



Kent Academic Repository

Rand, Stacey, Towers, Ann-Marie, Allan, Stephen, Blake, Margaret and Lambert, Claire (2025) *Measuring care work-related quality of life: A Rasch validation study of the Adult Social Care Outcomes Toolkit for Workforce (ASCOT-Workforce)*. *Applied Research in Quality of Life*, 21 . pp. 1395-1412. ISSN 1871-2584.

Downloaded from

<https://kar.kent.ac.uk/112037/> The University of Kent's Academic Repository KAR

The version of record is available from

<https://doi.org/10.1007/s11482-025-10536-9>

This document version

Publisher pdf

DOI for this version

Licence for this version

CC BY (Attribution)

Additional information

Versions of research works

Versions of Record

If this version is the version of record, it is the same as the published version available on the publisher's web site. Cite as the published version.

Author Accepted Manuscripts

If this document is identified as the Author Accepted Manuscript it is the version after peer review but before type setting, copy editing or publisher branding. Cite as Surname, Initial. (Year) 'Title of article'. To be published in **Title of Journal** , Volume and issue numbers [peer-reviewed accepted version]. Available at: DOI or URL (Accessed: date).

Enquiries

If you have questions about this document contact ResearchSupport@kent.ac.uk. Please include the URL of the record in KAR. If you believe that your, or a third party's rights have been compromised through this document please see our [Take Down policy](https://www.kent.ac.uk/guides/kar-the-kent-academic-repository#policies) (available from <https://www.kent.ac.uk/guides/kar-the-kent-academic-repository#policies>).



Measuring Care Work-Related Quality of Life: A Rasch Validation Study of the Adult Social Care Outcomes Toolkit for Workforce (ASCOT-Workforce)

Stacey Rand¹ · Ann-Marie Towers² · Stephen Allan¹ · Margaret Blake³ · Claire Lambert³

Received: 23 May 2025 / Accepted: 16 November 2025 / Published online: 30 March 2026
© The Author(s) 2026

Abstract

Rasch analysis was applied to establish the structural validity of the ASCOT-Workforce measure of care-work related quality of life (CWRQoL). The analysis was also used to guide potential item reduction to create a short-form version, which could be used in future studies to develop preference weights for use in economic evaluation of interventions and policy. Rasch analysis was applied to the ASCOT-Workforce (13 items) from a survey of the adult social care workforce in England ($n = 7233$). The assumption of a single scale was based on the finding of a single factor structure for the 13-item measure from a prior study that applied exploratory factor analysis. Rasch analysis of ASCOT-Workforce (13 items) had acceptable model fit, internal consistency and met assumptions of unidimensionality and local independence. There was suboptimal distinguishability at some thresholds between response options and evidence of differential item functioning (DIF). Most issues were addressed by omitting items to create a 9-item version, although there were still issues with three items. These were retained based on policy relevance and face validity to key stakeholders. ASCOT-Workforce (13-item, 9-item) are both valid instruments of CWRQoL for those working in the adult social care workforce. The short-form (9-items) performs slightly better than the 13-item measure, although suboptimal distinguishability at category thresholds and DIF persisted for three items. Further qualitative study to explore the reasons underlying DIF, and whether re-drafting the response options could improve the response category distinguishability, are recommended.

Keywords Workforce · Adult social care · Quality of life · Policy

Introduction

The English adult social care (ASC) sector in 2023/24 employed 1.6 million people across 1.7 million posts, of which 76% were direct care posts (i.e., care workers), whether in homecare, other community services (e.g., day centres), or residential care (Skills for Care, 2024). In addition to direct care roles, the ASC workforce in England also includes ancillary roles, administrative staff, activity coordinators, supervisors, registered or senior to mid-level managers, commissioners, and regulated professional roles (e.g., registered nurses, occupational therapists). As in other countries, internationally, an ASC workforce increase of around 30% will be required by 2040 to meet increased demand due to an ageing population in England (Skills for Care, 2025). Due to these pressures, there is increasing focus on recruitment and retention of staff, which is a challenge given the sector's relatively low pay and poor working conditions (Skills for Care, 2024). Improving work-related wellbeing has been proposed to promote staff retention and reduce vacancy rates, as well as improve quality and safety of care (Silarova et al., 2022).

To better understand and evaluate ways of promoting work-related quality of life of the ASC workforce in policy and practice, an acceptable and valid measure is needed. In the context of developing a survey of the ASC workforce in England, a rapid literature review of existing measures of work-related QoL already available in English was undertaken. This rapid review identified a suitable measure of work-related quality of life for the survey – the Van Laar work-related quality of life scale (Easton & Van Laar, 2018; Van Laar et al., 2007) – but also noted that this measure had not been developed specifically with the ASC workforce. Although it has been widely used in studies of healthcare and long-term care workforce, there remained a question over whether it was aligned to the experiences, priorities and concerns of the ASC workforce, especially across the diversity of ASC roles and care settings in England (Blake, 2025a). Therefore, a new ASC workforce-specific measure suitable for large-scale data collection and analysis to inform policy was developed by researchers at the University of Kent – the ASCOT-Workforce – for use in the survey (Blake et al., 2025a, b).

The ASCOT-Workforce adds to the Adult Social Care Outcomes Toolkit (ASCOT) (Rand et al., 2025), which is a suite of instruments that captures the social care-related quality of life (SCRQoL) of adults accessing social care services (ASCOT-SCT4) (Malley et al., 2012; Netten et al., 2012; Rand et al., 2017), family carers (ASCOT-Carer SCT4) (Rand et al., 2015) and now also the care-work-related quality of life (CWRQoL) of the ASC workforce (ASCOT-Workforce). The development of ASCOT-Workforce drew on a scoping literature review of work-related QoL concepts relevant to the ASC workforce from a previous study led by the University of Kent (Blake et al., 2025a, b; Silarova et al., 2022). The final selection of CWRQoL domains were identified through three focus groups with members of the ASC workforce in England, conducted by Ipsos (Blake et al., 2025a, b). University of Kent (Blake et al., 2025a, b) researchers drafted 13 questions (*items*), one for each of the 13 CWRQoL domains, to form the first draft questionnaire (Box 1). Unlike existing measures of work-related QoL, such as the Van Laar scale (Easton & Van Laar, 2018;

Van Laar et al., 2007), the ASCOT-Workforce was developed specifically with the ASC workforce to reflect their priorities, needs and concerns.

