

Measurement of quality of recovery using the QoR-40: a quantitative systematic review

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Editor's key points

- Quality of recovery is an important component of overall outcome measures.
- The authors evaluated psychometric properties of QoR-40, a quality of recovery measurement tool.
- Seventeen studies with a sample size of 3459 patients were entered into meta-analysis.
- The authors conclude that QoR-40 is well suited to measure quality of postoperative recovery.

Background. Several rating scales have been developed to measure quality of recovery after surgery and anaesthesia, but the most extensively used is the QoR-40, a 40-item questionnaire that provides a global score and subscores across five dimensions: patient support, comfort, emotions, physical independence, and pain. It has been evaluated in a variety of settings, but its overall psychometric properties (validity, reliability, ease of use, and interpretation) and clinical utility are uncertain.

Methods. We undertook a quantitative systematic review of studies evaluating psychometric properties of the QoR-40. Data were combined in meta-analyses using random effects models. This resulted in a total sample of 3459 patients from 17 studies originating in nine countries.

Results. We confirmed content, construct, and convergent [pooled $r=0.58$, 95% confidence interval (CI): 0.51–0.65] validity. Reliability was confirmed by excellent intraclass correlation (pooled $\alpha=0.91$, 95% CI: 0.88–0.93), test–retest reliability (pooled $r=0.90$, 95% CI: 0.86–0.92), and inter-rater reliability (intraclass correlation=0.86). The clinical utility of the QoR-40 instrument was supported by high patient recruitment into evaluation studies (97%), and an excellent completion and return rate (97%). The mean time to complete the QoR-40 was 5.1 (95% CI: 4.4–5.7) min.

Conclusions. The QoR-40 is a widely used and extensively validated measure of quality of recovery. The QoR-40 is a suitable measure of postoperative quality of recovery in a range of clinical and research situations.

Keywords: health status; meta-analysis; outcomes

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Provision of high-quality anaesthetic services in an economically constrained healthcare environment demanding evidence-based resource allocation requires validated measures of anaesthetic outcome.¹ Traditionally, such measures have primarily consisted of physiological endpoints such as cardiorespiratory perturbations, pain, nausea and vomiting, and recovery times.² Serious complications are rare, occur mostly in those with pre-existing comorbidity and after extensive surgery, and are mostly unrelated to anaesthesia care. Outcome measures have increasingly included the

patient's perspective of their healthcare,^{3 4} and a number of patient-centred measurement tools have been developed as a means of assessing quality of recovery in the postoperative setting.^{5 6}

In 2000, after the development and initial clinical experience of a nine-item quality of recovery score,⁷ Myles and colleagues⁴ developed the QoR-40, a more extensive 40-item questionnaire, in an effort to improve the validity, reliability, and responsiveness of the scale. The QoR-40 is a global measure of quality of recovery. It incorporates five dimensions

of health: patient support, comfort, emotions, physical independence, and pain; each item is graded on a five-point Likert scale. QoR-40 scores range from 40 (extremely poor quality of recovery) to 200 (excellent quality of recovery).⁷ In 2008, Kluivers and colleagues⁶ undertook a qualitative systematic review of postoperative, recovery-specific quality of life instruments and identified 12, most of which failed many of their eight prespecified criteria. There were two exceptions, the postoperative recovery scale⁸ and the QoR-40,⁴ with the latter being used in numerous studies. Herrera and colleagues⁵ undertook a similar review of postoperative recovery scales used in ambulatory surgery, and concluded that the QoR-40 was the only one that fulfilled all of their eight criteria, but they noted that there were limited data at that time for those undergoing day-stay surgery. Neither of the previous reviews attempted a meta-analysis of the psychometric data (validity, reliability, ease of use, responsiveness) reported in the individual studies.

