liver disease, or hepatitis were excluded from the study. Healthy control participants received \$20 compensation for their participation.

Demographic information (age, sex, race/ethnicity, marital status, and education) was collected from all participants by self-report. Clinical information (diagnosis and time on or off therapy) was abstracted from patients' medical records.

Statistical analysis

To refine the instrument and identify elements of HRQL in adult cancer survivors, we conducted principal components analysis with varimax rotation with Kaiser normalization. Since items were constructed using Likert-type response scales, responses were treated as assumed-interval data and a Pearson correlation matrix was used for the principal components analysis. We used a combination approach to determine how many factors to retain, focusing on factors with eigenvalues ≥ 1 , scree plot shape, and theoretical underpinnings. Items with factor loadings ≥ 0.40 were retained.

We assessed the instrument's internal consistency reliability (correlation of items hypothesized to represent a single construct) by calculating Cronbach's α [39] for each scale and for the overall MMQL-Adult Form. It has been recommended that scale reliability meet a minimum standard of 0.80 [40–42]. We also calculated corrected item-total correlations for each item, measuring the correlation of the item with its scale, after removing the item itself.

A subset of patients completed the MMQL-Adult Form twice, approximately two weeks apart, to measure test-retest reliability/stability. Intraclass correlations were calculated for each scale and overall for the two administrations.

Known-groups validity for each scale and for the overall MMQL-Adult Form was tested by comparing scores across the three participant groups using one-way analysis of variance (ANOVA) followed by Scheffe post hoc tests (appropriate for comparing groups of unequal size). We expected that the MMQL-Adult Form would differentiate between the groups, with healthy controls scoring higher (better HRQL) than patients, and off-therapy patients scoring higher than on-therapy patients.

Construct validity was assessed using Pearson's correlation coefficient, r , to compare scores from SF-36 scales with scores from MMQL-Adult Form scales hypothesized to tap similar domains. The SF-36 was chosen to align the assessment of the psychometric properties of the Adult Form with that used for the Youth and the Adolescent Forms (where the Child Health Questionnaire [CHQ] was used to establish construct validity). The CHQ was

developed to assess HRQL in children using structure and methodology similar to those used to develop the SF-36. Furthermore, the CHQ can be mapped onto the SF-36, allowing for longitudinal measurement of HRQL as patients transition from pediatric to adult care [43]. Furthermore, there is no existing cancer-specific questionnaire that would be appropriate for assessing HRQL in young adult survivors of childhood cancer that could have been used in place of the SF-36. Therefore, for consistency, it was most appropriate to use the SF-36 to assess construct validity for the MMQL-Adult Form. The SF-36 includes 36 items assessing the following domains: physical functioning, role limitations due to physical health, role limitations due to emotional health, vitality, mental health, social functioning, bodily pain, and general health. We hypothesized that certain MMQL-Adult Form scales would correlate with conceptually related SF-36 scales as follows: MMQL social functioning with SF-36 social functioning; MMQL physical functioning with SF-36 physical functioning, role physical, bodily pain, general health, and vitality; MMQL outlook on life with SF-36 general health; and MMQL psychological functioning with SF-36 role emotional and mental health. Effect sizes (Pearson's r values) of 0.10 were classified as small, 0.30 as medium, and 0.50 as large [44].

Two-sided P values below 0.05 were considered to be statistically significant. Statistical analysis was conducted using IBM SPSS Statistics v. 21.

RESULTS

A total of 499 adults participated; their demographic and clinical characteristics are shown in Table 2. Participants included 327 healthy controls, 65 on-therapy cancer patients, and 107 off-therapy cancer patients. The median time on therapy was 1.8 years (range, 7 weeks to 7.1 years) and the median time off therapy was 5.7 years (range, 5.5 months to 24.8 years). Approximately 30% of the off-therapy patients and 8% of the on-therapy patients participating in the study were survivors of childhood or adolescent cancer diagnosed before age 22; an additional 24% of off-therapy patients and 20% of on-therapy patients were diagnosed between ages 22 and 30. There were no significant differences in age, sex, or education for the three groups. However, there was an underrepresentation of Hispanics (9.8% vs. 23.8%, $P < 0.001$) and married individuals (35.8% vs. 57.6%, $P < 0.001$) among the healthy controls, compared to patients.