Box 1. ASCOT-Workforce domains

Domain	Definition: "The person feels..."
Making a difference	... they are making a difference to the lives of the people they support
Relationships with people drawing on care and support	... they have a positive working relationship with people drawing on care and support.
Autonomy	... they have autonomy within their job role
Time to care	... they have the time they need to do their job.
Worrying about work	... they do not need to worry about work during non-work hours
Self-care	... able to look after themselves at work.
Feeling safe at work	... safe from physical and psychological harm at work.
Professional working relationships	... they have good working relationships with colleagues, informal carers and other health and social care professionals.
Supported by managers	... supported by their manager(s)
Skills and knowledge	... they have the skills and knowledge to do their job well
Career pathway	... they have opportunities to advance their career in social care
Financial security	... they have an adequate and reliable Financial security.
Valued by Society	... that they work in a role valued by society.

The development of the ASCOT-Workforce questionnaire drew on the following principles, which are common to other ASCOT instruments. First, each question centred on the person's perspective and asked them to reflect and respond based on their personal values, attitudes and preferences. Second, the questions reflected Sen's concept of capability, which refers to what an individual is able to do and who they are able to be (Sen & Nussbaum, 1993). The focus is on enabling people to *do* and to *be* as they wish, based on their individual needs and freedom, in terms of the opportunities they have. For adults with care needs and their unpaid carers, their capability is affected by care availability, intensity and quality, as social care seeks to support and improve SCRQoL (Netten et al., 2012; Rand et al., 2020; van Loon et al., 2018). The ASCOT-Workforce adopts and applies a similar conceptual framework to the ASC workforce, whereby staff CWRQoL is affected by workplace quality (working conditions, culture and organisation) and working role, as it aligns to the person's preferences, needs and motivations. Finally, in line with other ASCOT measures (Rand et al., 2025), each question is rated according to a four-level response framework based on the person's ideal work-related QoL state, no needs, some needs or high-level needs in their current job role (Box 2).

Box 2. ASCOT response levels

Response level	Definition
Ideal state	The person's needs are met to their preferred level.
No needs	The person's needs met, but not to their preferred level
Some needs	The person's needs are not met, but it does not have long-term health and wellbeing implications.
High-level needs	The person's needs are not met, and it has longer-term health and wellbeing implications.

Once the draft questionnaire had been developed by University of Kent researchers, twenty semi-structured qualitative interviews were conducted by Ipsos (Blake et al., 2025a,b) with ASC workforce members using a cognitive testing approach (Willis, 2005). This method explores the comprehension, judgement, recall and response to questionnaire items drawing on Tourangeau's four-stage model of survey response (Tourangeau, 1984). The interview data were used by Kent researchers to further refine, iteratively, the wording of items and response options (Blake et al., 2025a, b). The revised questionnaire was then used in a survey of the ASC workforce in England. The reporting of the survey included preliminary psychometric evaluation of the ASCOT-Workforce that considered its feasibility (% missing data), construct validity by hypothesis testing, and structural validity by exploratory factor analysis (EFA) (Blake et al., 2025a, b). The findings were promising; the EFA supported a single factor structure for the 13-item measure of CWRQoL (Blake et al., 2025a, b).

The aim of this study is to further evaluate the measurement properties of ASCOT-Workforce using Rasch analysis. The combination of classical test theory (CTT) approaches, like EFA, and item response theory (IRT), like Rasch, is established in the psychometric literature and has previously been applied to the development of new ASCOT measures (e.g., ASCOT-Proxy (Rand et al., 2024; Silarova et al., 2023)). Whilst we already have evidence from EFA (Blake et al., 2025a, b), Rasch analysis provides in-depth insight into psychometric performance beyond that offered by CTT; in particular, it allows assessment of response threshold functioning and exploration of differential item functioning (DIF) by subgroup. It also generates insights that are useful in guiding decisions about item reduction (i.e., removal or omission of items to reduce measure length) (Tennant et al., 2004; Tennant & Conaghan, 2007). The latter is especially important, since ASCOT measures are designed for use in economic analysis to guide policy and decision-making. The development and application of preference weights to create a weighted index that reflect people's preferences is, therefore, important (Batchelder et al., 2019; Netten et al., 2012). Abbreviation of the scale is an important step for future development because preference-based measures are typically a maximum of 8 or 9 items, due to the challenge of generating weights from longer measures (Peasgood et al., 2020). Therefore, the study also aimed to generate evidence to guide recommendations for item reduction to create a 'short form' scale that could be applied in a future preference study.

Methods

The study was a psychometric study of ASCOT-Workforce data collected in a national survey of ASC workforce in England. The study aimed to investigate the measurement properties of ASCOT-Workforce (13 items) using Rasch analysis and generate evidence to guide item reduction ahead of a future preference study.

Data Collection and Sample

Data were collected as part of a national survey of the adult social care workforce in England conducted by Ipsos in collaboration with researchers at the University of

Kent and Skills for Care (Blake et al., 2025a, b). The survey was conducted as an initial pilot from 1st to 7th August 2023 ($n = 110$) followed by a mainstage survey from 17th August to 23rd October 2023 ($n = 7133$). In the analysis we present here, we consider the combined data ($n = 7243$), with ten cases dropped where the respondent indicated that they worked in children's social care ($n = 7233$).