The QoR-40 has since become the most widely reported measure of patient-assessed quality of recovery after surgery.^{5 6} The power of a large sample size derived from a broad range of surgical populations allows us to undertake a more extensive and accurate evaluation of this health status instrument. We therefore undertook a quantitative systematic review to further demonstrate the psychometric properties and clinical utility of the QoR-40.^{9 10}

Methods

Search strategy

We conducted a systematic literature search for clinical studies that included the QoR-40. Medline and EMBASE databases, Google, and the Cochrane Central Register of Controlled Trials were searched using the terms anaesthesia, outcome, quality, recovery, and surgery as exploded MeSH (Medical Subject Headings) terms. We also used 'quality of recovery' and 'QoR-40' as specific text words. We restricted the search to papers published between January 2000 and November 2011. There were no language restrictions. We followed appropriate methods for conducting a systematic review and meta-analysis as set out in the QUOROM statement.¹¹ Two reviewers independently performed the searches (B.F.G. and P.S.M.), with disagreement on trial inclusion resolved by consensus.

Data abstraction and analysis

Data for this review were obtained directly from the publication where such data were reported, or alternatively by contacting the primary author via e-mail, inviting them to conduct some additional analyses, or otherwise contribute their original data set for the pooled analyses.

Study endpoints for planned pooled analyses

We planned to conduct meta-analyses on a range of psychometric and other performance measures of the QoR-40. The key indices were validity, reliability, responsiveness, and clinical utility.

- (i) Validity refers to the accuracy of a scale in being able to measure what is intended, in this case the quality of postoperative recovery. Content validity has previously been established,⁷ and so did not require further evaluation. Because there is no gold standard method of measuring quality of recovery, we accepted and tested several previously demonstrated constructs, namely that patients with no complications had a better recovery when compared with those with complications after surgery, men had a better overall quality of recovery when compared with women,^{4 12} and that quality of recovery is negatively associated with duration of hospital stay. We thus calculated weighted mean QoR-40 scores according to each of these characteristics. Convergent validity was assessed using the correlation between the QoR-40 and a global estimate of quality of recovery using a 100 mm visual analogue scale.
- (ii) Reliability is a measure of consistency, and was assessed using measures of internal consistency (Cronbach's α), split-half, and test-retest reliability. Inter-rater reliability had previously been established.¹³
- (iii) Responsiveness is the ability to detect clinically important change. We used the standardized response mean (SRM),¹⁴ whereby values of 0.2, 0.5, and 0.8 correspond to small, medium, and large thresholds for detecting a change in health status.
- (iv) Clinical utility describes how well a health status instrument can be understood and applied in routine practice; that is, is it user-friendly for both patients and staff? For this, we assessed patient recruitment rate, successful completion and return rate, and the time taken by patients to complete the QoR-40.

Statistical analyses

We aimed to use the postoperative day 3 QoR-40 item scores whenever available; if not, we used the nearest time point. We recorded mean and standard deviation (*sd*) for numerical outcomes. If median and range were reported in the original study and the data set was unavailable for further analysis, we substituted the mean for the median and one-fourth of the range for *sd* in order to undertake the pooled analyses. Some studies had missing item scores at one or more times (total <1%), and so we imputed these score from the median value of the dimension (if calculable) or otherwise used the last observation carried forward method.

For meta-analysis, we calculated a summary statistic for each study and then a weighted average was used to estimate an overall summary statistic across all of the studies. In view of the anticipated heterogeneity because of the (intended) study diversity, we used a random effects model based on the DerSimonian and Laird¹⁵ method for each meta-analysis. Under the random effects model, we assume that each study is estimating a different effect, but from the same underlying distribution of effects. Hence,

the study estimates are expected to vary more since it fundamentally incorporates the differences between studies. Forest plots were constructed to show the individual study effects and their 95% confidence intervals (CIs), and the overall pooled random effects. Study heterogeneity was quantified using the I^2 statistic.¹⁶

When correlation outcomes were pooled, the correlation coefficients were initially transformed using a Fisher z -transformation to estimate the combined results, CI, and P -values.¹⁷ The pooled results were then back-transformed to give estimates and forest plots in the original correlation scale and these are the estimates reported. Similarly, when recruitment and completion rates were pooled, the initial proportions were transformed using the Freeman–Tukey variant of the arcsine square root transformed proportion.¹⁸ This was necessary because the proportions are close to or equal to one and normal distribution theory cannot be applied. As for the correlation data, the pooled results are back-transformed to give estimates in the original proportion scale and these are the estimates reported. For the analysis of the SRM, the variance of the SRM was calculated as: $1/n + \{SRM^2/[2 \times (n-1)]\}$, where n is the sample size.¹⁹

Meta-analyses were performed using STATA (v11). All P -values are two-sided. A P -value of <0.05 was considered statistically significant.