Principal components analysis

The Kaiser-Meyer-Olkin value, a measure of sampling adequacy, was 0.93, and the P value of Bartlett's test of sphericity was < 0.001 . Using the combination approach for determining number of factors, we initially found a seven-factor solution. The last factor, containing just three items addressing energy, was conceptually related to another factor addressing physical functioning, so we ran a six-factor solution. The final six-factor solution explained 52.3% of the total variance. Thirty-seven items with low factor loadings were eliminated from the final version of instrument. The instrument's 44 remaining items comprised six scales: (1) social functioning (interpersonal relationships, 9 items, eigenvalue 14.2, explaining 10.9% of variance); (2) physical functioning (functional status in activities of daily living, pain, and energy, 12 items, eigenvalue 3.45, explaining 10.9% of variance); (3) cognitive functioning

(disease- and treatment-related cognitive sequelae, 7 items, eigenvalue 2.62, explaining 9.4% of variance); (4) outlook on life (satisfaction with current life situation, 4 items, eigenvalue 2.08, explaining 7.4% of variance); (5) body image (self-perception of body image, an indicator of self-esteem, 5 items, eigenvalue 1.97, explaining 7.1% of variance); and (6) psychological functioning (emotional functioning, 7 items, eigenvalue 1.44, explaining 6.7% of variance).

Overlap in scales measured by the MMQL-Adult Form, the MMQL-Adolescent Form, and the MMQL-Youth Form is shown in Table 3. All three versions include scales measuring physical functioning, psychological functioning, and outlook on life (though in the Youth Form, this scale is called outlook on life/family dynamics and also includes items about parent and sibling relations). Additionally, both the Adolescent and Adult Forms include scales measuring cognitive functioning, body image, and social functioning. Furthermore, of the 44 items retained in the Adult Form, 34 also appeared on the final version of the Adolescent Form (Table 4). Of these items, 31 loaded on the same scale in the Adolescent Form and three loaded on a different scale in the Adolescent Form (all were on the intimate relations scale of the Adolescent Form, which did not emerge in the Adult Form analysis; two ended up on the social functioning scale of the Adult Form and one on the outlook on life scale). Ten items were unique to the Adult Form.

Internal consistency reliability

Item-total correlations, corrected for overlap, ranged from 0.44 to 0.81 (Table 4). Internal consistency (Cronbach's α) for each scale ranged from 0.80 to 0.90 (Table 4). The instrument's overall internal consistency was 0.95. The weighted mean of the scales was also calculated ($\alpha=0.95$). These results suggest that the MMQL-Adult Form items are internally consistent and appear to represent a single construct.

Test-retest reliability/stability

A subset of 41 cancer patients completed the MMQL-Adult Form twice. Intraclass correlations for the two administrations of the MMQL-Adult Form were 0.82 for social functioning, 0.96 for physical functioning, 0.88 for cognitive functioning, 0.94 for outlook on life, 0.92 for body image, and 0.95 for psychological functioning ($P<0.05$ for all scales). The intraclass correlation for the overall MMQL-Adult Form was 0.95 ($P<0.05$), indicating high stability.

Known-groups validity

Results from known-groups validity tests from the three study populations are shown in Table 5. Healthy controls scored higher than on-therapy and/or off-therapy patients on the overall MMQL-Adult Form and on four of the six scales (physical functioning, cognitive functioning, body image, and psychological functioning), with no differences between groups for the social functioning and outlook on life scales. Off-therapy patients scored higher than on-therapy patients on physical functioning, while on-therapy patients scored higher than off-therapy patients on social functioning.

Construct validity

A subset of 131 cancer patients (49 on-therapy and 82 off-therapy) completed the MMQL-Adult Form and the SF-36 concurrently. Table 6 shows correlations between MMQL-Adult Form and SF-36 scales. All of the hypothesized correlations were statistically significant, with medium-to-large effect sizes. Significant (although generally weaker) correlations were also found between nearly all of the other MMQL-Adult Form and SF-36 scales, which was not predicted *a priori*. The stronger unpredicted correlations are not surprising; for example, the large correlation between MMQL-Adult Form cognitive functioning and SF-36 vitality is consistent with literature linking cognitive functioning and energy levels [15,45,46].