The survey was advertised and distributed as an open link online self-completion survey with the option to request data collection by telephone interview. Only one response was completed by telephone. Sample quotas were set by job role, service type, employer type, gender, age, ethnicity, and region of England. To ensure sufficient sample for subgroup analysis, the quotas for some groups exceeded their representation in the English ASC workforce. These groups included people in professional roles (social workers, occupational therapists, nurses), those working for a day centre or providing community care, personal assistants, people employed by a local authority or individual employer using direct payments, people aged under 25, and those from UK ethnic minorities. We included the full sample in the analyses presented here, without applying population weights or other methods to extract a representative sub-sample for analysis.

The survey methodology, questionnaire design and sampling are reported in detail elsewhere (Blake et al., 2025a, b).

Statistical Analysis

Analyses were conducted in WINSTEPS 3.91.1 (Linacre, 2020).

This study aimed to evaluate the ASCOT-Workforce's measurement properties by applying Rasch analysis (Pallant & Tennant, 2007; Tennant & Conaghan, 2007). We also applied Rasch to guide decisions on item reduction from the full 13-item ASCOT-Workforce questionnaire (Tennant et al., 2004). Rasch analysis compares observed ordinal data against a theoretical unidimensional measurement model, known as the Rasch model. Ordinal data is converted into interval level measurement by applying the assumption that the probability of affirming an item is a logistic function of the item's 'difficulty' and the respondent's 'ability', as well as assuming local independence and unidimensionality (Tennant et al., 2004).

In this analysis, we applied a partial credit model because each ASCOT-workforce item has a unique set of ordered response options (Masters, 1982). Overall fit summary statistics were considered to evaluate how well the observed data fitted to the Rasch model. The following criteria were applied to indicate acceptable fit: (1) a non-significant overall summary Chi-square interaction fit statistic; and (2) a standard deviation of the item summary residual statistic of <1.5 (Shea et al., 2009). INFIT and OUTFIT mean square statistics for each item were also reported to explore misfit to the Rasch model. Values of $.5$ to 1.5 were taken to indicate good fit. A criterion of >1.5 was applied to the item separation index, as an indicator of adequate internal consistency (Tennant & Conaghan, 2007).

The fit of observed data to the Rasch model was further assessed using principal component analysis of the standardised residuals. If the observed data were unidimensional (i.e., fit to a single latent dimension), residual variance after the primary measurement dimension ought to be random. Therefore, we applied the criterion of an Eigenvalue of less than 2.0 to the first principal component of standardised residu-

als to evaluate the assumption of unidimensionality (Bond & Fox, 2015; Tennant & Conaghan, 2007). We also examined the standardised residual correlations for items to assess local independence of items, with positive correlations between items of less than .20 indicative of local independence (Lambert et al., 2021).

The category response curve for each item was visually inspected to evaluate whether there is evidence of disordered thresholds between the items' four response options (see Box 2). Ordered category rating scale functionality was also assessed by applying Linacre's criteria (Linacre, 2002), i.e. (1) ≥ 10 cases per response category; (2) an OUTFIT MNSQ of < 2.0 for each response category; (3) an increase between response categories for average measures and Rasch-Andrich category thresholds; and (4) an increase of Rasch-Andrich category thresholds of 1.4 to 5.0 logits between categories (Linacre, 2002).

Finally, we also considered differential item functioning (DIF). DIF refers to the different probability of rating an item by characteristic (e.g. job role), after controlling for overall scale scores. It can indicate that an item functions differently when completed by respondents from different subgroups. Since the ASCOT-Workforce was developed to measure the CWRQoL of the ASC workforce, which comprises diverse roles across different settings, we considered DIF by job role. The aim was to establish whether there is evidence of inconsistency of item response by ASC role-related group. In this study, job roles were categorised according to the groups listed in Table 1 (i.e., direct care roles, senior or mid-level managers, registered managers, social workers, occupational therapists, and nurses or other allied health professionals). The baseline group was direct care. We applied a criterion of DIF contrast of $\geq .64$ logits to identify moderate-to-large differences in item difficulty between groups (Zwick et al., 1999). Acknowledging that false positives are likely, we focussed on substantive differences, which were defined using a more restrictive criterion of ≥ 1.0 logit. The Mantel chi-square test was applied and is reported for pairwise comparisons, where there was evidence of substantive difference, with a significance level of $p < .0007$ (Bonferroni adjusted for multiple comparisons).

Results

The sample descriptive statistics are shown in Table 1.

The overall model fit statistics (Table 2) indicated good fit of the observed data to the Rasch model for the 13-item ASCOT-Workforce, with an insignificant overall Chi-square statistic and standard deviation of item summary residual statistic of < 1.5 . The item separation index was also > 1.5 , which indicated adequate internal consistency. INFIT and OUTFIT mean square values were all within the acceptable range of .5 to 1.5 (Table 3). The Eigenvalue for the first principal component of residual was 1.79, below the criterion of 2.0, which indicated good fit of observed data to the unidimensional Rasch model. There were two positive correlations of standardised residuals (.16) for *Time to care* and *Worry about work*, both of which were under the criterion of .20. Therefore, there is no strong evidence of violation of the assumption of local independence of items. Visual inspection of the category

Table 1 Sample characteristics

	Frequency, <i>N</i> (%)
Sex	
Male	1164 (16.1%)
Female	5945 (82.2%)
Missing	124 (1.7%)
Age	
Under 25 years	151 (2.1%)
25–34 years	867 (12.0%)
35–44 years	1378 (19.1%)
45–54 years	1999 (27.6%)
55–64 years	2,368 (32.7%)
65 or over	415 (5.7%)
Missing	55 (0.8%)
Ethnicity	
White	5709 (78.9%)
Mixed	127 (1.8%)
Asian	278 (3.8%)
Black	611 (8.5%)
Other	327 (4.5%)
Missing	181 (2.5%)
UK citizenship	
No	797 (11.0%)
Yes	6436 (89.0%)
Job role	
Direct care	4252 (58.8%)
Senior or mid-level manager	1441 (19.9%)
Registered manager	679 (9.4%)
Social worker	502 (6.9%)
Occupational therapist	262 (3.7%)
Nurse or allied health professional	97 (1.3%)