Results

Electronic searching identified a total of 263 citations of the original QoR-40 study which resulted in a total of 99 citations when combined and cross-checked for duplicates (Fig. 1). A manual search of these 99 citations by title and abstract yielded a total of 53 studies of interest. Some of the retrieved studies could not provide any relevant data for our intended meta-analyses. After this initial evaluation, eligibility was assessed through careful review of the full-text publication done by both B.F.G. and P.S.M. This secondary evaluation yielded a total of 19 studies that satisfied the selection criteria. Contact list searching revealed one additional study which was unpublished but available as a thesis that had conducted a psychometric evaluation of a Portuguese translation of the QoR-40.⁴ We identified one duplicate, and one of the authors contacted did not have the time or resources to supply their data upon request.²⁰ We thus included 96% of eligible participants.

There were 17 eligible studies, conducted in seven countries and enrolling up to 3621 patients for meta-analysis.^{12 13 21–34} Eight of these studies had conducted further psychometric evaluation and the remaining nine studies had utilized the QoR-40 as an outcome measure. Because the electronic data set from the original QoR-40 validation study⁴ had been destroyed after a computer upgrade, the archived case report forms were retrieved and entered into a new database. However, this process could not locate 40 records from the original study. The population characteristics of the sample represented in each of the studies is presented in Table 1. The summary results from the

meta-analyses are detailed below, with selected tabulated results available as Supplementary Tables S1–S3.

Validity

The mean (95% CI) QoR-40 score for those without and with complications was 170 (163–179) and 159 (153–166), respectively; weighted mean difference 11 (4–18), $P=0.002$ (Fig. 2). The mean (95% CI) QoR-40 score for males and females was 170 (163–176) and 169 (161–172), respectively; weighted mean difference 3.1 (–0.6–6.9), $P=0.099$ (Supplementary Table S1). There was a negative pooled correlation between the QoR-40 score and hospital length of stay, $r=-0.24$ (–0.31 to –0.16), $P<0.0005$ (Supplementary Fig. S1). The pooled correlation between the QoR-40 score and a unidimensional visual analogue scale measure of quality of recovery was 0.58 (0.51–0.65), $P<0.0005$ (Fig. 3).

Reliability and responsiveness

Internal consistency of the QoR-40 using a pooled estimate of Cronbach's α was 0.91 (0.88–0.93), $P<0.0005$ (Fig. 4A). The pooled split-half reliability coefficient was 0.74 (0.69–0.79), $P<0.0005$ (Fig. 4B). The pooled test–retest reliability

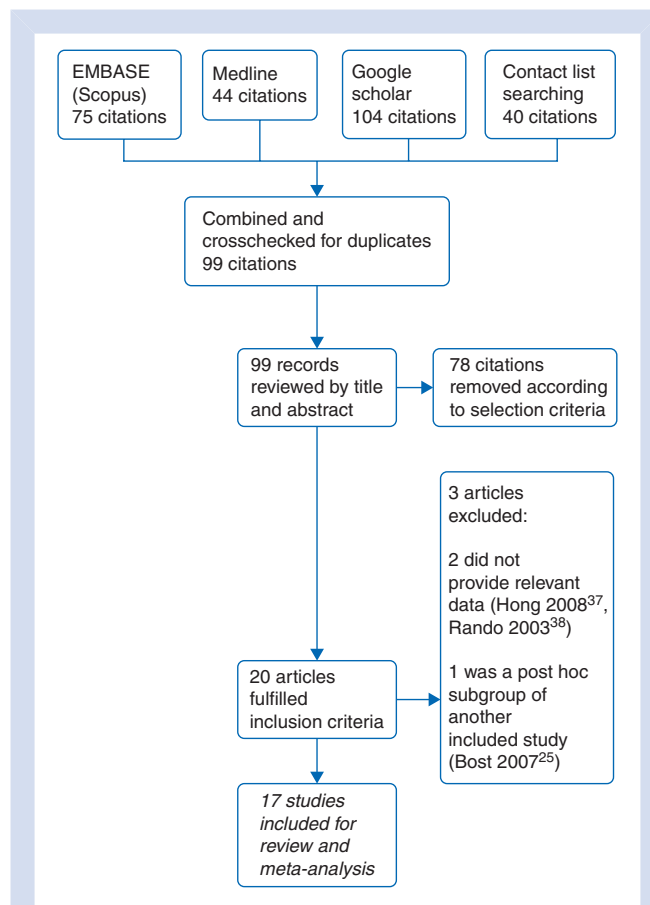


Fig 1 Results of the literature search and study selection for meta-analysis.