DISCUSSION

The present study provides evidence for the reliability and validity of the MMQL-Adult Form, a comprehensive self-report instrument created to measure multidimensional HRQL in adult survivors of childhood cancer. Strong intraclass correlations (0.98 overall) indicated high stability. The MMQL-Adult Form distinguished between known groups. Healthy controls scored higher than on-therapy and/or off-therapy patients on the overall MMQL-Adult Form, as well as on four of the six scales. Off-therapy patients scored higher than on-therapy patients on physical functioning. The MMQL-Adult Form scales correlated highly with similar SF-36 scales, demonstrating construct validity.

A number of HRQL instruments are available for use in cancer survivors. The MMQL-Adult Form may be a more appropriate instrument for use specifically in adult survivors of childhood cancer. Existing instruments may not capture unique concerns of this group because they were created for the general population [9], cancer patients receiving active treatment [10–12], or older survivors [14,15]. The MMQL-Adult Form improves on past instruments by addressing concerns that were identified as missing from other tools in interviews with young adult survivors of childhood cancer [47]. For example, the MMQL-Adult Form includes an item on difficulties in having intimate relationships (an area missing from the SF-36, QLACS, and QOL-CS), and a seven-item scale on problems with concentration and memory (concerns not addressed in the SF-36).

The findings in this study need to be placed within the context of its limitations. Although the instrument is intended to be used by adult survivors of childhood cancer, it should be noted that some of the patients who participated in this validation study were survivors of adult-onset cancer. Most survivors of childhood cancer have completed therapy by the time they reach adulthood and thus it would not be possible to establish known-groups validity by comparing adult survivors of childhood cancer who were presently receiving therapy to those who had completed therapy. We chose to ensure that age-appropriate HRQL issues were adequately represented in the study by including survivors of adult cancer. However, while fewer than one-quarter of patients in the study were diagnosed before age 22, survivors of childhood cancers were still fairly well represented, especially among off-therapy patients (the instrument's intended population); over half of the off-therapy patients in the study were diagnosed before age 30.

Additionally, because the MMQL-Adult Form was adapted from the MMQL-Adolescent Form to maximize consistency and enable comparisons across the three versions of the instrument, no additional items specific to the adult population were added. Some adult survivors of childhood cancer may have quality of life concerns in areas that are not addressed in the MMQL-Adult Form, such as fertility and sexual functioning [48]. Thus, the primary purpose of the MMQL-Adult Form is to allow assessment of cancer survivors across all ages. When considering use of MMQL-Adult Form to assess HRQL in adult cancer survivors, it may be helpful to use it in combination with other QOL instruments that address issues such as sexual functioning and fertility concerns.

While self-identification and volunteer participation by the healthy controls could have introduced some un-measured bias, frequency matching on the three most critical demographic variables—age, sex, and education—ensured that the controls were as similar to the cases as possible, with the obvious absence of cancer.

Although most scales of the MMQL-Adult Form were able to differentiate between on-therapy patients, off-therapy patients, and healthy controls, we found that scores for these three groups did not differ significantly in some domains. The social functioning and outlook on life scales did not differentiate among the three groups; however, the lack of differences is consistent with past findings of minimal, if any, differences between cancer survivors and comparison groups in social well-being [49]. The cognitive functioning scale differentiated between off-therapy patients and healthy controls, but unexpectedly could not differentiate on-therapy patients from the other two groups. The lack of differences may be a result of the scale's focus on cognitive functioning at work and school, which may not be relevant to those patients who suspend their participation in these activities during their treatment. The same pattern was seen for the body image scale, though one study of adolescent cancer survivors has suggested that body image concerns may not arise until several years after the completion of treatment [50]. Although the MMQL-Adult Form overall and the psychological functioning scales differentiated both groups of patients from healthy controls, they did not differentiate between on-therapy and off-therapy patients. We found that only two of the eight SF-36 scales (role limitations due to physical health and bodily pain) could differentiate between on-therapy and off-therapy patients (data not shown), and other studies that have compared HRQL in patients with different treatment phases have found that HRQL instruments can differentiate between groups only inconsistently [20,21,51], so our findings are not surprising.