Table 2 Model fit statistics

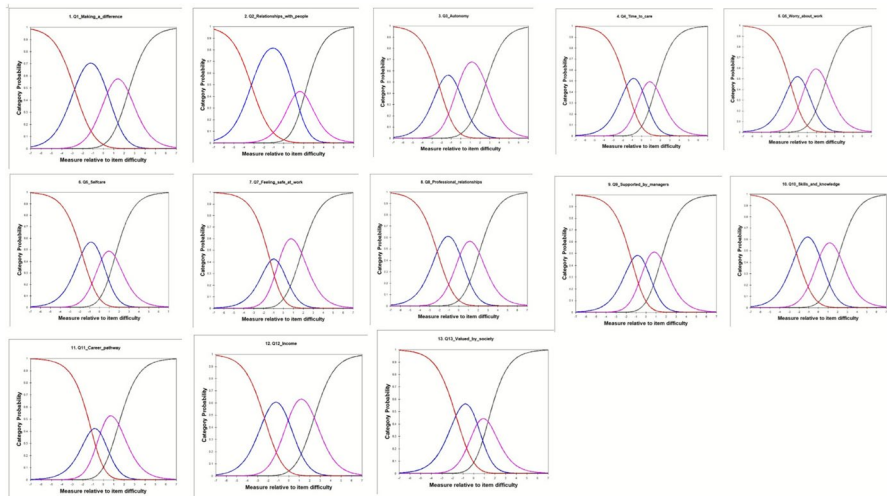
	Overall model fit	Item fit residual Mean (Std. Dev.)	Person fit residual Mean (Std. Dev.)	Item separation index
ASCOT-Workforce (13 items)	χ^2 (178,389 df)= 178,123.99, p =.671	.96 (.00)	1.24 (.14)	51.96
ASCOT-Workforce Brief (9 items)	χ^2 (117,202 df)= 116,994, p =.665	1.33 (.09)	.95 (.00)	48.01

probability curves (Fig. 1) did not indicate disordered thresholds between any of the item response categories.

Table 4 reports the rating scale diagnostics of the 13-item ASCOT-Workforce against Linacre's criteria (Linacre, 2002). The first two criteria were met, i.e., (1) all items had at least 10 ratings per category and (2) the OUTFIT MNSQ for each response category was <2.0 for all ratings. However, we note that one item (*Relationship with clients*) had only 17 ratings of high-level needs (worst CWRQoL), which

Table 3 Item statistics for ASCOT-Workforce (13 items)

	Item difficulty	SE	INFIT MNSQ	OUTFIT MNSQ	Point- measure correlation
1. Making a difference	-.33	.02	1.00	1.02	.58
2. Relationships with clients	-1.81	.02	1.10	1.12	.49
3. Autonomy	.24	.02	.87	.86	.65
4. Time to care	.77	.02	.91	.92	.67
5. Worry about work	1.06	.02	1.12	1.13	.57
6. Self-care	.72	.02	.88	.87	.68
7. Feeling safe at work	-.57	.02	.88	.87	.62
8. Professional relationships	-1.08	.02	.98	.96	.56
9. Supported by managers	.10	.02	.89	.88	.66
10. Skills and knowledge	-1.54	.02	1.17	1.13	.44
11. Career pathway	.38	.02	1.04	1.04	.62
12. Financial security	1.35	.02	1.12	1.13	.54
13. Valued by society	.71	.02	1.05	1.06	.62

**Fig. 1** Category Probability Curves

represented only .2% of the sample, which could lead to <10 ratings in smaller samples. The third criterion was also met since the average category measure and Rasch-Andrich category thresholds increased by response category for all items. However, there was evidence of suboptimal distinguishability at some category thresholds, with a step logit increase of Rasch-Andrich category thresholds of less than 1.4 logits (i.e., criterion (4) was not met). This affected six ASCOT-Workforce items, either between 'some needs' and 'no needs' (*Feeling safe at work* (.84 logits), *Supported by managers* (1.35 logits) and *Career pathway* (.86 logits)) or 'no needs' and 'ideal state' (*Self-care* (1.35 logits), (*Relationship with clients* (.94 logits) and *Valued by society* (1.01 logits)). Two of the items (*Supported by managers* and *Self-care*) are

Table 4 Rating scale diagnostics for ASCOT-Workforce (13 items)

	Observed count	Observed average	OUTFIT MNSQ	Rasch-Andrich threshold	Cat- egory measure
1. Making a difference					
High-level	151	-.82	1.08	NONE	-4.23
Some needs	2249	-.04	.94	-2.77	-1.55
No needs	3258	.93	.96	.28	1.08
Ideal state	1575	1.76	1.12	2.39	3.25
2. Relationships with clients					
High-level	17	-1.45	1.10	NONE	-6.16
Some needs	1129	-.35	1.02	-3.24	-2.90
No needs	2209	.52	1.17	1.15	-1.8
Ideal state	3878	1.25	1.20	2.09	1.60
3. Autonomy					
High-level	375	-.88	.87	NONE	-3.19
Some needs	2,06	-.04	.76	-2.24	-1.06
No needs	3794	1.04	.81	-.34	1.40
Ideal state	1001	2.06	1.00	2.58	3.96
4. Time to care					
High-level	1144	-.53	.83	NONE	-2.04
Some needs	2606	.41	.96	-1.59	-.06
No needs	2309	1.15	.89	.09	1.65
Ideal state	1174	2.11	1.02	1.50	3.53
5. Worry about work					
High-level	1220	-.20	1.20	NONE	-1.97
Some needs	2,707	.42	1.07	-1.81	.01
No needs	2,595	1.25	1.02	.20	2.03
Ideal state	711	2.08	1.21	2.01	4.25
6. Self-care					
High-level	981	-.47	.95	NONE	-2.26
Some needs	2809	.29	.79	-1.79	-.15
No needs	2288	1.19	.80	.22	1.67
Ideal state	1155	2.19	.91	1.57	3.55
7. Feeling safe at work					
High-level	253	-1.11	.87	NONE	-3.24
Some needs	962	-.32	.86	-1.33	-1.54
No needs	3330	.55	.85	-.49	.20
Ideal state	2688	1.61	.90	1.82	2.41
8. Professional relationships					
High-level	80	-1.14	1.01	NONE	-4.46
Some needs	1061	-.37	.89	-2.21	-2.17
No needs	3092	.54	.91	.12	.05
Ideal state	3000	1.46	1.05	2.08	2.19
9. Supported by managers					
High-level	620	-.69	.99	NONE	-2.59
Some needs	1816	.01	.80	-1.43	-.74
No needs	2797	.83	.76	-.08	.91
Ideal state	2000	1.84	.93	1.51	2.84