Table 1 Patient, anaesthetic, and surgical characteristics of the pooled study population. n.r., not recorded

Study	Publication year	Country	Sample size	Mean age	Male no. (%)	General anaesthesia no. (%)	Regional block no. (%)	Ambulatory surgery no. (%)	Major surgery no. (%)
Myles and colleagues ⁴	2000	Australia	160	44	75 (47)	160 (100)	n.r.	25 (16)	57 (36)
Myles and colleagues ²¹	2001	Australia	120	63	93 (78)	120 (100)	0	0	120 (100)
Leslie and colleagues ²²	2003	Australia	192	52	92 (48)	192 (100)	n.r.	0	192 (100)
Gower and colleagues ¹³	2006	Australia	62	50	40 (65)	62 (100)	n.r.	15 (24)	16 (25)
Hansdottir and colleagues ²³	2006	Sweden	113	66.5	76 (67)	136 (100)	55 (49)	0	136 (100)
Paech and colleagues ²⁴	2007	Australia	614	32.5	0	614 (100)	n.r.	614 (100)	0
Bost and colleagues ²⁵	2007	USA	154	27.4	86 (56)	0	76 (49)	154 (100)	0
Pereira ²⁶	2007	Portugal	150	51.5	57 (38)	150 (100)	0	0	150 (100)
Kluivers and colleagues ²⁷	2008	The Netherlands	161	49.1	0	161 (100)	23(14)	0	161 (100)
Lena and colleagues ²⁸	2008	France	83	66	66 (80)	83 (100)	42 (51)	0	83 (100)
Idvall and colleagues ²⁹	2009	Sweden	525	51	246 (47)	318 (60)	176 (33)	525 (100)	0
Murphy and colleagues ³⁰	2009	USA	84	63.6	13 (15)	84 (100)	0	0	84 (100)
Wengritzky and colleagues ³¹	2010	Australia	163	50	66 (40)	163 (100)	n.r.	11 (7)	69 (42)
Buchanan and colleagues ¹³	2011	Australia	500	39.5	253 (51)	500 (100)	n.r.	102 (20)	25 (5)
McIntosh and Adams ³²	2011	United Kingdom	54	43.9	32 (59)	54 (100)	n.r.	54 (100)	16 (30)
Murphy and colleagues ³³	2011	USA	109	63.2	77 (74)	109 (100)	0	0	109 (100)
Tanaka and colleagues ³⁴	2011	Japan	192	57	99 (52)	192 (100)	57 (30)	0	88 (46)
Pooled total			3459	45	1412 (39)	2887 (79)	429 (12)	1662 (43)	1306 (38)

coefficient was 0.90 (0.86–0.92), $P < 0.0005$ (Fig. 4c). The pooled SRM was 0.75 (0.62–0.89), $P < 0.0005$ (Fig. 5).

Clinical utility

The pooled recruitment rate was 97% (91% to >99%) (Supplementary Table S2), the completion and return rate was 97% (92% to >99%) (Supplementary Table S3), and the time taken to complete the QoR-40 was 5.1 (4.4–5.7) min (Supplementary Fig. S2).

Discussion

This quantitative systematic review of the QoR-40 allows a more thorough psychometric evaluation of its properties and clinical usefulness. This is a novel approach to the review and synthesis of information detailing the psychometric properties of a health status instrument. We found that the QoR-40 is a widely used and extensively validated

measure of quality of recovery. It has excellent validity, reliability, responsiveness, and clinical utility in a broad range of clinical settings. Our analysis included 3459 participants enrolled in 17 studies across many countries around the world and representing diverse cultural backgrounds. Both sexes and all (adult) age groups were represented. There was an equally diverse surgical population, with participants receiving many types of anaesthetic techniques and peri-operative care. This variation across studies strongly supports the generalizability of the results obtained, and the applicability of the QoR-40 to other situations.