Together, the three versions of the MMQL can assess HRQL in childhood cancer survivors aged 8 to 55, allowing for longitudinal and cross-sectional studies of this population to address their needs as they age. A limitation of existing HRQL measures is that each is intended to measure HRQL in a single developmental group (e.g., children or adults) due to the evolving concerns of cancer survivors as they age, precluding continuity of assessment across the age spectrum. For example, in a study of cancer patients aged 15 to 39 years, Smith [52] used both the Short-Form Health Survey 12 (SF-12), validated for those 18 and over, and the Pediatric Quality of Life Inventory (PedsQL), validated in for those 25 and under, because no single instrument had been validated in the entire population of interest. As a result, the analysis sample was divided and the ability to describe the sample as a whole

was restricted. Furthermore, research has revealed that similarly named subscales on different instruments may correlate only weakly, which highlights the potential methodological challenges in comparing HRQL measured by different instruments [53]. In contrast, the domains in the three versions of the MMQL overlap significantly (with some variation in the scales and in the items in similar scales due to the developmental differences in the three age groups), and they were created using similar methodology. In fact, three scales (physical functioning, psychological functioning, and outlook on life) appear on all three versions of the MMQL. Additionally, all of the scales on the MMQL-Adult Form are also included in the MMQL-Adolescent Form, with 70% of the items on the Adult Form appearing on the same scale of the Adolescent Form. The MMQL eliminates the need to switch to entirely different instruments capturing different domains (or capturing domains that look similar but are actually poorly correlated), which should enable more valid comparisons in a wider age range of cancer survivors, as well as allow for longitudinal evaluation of HRQL in cancer survivors.

CONCLUSIONS

The MMQL-Adult Form is a reliable and valid self-report instrument for assessing multidimensional HRQL in cancer survivors aged 21 to 55 years. It can be used along with the MMQL-Youth Form and Adolescent Form to measure HRQL in 8- to 55-year-olds, enabling cross-sectional and longitudinal assessment of childhood cancer survivors. We hope that the MMQL will be used by healthcare providers to aid in identifying, measuring, and managing HRQL concerns in childhood cancer survivors as they age with the goal of maximizing HRQL in this vulnerable population. Normative data from a large group of healthy controls is provided to allow for future comparisons of HRQL between cancer survivors and a control group. All three versions of the MMQL are available to healthcare professionals.

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Table 1

MMQL-Adolescent Form items excluded from the MMQL-Adult Form

<ul style="list-style-type: none">• Think their body is developing any earlier or later than most boys/girls of their age• Are satisfied with their body development right now• Are uncomfortable about the way their body is developing• Their parents treat them same as brothers and sisters• Their parents fuss more about them than about their brothers and sisters• Their parents are usually patient with them• Have the same quantity of chores and responsibilities when compared to their brothers and sisters• Have to miss school because they are not well• Miss school because of hospital appointments or visits to the doctor, nurse, or physical therapist• Need more help with school work than others in their class• Have difficulty with their school work, compared to others in their class• Often date people

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Table 2

Demographic and clinical characteristics of study population

	Study population			P value
	Healthy controls (n=327)	Cancer patients		
		On therapy (n=65)	Off therapy (n=107)	
Age at study participation				
Median (range)	40 (21–55)	41 (21–55)	39 (21–55)	0.5
Sex				
Males	104 (31.8%)	20 (30.8%)	37 (34.6%)	0.8
Race/ethnicity				
Non-Hispanic whites	193 (59%)	41 (63.1%)	69 (64.5%)	<0.001
Hispanics	32 (9.8%)	15 (23.1%)	26 (24.3%)	
Other	102 (31.2%)	9 (13.9%)	12 (11.2%)	
Marital status				
Single	143 (43.7%)	17 (26.2%)	30 (28.0%)	<0.001
Married	117 (35.8%)	37 (56.9%)	62 (57.9%)	
Separated/widowed	67 (20.5%)	11 (16.9%)	15 (14.0%)	
Education				
High school or less	46 (14.1%)	7 (10.8%)	18 (16.8%)	0.6
Some college/other training	125 (38.2%)	23 (35.4%)	43 (40.2%)	
College graduate	109 (33.3%)	20 (30.8%)	29 (27.1%)	
Post graduate	47 (14.4%)	15 (23.1%)	17 (15.9%)	
Primary cancer diagnosis				
Hematological malignancies		24 (36.9%)	55 (51.4%)	0.06
Non-hematological malignancies		41 (63.1%)	52 (48.6%)	
Age at diagnosis				
< 22		5 (7.7%)	32 (29.9%)	<0.001
22 to 29		13 (20.0%)	26 (24.3%)	
>29		47 (72.3%)	49 (45.8%)	
Treatment				
Chemotherapy and radiation		31 (47.7%)	62 (57.9%)	0.005
Chemotherapy alone		34 (52.3%)	36 (33.6%)	
Radiation alone		0 (0%)	9 (8.4%)	