Table 4 (continued)

	Observed count	Observed average	OUTFIT MNSQ	Rasch-Andrich threshold	Cat-egory measure
10. Skills and knowledge					
High-level	39	-1.24	1.03	NONE	-4.97
Some needs	724	-.34	1.07	-2.27	-2.64
No needs	2838	.50	1.09	.14	-.37
Ideal state	3632	1.23	1.23	2.13	1.78
11. Career pathway					
High-level	935	-.36	1.24	NONE	-2.12
Some needs	1765	.12	.93	-1.16	-.45
No needs	2801	.89	.91	-.30	1.09
Ideal state	1732	1.85	1.04	1.46	3.05
12. Financial security					
High-level	1122	-.21	1.09	NONE	-2.17
Some needs	3353	.54	1.15	-2.35	.11
No needs	2353	1.31	1.13	-.07	2.55
Ideal state	405	2.37	1.17	2.42	4.93
13. Valued by society					
High-level	1065	-.38	1.10	NONE	-2.16
Some needs	2804	.37	1.01	-1.67	-.07
No needs	2070	1.11	.88	.33	1.61
Ideal state	1294	2.06	1.21	1.34	3.36

close to the criterion of 1.4 logits. The remaining four items (*Feeling safe at work*, *Career pathway*, *Relationship with Clients*, *Valued by Society*) may be candidate items to omit for item reduction. Alternatively, affected categories could be collapsed into single categories, although this would move away from the ASCOT four-level rating framework (see Box 2), or the rating scale for these items could be subject to further review and redrafting to determine if it is possible to improve the category distinctions at the relevant intervals.

Finally, uniform differential item functioning (DIF) was considered by ASC role. There were eleven comparisons where the DIF contrast was moderate-to-large based on a criterion of $\geq .64$ logits (Zwick et al., 1999) that affected five items: *Making a difference*; *Time to care*; *Worrying about work*; *Feeling safe at work*; and *Financial security*. Substantive and significant (≥ 1.0 logit, Mantel Chi-square statistic $p < .0007$) differences were evident for three items: *Worrying about work*; *Feeling safe at work*; and *Financial security*. Specifically, there was evidence of differences in item difficulty for registered managers for *Worrying about work* ($\chi^2 = 99.99$, $p < .00001$) and *Feeling safe at work* ($\chi^2 = 99.99$, $p < .00001$), with registered managers more likely to respond that they worry about work and feel safe than direct care staff. There was also a group difference in item difficulty for occupational therapists (OTs) for *Financial security* ($\chi^2 = 99.99$, $p < .00001$). OTs were more likely to respond that they had their preferred Financial security CWRQoL compared to direct care staff. These findings indicate that there is different conceptualisation of these three items by people in different job role categories. Given the ASCOT-Workforce is designed for the whole

ASC workforce, across roles, the evidence of DIF indicates that these three items could be considered for item reduction.

Taking the evidence together, the Rasch analysis indicated six items for omission on the basis of suboptimal distinguishability at category thresholds (*Feeling safe at work*, *Career pathway*, *Relationship with Clients*, *Valued by Society*) and evidence of DIF (*Worry about work*, *Financial security*). However, it was decided to retain two of these six items (*Feeling safe at work* and *Financial security*) due to their relevance to current policy and evidence of their importance to the measure's face validity for respondents and key stakeholders (Blake et al., 2025a, b). The Rasch model was then repeated with the abbreviated 9-item version of ASCOT-Workforce to explore its performance.

The overall fit statistics of non-significant χ^2 and item separation index of >1.5 (Table 2) were taken to indicate a good overall fit to the Rasch model. INFIT and OUTFIT statistics were all within the acceptable range of .50 to 1.50 (Table 5). The Eigenvalue for the first principal component of residual was 1.51, within the criterion of <2.0 , which indicates good fit of the observed data to the unidimensional Rasch model. There were no positive standardised residual correlations for any item, which supports the model assumption of local independence and indicates that there is no item redundancy.

In applying Linacre's criteria (Linacre, 2002) to the rating scale diagnostics (see Table 6), all criteria were met. Specifically, all items had >10 ratings per category and OUTFIT MNSQ of <2.0 . There was an increase for average measures and Rasch-Andrich category thresholds between response categories for all items. The step logit increase of the Rasch-Andrich category thresholds were between 1.4 and 5.0 logits, except for the step between some needs and no needs for *Feeling safe at work* (.99). This replicates the finding from the Rasch model with all 13 items of suboptimal distinguishability at this category threshold. Finally, there were seven comparisons with moderate-to-large DIF contrast based on a criterion of $\geq .64$ logits (Zwick et al., 1999) that affected four items: *Making a difference*; *Time to care*; *Feeling safe at work*; *Skills and Knowledge*; and *Financial security*. Three substantial (≥ 1.0 logit) significant (Mantel Chi-square statistic $p < .0007$) DIF contrasts were observed. Two of these replicated issues identified in the full 13-item model for the two items that were retained, despite evidence of issues (i.e. *Financial security* and *Feeling safe at work*).