This quantitative systematic review is novel in that it was focused primarily on pooled estimates of correlation coefficients, rather than the more usual meta-analyses that use odds or risk ratios, or weighted mean difference, as estimates of a treatment effect.^{9 10} Study heterogeneity is problematic in traditional meta-analyses, but it is a strength when

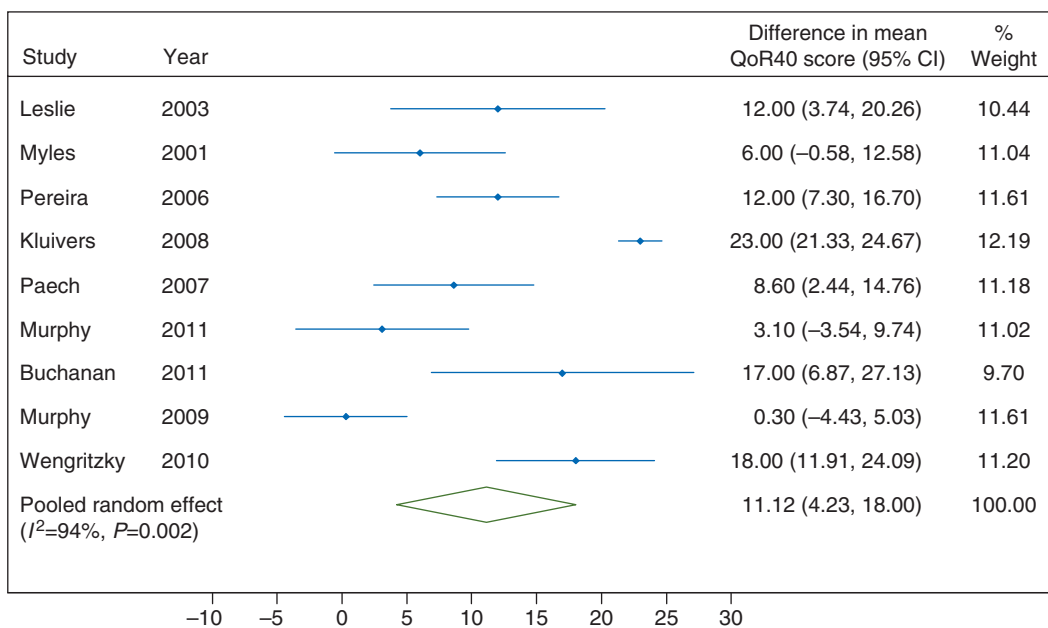


Fig 2 Meta-analysis of the difference in QoR-40 scores comparing those free from postoperative complications and those with complications.