Table 3

Scale overlap among MMQL-Adult Form, MMQL-Adolescent Form, and MMQL-Youth Form

Scale	MMQL version		
	MMQL-Youth Form	MMQL-Adolescent Form	MMQL-Adult Form
Outlook on life	X *	X	X
Physical symptoms	X		
Physical functioning	X	X	X
Psychological functioning	X	X	X
Cognitive functioning		X	X
Body image		X	X
Social functioning		X	X
Intimate relations		X	

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* On the MMQL-Youth Form, the outlook on life scale is called “outlook on life/family dynamics” and also includes items about parent and sibling relations.

Table 4

Internal consistency reliability of MMQL-Adult Form (n=499) and item overlap with MMQL-Adolescent Form: 44 items

Factor	Item description	Corrected item-total correlation *
Social functioning		Alpha=0.87
	<i>Get along well with people their own age ^a</i>	0.67
	<i>Find it difficult to make friends ^b</i>	0.66
	<i>Have similar hobbies and interests to those of people their own age ^a</i>	0.65
	<i>Have many close friends ^a</i>	0.65
	<i>Feel left out in groups of people their own age ^b</i>	0.64
	<i>Believe that people like to be with them ^a</i>	0.59
	<i>Have a lot in common with their friends ^a</i>	0.58
	<i>Feel happy ^c</i>	0.54
	<i>Being together with other people gives them a good feeling ^a</i>	0.54
Physical functioning		Alpha=0.90
	<i>Are a healthy person ^c</i>	0.75
	<i>Feel strong and healthy ^a</i>	0.74
	<i>Cannot do many activities because of their health ^a</i>	0.71
	<i>Are happy with the state of their health ^c</i>	0.68
	<i>Have a lot of energy for running or sports ^a</i>	0.68
	<i>Keep up with their friends in sports ^c</i>	0.66
	<i>Cannot do many activities because of their arms and legs ^a</i>	0.64
	<i>Have a lot of energy ^a</i>	0.64
	<i>Their arms or legs ache ^c</i>	0.63
	<i>Get pains that wake them up at night ^c</i>	0.54
	<i>Have discomfort in their chest during active exercise ^c</i>	0.52
	<i>Have pain in any part of their body that never goes away ^c</i>	0.45
Cognitive functioning		Alpha=0.90
	<i>Have difficulty concentrating at work or school (intensity) ^a</i>	0.80
	<i>Have difficulty concentrating at other times ^a</i>	0.76
	<i>Have difficulty concentrating at school/work (frequency) ^a</i>	0.76
	<i>Have difficulty remembering things at college or work ^a</i>	0.72
	<i>Work or study is hard for them ^a</i>	0.71
	<i>Have difficulty with reading and writing ^a</i>	0.66

Factor	Item description	Corrected item-total correlation *
	<i>Have difficulty with math and calculations ^a</i>	0.56
Outlook on life		Alpha=0.85
	<i>Are satisfied with their current life situation ^a</i>	0.81
	<i>Are happy with the way things are ^a</i>	0.77
	<i>Are happy with life in general ^a</i>	0.75
	<i>Find it easy to have an intimate relationship ^b</i>	0.44
Body image		Alpha=0.80
	<i>Like their body the way it is ^a</i>	0.74
	<i>Are happy with the way they look ^a</i>	0.65
	<i>Are satisfied with their weight ^a</i>	0.63
	<i>Wish they were in better physical condition ^c</i>	0.53
	<i>Can always look good if they try ^c</i>	0.51
Psychological functioning		Alpha=0.85
	<i>Feel frightened ^a</i>	0.66
	<i>Are worried about things in general ^a</i>	0.65
	<i>Feel anxious or nervous ^a</i>	0.62
	<i>Are worried about their health ^a</i>	0.61
	<i>Feel sad ^a</i>	0.60
	<i>Feel lonely ^a</i>	0.60
	<i>Are worried about dying ^a</i>	0.54

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* α is Cronbach's internal consistency reliability coefficient [35]. MMQL-Adult Form overall scale α =0.95.