Table 5 Item statistics for ASCOT-Workforce (9 items)

	Item difficulty	SE	INFIT MNSQ	OUTFIT MNSQ	Point- measure correlation
1. Making a difference	-.30	.02	1.06	1.08	.59
3. Autonomy	.30	.02	.87	.87	.68
4. Time to care	.87	.02	.95	.96	.69
6. Self-care	.82	.02	.89	.88	.71
7. Feeling safe at work	-.59	.02	.87	.86	.66
8. Professional relationships	-1.12	.02	1.03	1.01	.58
9. Supported by managers	.14	.02	.91	.90	.69
10. Skills and knowledge	-1.61	.02	1.23	1.22	.46
12. Financial security	1.50	.02	1.19	1.20	.56

Table 6 Rating scale diagnostics for ASCOT-Workforce (9 items)

	Observed count	Observed average	OUTFIT MNSQ	Rasch-Andrich threshold	Cat- egory measure
1. Making a difference					
High-level	151	−.99	1.11	NONE	−4.38
Some needs	2249	−.06	.99	−2.96	−1.60
No needs	3258	1.04	1.02	.38	1.19
Ideal state	1575	1.97	1.21	2.57	3.45
3. Autonomy					
High-level	375	−1.08	.88	NONE	−3.31
Some needs	2063	−.09	.77	−2.43	−1.10
No needs	3794	1.17	.80	−.35	1.54
Ideal state	1001	2.36	1.00	2.77	4.20
4. Time to care					
High-level	1144	−.63	.87	NONE	−2.08
Some needs	2606	.44	.95	−1.74	−.03
No needs	2309	1.30	.96	.08	1.81
Ideal state	1174	2.39	1.05	1.66	3.77
6. Self-care					
High-level	981	−.58	.99	NONE	−2.31
Some needs	2809	.30	.80	−1.95	−.12
No needs	2288	1.36	.80	.22	1.84
Ideal state	1155	2.49	.93	1.73	3.79
7. Feeling safe at work					
High-level	253	−1.36	.88	NONE	−3.39
Some needs	962	−.44	.81	−1.49	−1.63
No needs	3330	.61	.92	−.50	.24
Ideal state	2688	1.84	.93	1.99	2.55
8. Professional relationships					
High-level	80	−1.39	1.04	NONE	−4.66
Some needs	1061	−.45	.94	−2.38	−2.29
No needs	3092	.59	.98	.12	.09
Ideal state	3000	1.65	1.09	2.26	2.32
9. Supported by managers					
High-level	620	−.84	1.03	NONE	−2.68
Some needs	1816	−.02	.84	−1.58	−.77
No needs	2797	.93	.78	−.08	1.01
Ideal state	2000	2.09	.94	1.66	3.01
10. Skills and knowledge					
High-level	39	−1.51	1.06	NONE	−5.20
Some needs	724	−.45	1.13	−2.44	−2.79
No needs	2838	.55	1.21	.13	−.36
Ideal state	3632	1.38	1.31	2.31	1.88
12. Financial security					
High-level	1122	−.26	1.19	NONE	−2.20
Some needs	3353	.59	1.19	−2.54	.17
No needs	2353	1.49	1.19	−.09	2.79
Ideal state	405	2.60	1.23	2.63	5.27

Specifically, registered managers were more likely to be able to rate *Feeling safe at work* ($\chi^2=99.99, p<.00001$) and occupational therapists were more likely to be able to positively rate *Financial security* ($\chi^2=99.99, p<.00001$), compared to direct care staff. In addition, it was also found that registered managers were less likely to be able to positively rate that they had enough *Time to care* ($\chi^2=99.99, p<.00001$). These findings indicate that there are group differences in the conceptualisation of ASCOT-Workforce items by workforce groups.

Discussion

The ASCOT-Workforce has been developed to measure CWRQoL in the ASC context, which is increasingly important considering the pressure on the ASC workforce due to ageing populations and the need to develop and evaluate policy or workplace interventions to promote staff recruitment and retention in the sector, internationally. This analysis contributes to the evidence of ASCOT-Workforce's psychometric properties by adding to analysis using CTT approaches (specifically, EFA), as reported elsewhere (Blake et al., 2025b). In line with the EFA (Blake et al., 2025b), the Rasch analysis supports that the ASCOT-Workforce (13 items) is a unidimensional measure. There was adequate fit to the Rasch model, but a number of issues were highlighted that were not evident with the EFA. Specifically, there was evidence of suboptimal distinguishability at category thresholds for *Feeling safe at work*, *Career pathway*, *Relationship with Clients*, *Valued by Society* and DIF for *Worry about work*, *Feeling safe at work* and *Financial security*. Therefore, we also considered the measurement properties of a 9-item version that omitted four of the six items affected by DIF or suboptimal distinguishability. Two of the items (*Financial security* and *Feeling safe at work*) were retained due to their policy relevance and face validity (Blake et al., 2025a, b). Aside from the persistent issue of suboptimal distinguishability between some needs and no needs for *Feeling safe at work* and potential evidence of DIF, the 9-item version had good fit to the Rasch model.

The 9-item version offers a way to reduce items, which is necessary for future development of a preference-based measure. Preference-based measures are measures of health- or social care-related quality of life that have an associated set of preference weights that allow the calculation of an index score, which can be used to calculate quality-adjusted life years (QALY) for cost-effectiveness analysis (Brazier et al., 2017; Netten et al., 2012). While most preference-based instruments are designed for patients or people using services, preference-based measures for unpaid carers have also been developed (Batchelder et al., 2019; Engel et al., 2020). These developments are based on the premise that carers can be understood as co-beneficiaries or co-clients of health and care, so their utility ought to also be considered in economic evaluation (Al-Janabi et al., 2011; Goodrich et al., 2012). As yet, there are no measures that seek to extend this wider perspective beyond people using care services and their carers (a dual or 'dyadic' lens (Rand, 2020)). However, given the importance of work to a person's overall wellbeing (Clark & Oswald, 1994; Green et al., 2024) and of the ASC workforce to the delivery of good quality care (Allan & Vadean, 2023; Castle, 2021), there is growing interest in considering the ASC work-

force perspective in economic evaluation to inform policy and decision-making. This is further reinforced by the current context and challenges in the sector, in England and internationally. A further step in development of the ASCOT-Workforce would be to consider whether and how it could be developed into a preference-based measure via a preference elicitation study. Such studies typically involve measures with a maximum of 8–9 items to avoid undue participant burden and complexity. This study provides a possible way ahead, to develop preferences for a 9-item short form version.