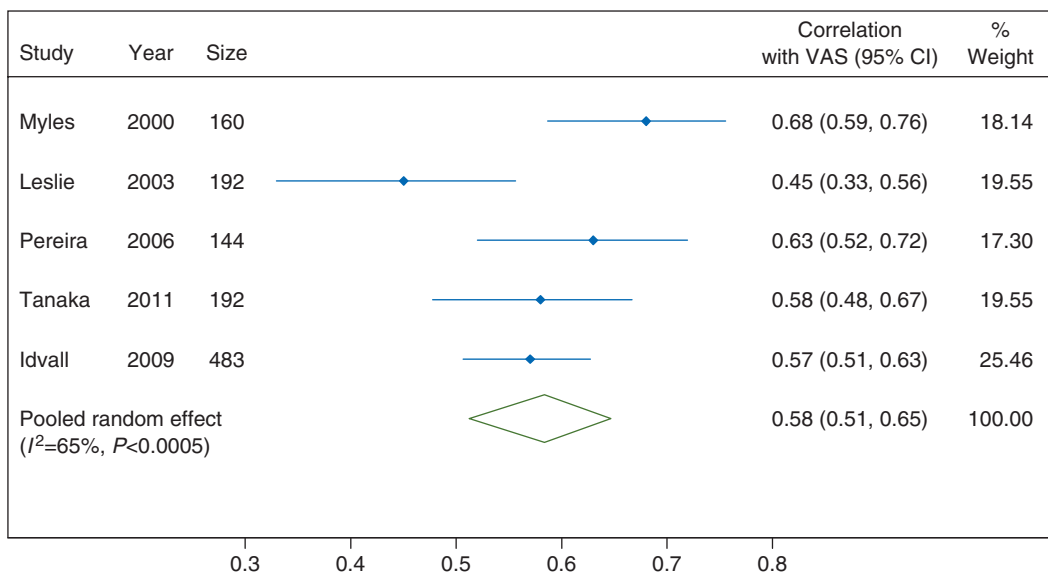


Fig 3 Meta-analysis of the correlation between the QoR-40 and a 100 mm quality of recovery visual analogue scale scores.

evaluating psychometric and diagnostic utility because it reflects the usefulness of a scale or test in a broad range of clinical situations.^{9 10 35} The considerable differences between the retrieved studies in terms of study aims, study design, sample population, interventions used, and outcomes measured increase heterogeneity.

Two previous qualitative systematic reviews of health status instruments used to measure quality of recovery

provided strong endorsement of the QoR-40,^{5 6} but both had some reservations because of the limited number of studies available at that time (up to 2007). Our review provides reassurance because of the accruing experience using the QoR-40 as an outcome measure, including in those undergoing ambulatory surgery, and those receiving a regional block, and also providing pooled estimates of its psychometric properties.