^a Item appears on same scale of MMQL-Adolescent Form.

^b Item appears on different scale (intimate relations) of MMQL-Adolescent Form.

^c Item does not appear on MMQL-Adolescent Form.

Table 5

Known-groups validity for MMQL-Adult Form

Factor	Scale range	Study population								P value
		Healthy controls (n=327)				Cancer patients				
		Off therapy (n=107)		On therapy (n=65)		Off therapy (n=107)		On therapy (n=65)		
	Min	Max	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Social functioning	1.00	5.00	3.97	0.7	3.89	0.8	4.18	0.6	0.03	0.03
Physical functioning	1.17	5.00	4.29	0.6	3.81	0.8	3.47	1.0	<0.001	<0.001
Cognitive functioning	1.00	5.00	4.20	0.7	3.90	0.9	4.02	0.8	<0.001	<0.001
Outlook on life	1.00	5.00	3.76	1.0	3.80	0.9	3.50	1.1	0.1	0.1
Body image	1.00	5.00	3.36	0.8	3.04	0.8	3.13	0.7	0.001	0.001
Psychological functioning	1.29	5.00	4.02	0.6	3.76	0.7	3.78	0.7	<0.001	<0.001
MMQL	1.51	5.00	4.01	0.6	3.73	0.6	3.72	0.6	<0.001	<0.001

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Post hoc findings:

Social functioning: off-therapy scores significantly lower than on therapy scores.

Physical functioning: on-therapy scores significantly lower than off-therapy and healthy control scores; off-therapy scores significantly lower than healthy control scores.

Cognitive functioning: off-therapy scores significantly lower than healthy control scores.

Outlook on life: no difference post hoc.

Body image: off-therapy scores significantly lower than healthy control scores.

Psychological functioning: on-therapy and off-therapy scores significantly lower than healthy control scores.

MMQL: on-therapy and off-therapy scores significantly lower than healthy control scores.

Table 6

Construct validity of MMQL-Adult Form with SF-36 (n=131)

MMQL	SF-36							
	Physical functioning	Role physical	Role emotional	Vitality	Mental health	Social functioning	Bodily pain	General health
Social functioning								
Pearson correlation	0.11	0.15	0.24 [†]	0.37 [†]	0.48 [†]	0.44[*]	0.29 [†]	0.36 [†]
Significance	0.2	0.09	0.007	<0.001	<0.001	<0.001	0.001	<0.001
Physical functioning								
Pearson correlation	0.59[*]	0.57[*]	0.26 [†]	0.74[*]	0.33 [†]	0.55 [†]	0.70[*]	0.75[*]
Significance	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001
Cognitive functioning								
Pearson correlation	0.26 [†]	0.42 [†]	0.39 [†]	0.63 [†]	0.48 [†]	0.50 [†]	0.48 [†]	0.43 [†]
Significance	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Outlook on life								
Pearson correlation	0.22 [†]	0.34 [†]	0.40 [†]	0.53 [†]	0.59 [†]	0.55 [†]	0.39 [†]	0.49[*]
Significance	0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Body image								
Pearson correlation	0.19 [†]	0.19 [†]	0.25 [†]	0.35 [†]	0.30 [†]	0.29 [†]	0.32 [†]	0.45 [†]
Significance	0.03	0.03	0.004	<0.001	0.001	0.001	<0.001	<0.001
Psychological functioning								
Pearson correlation	0.13	0.24 [†]	0.38[*]	0.48 [†]	0.64[*]	0.40 [†]	0.34 [†]	0.48 [†]
Significance	0.1	0.006	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

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^{*}Correlations consistent with a priori hypotheses[†]Significant correlations that were not hypothesized a priori