The advantage of the ASCOT-Workforce (13 items) is that it considers all CWRQoL domains identified to be important and relevant to ASC staff and stakeholders (Blake et al., 2025a, b). This will likely improve the content validity and acceptability of the measure to respondents and key stakeholders. Therefore, we recommend further qualitative research to establish whether the 9-item version (or another short-form) is acceptable to ASC staff and other key stakeholders for use alongside the full 13-item measure. Also, the issue of suboptimal distinguishability between response categories is evident in both 13-item and short 9-item scales. Therefore, we recommend further qualitative work to explore whether revisions to the wording of the four response options, especially for *Feeling Safe at Work* in the 9-item version, could improve the psychometric properties.

This study found evidence of substantive significant DIF for three items in the 13-item ASCOT-Workforce (*Worrying about work*; *Feeling safe at work*; and *Financial security*). Since two of these items were retained in the 9-item version (*Feeling safe at work* and *Financial security*), it is unsurprising that the evidence of significant DIF was still evident. In addition, there was also substantive DIF for *Time to care*. DIF does not indicate differences in CWRQoL by job role group, which will be evident and could be explored further through bivariate or multiple regression analysis. More specifically, it indicates that there is a difference in item difficulty by group. DIF indicates a by-group difference for an item that is more or less than the difference predicted by the overall ‘ability’ of the group and the overall item ‘difficulty’. DIF is indicative of different conceptualisations of an item by groups, which then affects the patterns of response. One response to the evidence of DIF is to guide item reduction, as we have partly proposed and applied in the 9-item version. The persistence of DIF for the two retained items in the 9-item version (*Feeling safe at work* and *Financial security*), plus additional evidence of DIF for *Time to care*, may be a cause for concern, since DIF across groups is one of the proposed criteria of item exclusion for preference-based measures (Peasgood et al., 2020).

The use of DIF to inform item reduction may also require caution, however, since it may reflect differences in job role and environment (akin to how differences due to health conditions experienced by patients can cause DIF (Peasgood et al., 2020)). For example, it is possible that DIF for registered managers with regard to *Time to care* and *Feeling safe at work* may be due to the nature of the scope and responsibility of their role, by comparison to direct care staff. Further qualitative study may usefully explore the wording of the four affected items, across the job roles identified in this analysis (i.e. registered managers and OTs by comparison to direct care staff), to further understand potential causes of the DIF and whether these are acceptable differences in the context, or whether item re-drafting may address it (Scott et al., 2010).

Conclusion

This analysis is the first psychometric evaluation of ASCOT-Workforce using Rasch analysis. It builds on the initial development and psychometric evaluation of the measure using CTT approaches, as reported elsewhere (Blake et al., 2025a, b), by applying Rasch analysis to data collected in a national survey of the ASC workforce in England. The large sample size ($n = 7233$) and nation-wide collection of data from people working in diverse ASC roles in England are strengths. This enabled exploration of DIF by job role, alongside the validity and reliability of the scale. However, we note the limitation of the use of online survey methodology and lack of data on non-respondents, which means we were not able to consider or evaluate sampling or non-response biases.

In summary, the findings of the analysis with the full ASCOT-Workforce measure (13 items) indicated adequate fit to the Rasch model, but some issues were evident with six items. After omission of four of these items (but retaining *Financial security* and *Feeling safe at work*, due to policy relevance and for face validity), the 9-item ASCOT-Workforce had a good fit to the Rasch model, but there was still evidence of suboptimal distinguishability for *Feeling safe at work* and DIF for *Financial security* and *Feeling safe at work*. There was also evidence of DIF for *Time to care* for registered managers compared against direct care staff. The findings support further qualitative work to explore whether revisions to the questionnaire could address the DIF and suboptimal distinguishability and whether the 9-item ASCOT-Workforce, is acceptable to ASC staff and stakeholders likely to use the data. Overall, the study provides tentative evidence of the validity of the ASCOT-Workforce measure of CWRQoL and indicates directions for further development work and psychometric evaluation, including the potential development of a preference-based measure of CWRQoL.

Acknowledgements We would like to acknowledge and thank Freddie Gregory, Mary-Clare Ridge, Laura Dale (Ipsos), Tobias Stadler, Davina Figgett, Oliver French, Nicola Tudor, Graham Geddes (Skills for Care) and Sinead Palmer, Barbora Silarova and Nadia Brookes (University of Kent), who were all involved in and contributed to the development of the Wave 1 survey and/or recruitment and/or data collection. We would also like to thank the members of the Executive Resource Group (ERG), who informed the survey data collection, and those from the adult social care workforce who contributed to the survey development (e.g., through focus groups or cognitive/pilot interviews) and/or participated in the survey.

Funding This study was funded by the Department of Health and Social Care (DHSC), as commissioned under the crown commercial services (CCS) RM6126 Research and Insights Dynamic Purchasing System (DPS) framework.

Declarations

Ethics Approval and Consent to Participate The chair of Ipsos internal ethics group reviewed the project and ensured that all ethical issues had been considered and addressed (reference: 22-090620-01). Survey participants were provided with information about the survey in the invitation to complete the survey and were asked to provide consent before accessing the survey.