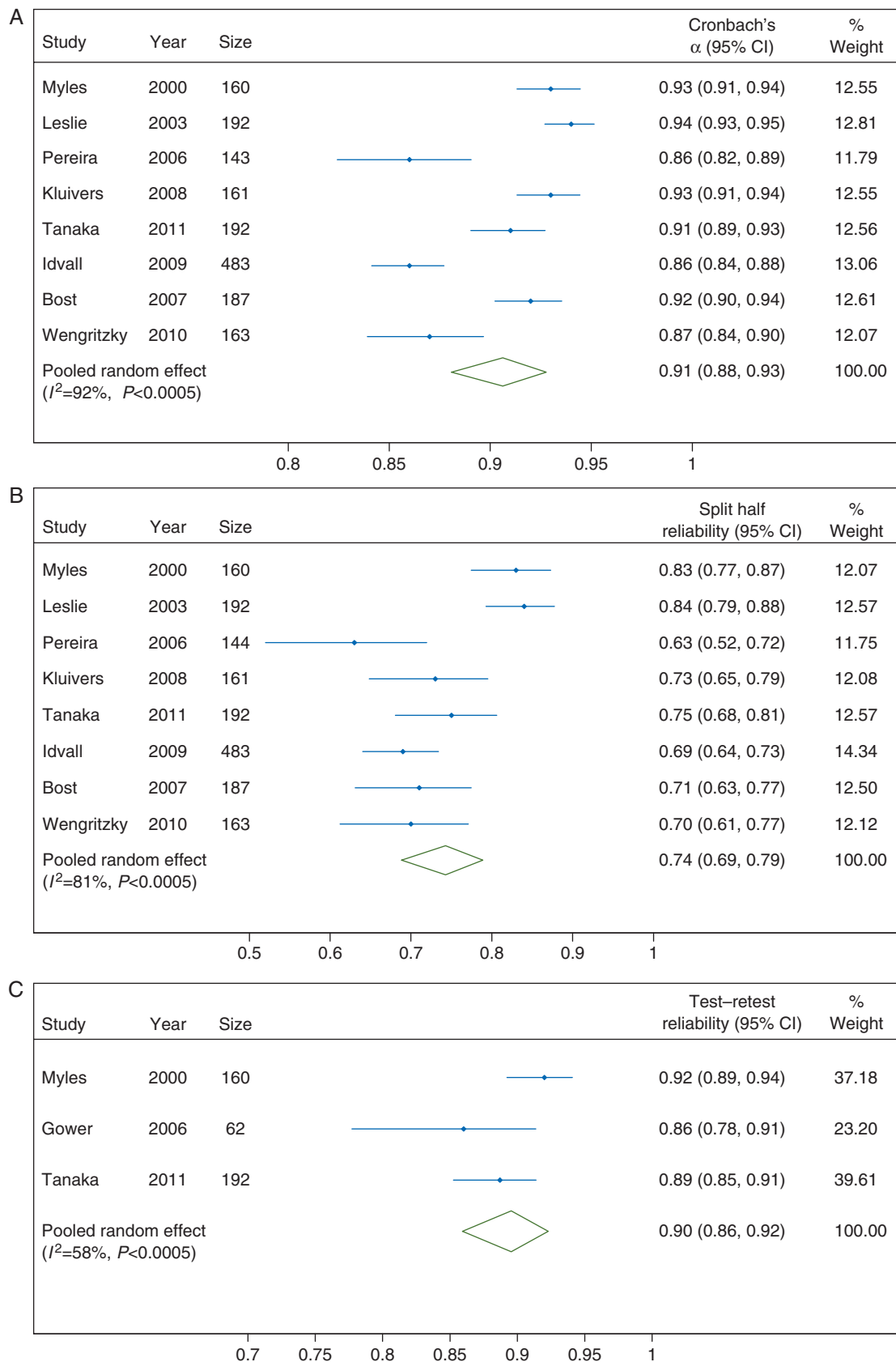


Fig 4 Meta-analysis of the (A) internal reliability, as measured by Cronbach's α ; (B) split-half reliability; and (C) test-retest reliability of the QoR-40.

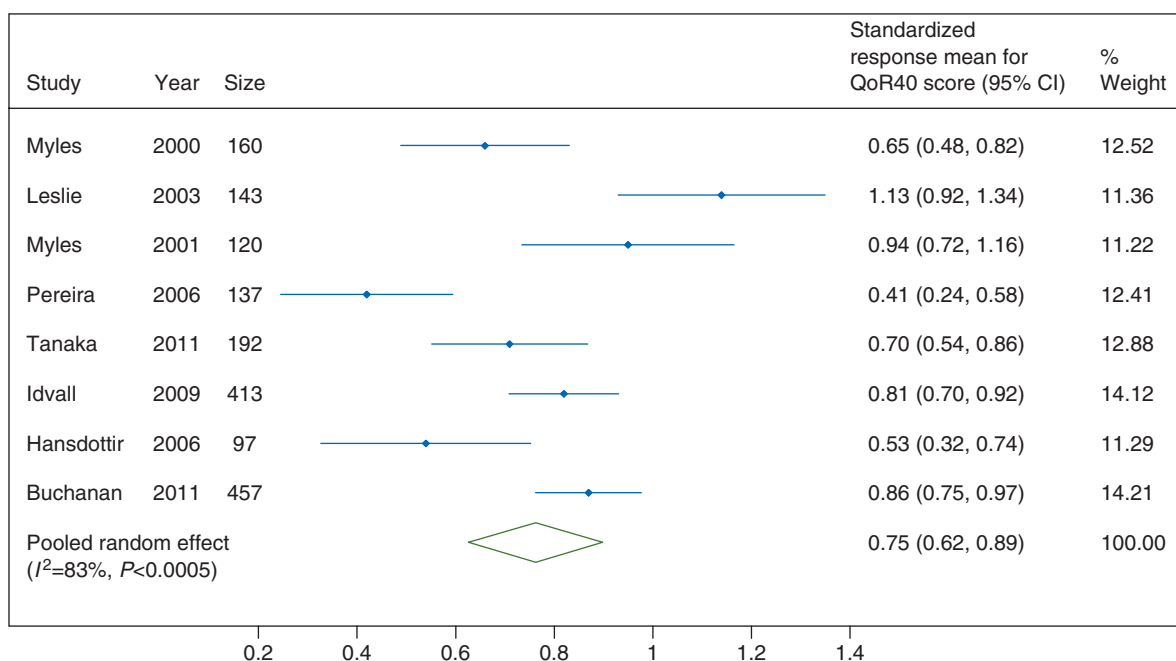


Fig 5 Meta-analysis of the SRM, a measure of responsiveness of the QoR-40.

Validity

Content validity of the QoR-40 has previously been established.⁷ The construct validity of the QoR-40 was confirmed by evaluating the performance of the QoR-40 in accordance with three distinct hypotheses. First, patients free of post-operative complications had higher QoR-40 scores when compared with those who had experienced complications. Variation in the effect size is probably attributable to the difference in the definitions used in the individual studies to describe postoperative complications, including their time onset relative to when the QoR-40 measurement was taken. This is demonstrated when comparing the study by Murphy and colleagues,³³ which only considered anaesthetic complications, and Leslie and colleagues,²² which used a broader definition of postoperative complications. Secondly, men had slightly higher QoR-40 scores when compared with women, although the weighted mean difference was not constant across the 11 included studies. This is likely to be a consequence of confounding because other factors that influence recovery, such as patient age and extent of surgery, were not balanced when making this comparison. A recent study specifically balanced these factors and could identify a clear gender difference.¹² Finally, the QoR-40 score had a negative correlation with duration of hospital stay. It is likely that this analysis was hindered by the different types and extents of surgery undertaken in each of the studies, and also the many other factors which can affect hospital stay. Convergent validity was confirmed by a moderate association between the QoR-40 and a unidimensional visual analogue measure of quality of recovery.

Reliability

The reliability of the QoR-40 was established by evaluating internal consistency, split-half, and test-retest reliability. Each of these was very strong and exceeds recommendations for health status instrument. Inter-rater reliability had previously been established in a comparison of patient self-administered and investigator-administered QoR-40 questionnaires.¹³ This means that reproducible results can be obtained with the QoR-40.

Responsiveness and clinical utility

The ability to detect and measure clinically important change is a key feature of any health status instrument used to measure outcome. Kirshner and Guyatt³⁵ point out that appraisal of health status instruments should be guided by the instrument's intended purpose. Given that the QoR-40 is most commonly used as an evaluative outcome measure in clinical trials and other studies, the most relevant psychometric characteristic is responsiveness.³⁵ The pooled estimate of the SRM was 0.75, signifying very strong ability of the QoR-40 to quantify a change in health status,^{9 14} in our case, overall quality of recovery.

The consistently high recruitment rate of studies that used the QoR-40 as a measure of outcome indicates excellent acceptability of the instrument to clinicians and researchers, and across a broad patient population. The time taken to complete the QoR-40, around 6 min, was consistent across studies. This indicates excellent clinical utility in most settings.

Practical implications for clinical practice and research

Quality of recovery is directly related to patient satisfaction.³⁶ This is unsurprising, considering most aspects of a poor quality recovery after surgery will impair satisfaction with care. Efforts to avoid postoperative discomfort and complications, optimize early feeding and ambulation, and facilitate early hospital discharge should improve quality of recovery and enhance patient satisfaction. These are central aims of all good perioperative care. There is also a relationship between quality of recovery in the days and weeks after surgery, with quality of life up to 3 yr after cardiac surgery.²¹

For a health status measurement tool such as the QoR-40 to be considered useful in perioperative practice, it needs to be valid and reliable, responsive, and simple to use. This review has shown that the QoR-40 is a high-quality measurement tool which measures what it intends to measure, produces consistent results, is highly sensitive to clinical change, and is appropriate to the purpose for which it was created. The QoR-40 is a suitable measure of the quality of recovery after surgery and anaesthesia, for both routine clinical practice (quality assurance) and research. It performs well in ambulatory surgery, inpatient surgery, and in those receiving a regional block.

Ideally, a meta-analysis will combine the results of studies utilizing comparable methodologies and the same outcome measures in a similar patient population. In the course of this analysis, to include all studies that used the QoR-40, there was considerable variability across studies. This has resulted in substantial heterogeneity, a feature, we argue, that enhances generalizability. Also, we used random effects models in order to obtain reliable summary estimates.

This quantitative systematic review has synthesized a lot of relevant information detailing the use of the QoR-40 in the perioperative setting. The power of a large sample size derived from a broad population has allowed a detailed evaluation of the psychometric properties of the QoR-40. The consistently strong validity, reliability, responsiveness, and clinical utility parameters are indicative of a very good recovery scale.

Supplementary material

Supplementary material is available at *British Journal of Anaesthesia* online.

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Declaration of interest

None declared.

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