Competing interests SR, AMT and SA are developers of the ASCOT-Workforce measure and members of the ASCOT team.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Al-Janabi, H., Flynn, T. N., & Coast, J. (2011). QALYs and carers. *Pharmacoeconomics*, 29, 1015–1023.
- Allan, S., & Vadean, F. (2023). The impact of wages on care home quality in England. *Gerontologist*, 63, 1428–1436. <https://academic.oup.com/gerontologist/article/63/9/1428/7086012>
- Batchelder, L., Malley, J., Burge, P., Lu, H., Saloniki, E.-C., Linnoosmaa, I., et al. (2019). Carer social care-related quality of life outcomes: Estimating English preference weights for the adult social care outcomes toolkit for Carers (ASCOT-Carer). *Value in Health*, 22, 1427–1440. <https://doi.org/10.1016/j.jval.2019.07.014>
- Blake M., Lambert C., Gregory F., Ridge M-C., Dale L., Stadler T., et al. (2025a) The adult social care workforce and their work-related quality of life findings on work related quality of life and wellbeing-wave 1. Available from: <https://assets.publishing.service.gov.uk/media/67b89470b3a80ad63e782c38/Adult-social-care-workforce-survey-main-findings-report-february-2025.pdf>
- Blake M., Lambert C., Gregory F., Ridge M-C., Dale L., Stadler T., et al. (2025b). The Adult Social Care workforce and their work-related quality of life Wave 1 technical report 2 2023. Available from: <https://assets.publishing.service.gov.uk/media/67b8948398ea2db44faddcf9/Adult-social-careworkforce-survey-technical-report-february-2025.pdf>
- Bond, T., & Fox, C. (2015). *Applying the Rasch model: Fundamental measurement in the human sciences*. LEA.
- Brazier, J., Ara, R., Rowen, D., & Chevrou-Severac, H. (2017). A review of generic preference-based measures for use in cost-effectiveness models. *Pharmacoeconomics*, 35(Suppl 1), 21–31. <https://doi.org/10.1007/s40273-017-0545-x>
- Castle, N. G. (2021). Measuring caregiver retention in nursing homes. Meeks S, editor. *Gerontologist*, 61, e118–e128. <https://academic.oup.com/gerontologist/article/61/4/e118/6125669>
- Clark, A. E., & Oswald, A. J. (1994). Unhappiness and unemployment. *The Economic Journal*, 104, 648. <https://academic.oup.com/ej/article/104/424/648-659/5158769>
- Easton, S., & Van Laar, D. (2018). *User manual for the work-related quality of life (WRQoL) scale* (Second ed.). A Measure of Quality of Working Life.
- Engel, L., Rand, S., Hoefman, R., Bucholtz, J., Mihalopoulos, C., Muldowney, A., et al. (2020). Measuring Carer outcomes in an economic evaluation: A content comparison of the adult social care outcomes toolkit for Carers, Carer experience scale, and care-related quality of life using exploratory factor analysis. *Medical Decision Making*, 40, 885–896. <https://doi.org/10.1177/0272989X20944193>
- Goodrich, K., Kaambwa, B., & Al-Janabi, H. (2012). The inclusion of informal care in applied economic evaluation: A review. *Value in Health*, 15, 975–981. <https://doi.org/10.1016/j.jval.2012.05.009>
- Green, F., Lee, S., Zou, M., & Zhou, Y. (2024). Work and life: The relative importance of job quality for general well-being, and implications for social surveys. *Socioecon Rev*, 22, 835–857 <https://academic.oup.com/ser/article/22/2/835/7613879>
- Lambert, S., McCusker, J., Belzile, E., Yaffe, M., Ihejirika, C., Richardson, J., et al. (2021). Using confirmatory factor analysis and Rasch analysis to examine the dimensionality of the patient assessment of Care for Chronic Illness Care (PACIC). *Quality of Life Research*, 30, 1503–1512. <https://doi.org/10.1007/s11136-020-02750-9>
- Linacre, M. (2002). Optimizing rating scale category effectiveness. *Journal of Applied Measurement*, 3, 85–106.
- Linacre M. A users guide to winsteps/ministep Rasch model computer programs. Program manual 4.5.1. 2020. Available from: <http://www.winsteps.com/a/Winsteps-ManualPDF.zip>.

- Malley, J. N., Towers, A.-M., Netten, A. P., Brazier, J. E., Forder, J. E., & Flynn, T. (2012). An assessment of the construct validity of the ASCOT measure of social care-related quality of life with older people. *Health and Quality of Life Outcomes*, 10, 21. <https://link.springer.com/article/10.1186/1477-7525-10-21>
- Masters, G. N. (1982). A Rasch model for partial credit scoring. *Psychometrika*, 47, 149–174.
- Netten, A., Burge, P., Malley, J., Potoglou, D., Towers, A.-M. M., Brazier, J., et al. (2012). Outcomes of social care for adults: Developing a preference-weighted measure. *Health Technol Assess*, 16, 1–165. <https://www.journalslibrary.nihr.ac.uk/hta/HTA16160>
- Pallant, J. F., & Tennant, A. (2007). An introduction to the Rasch measurement model: An example using the hospital anxiety and depression scale (HADS). *British Journal of Clinical Psychology*, 46, 1–18.
- Peasgood, T., Mukuria, C., Carlton, J., Connell, J., & Brazier, J. (2020). Criteria for item selection for a preference-based measure for use in economic evaluation. *Quality of Life Research*, 1425–1432. <https://link.springer.com/article/10.1007/s11136-020-02718-9>
- Rand, S. (2020). What does an outcomes-based perspective bring to an understanding of care and caring? *Int J Care Caring*, 4, 605–610.
- Rand, S., Malley, J., Towers, A. M., Netten, A., & Forder, J. (2017). Validity and test-retest reliability of the self-completion adult social care outcomes toolkit (ASCOT-SCT4) with adults with long-term physical, sensory and mental health conditions in England. *Health and Quality of Life Outcomes*, 15, 163. <https://doi.org/10.1186/s12955-017-0739-0>
- Rand, S., Malley, J. N., Netten, A. P., & Forder, J. E. (2015). Factor structure and construct validity of the adult social care outcomes toolkit for Carers (ASCOT-Carer). *Quality of Life Research*, 24, 2601–2614. <http://www.ncbi.nlm.nih.gov/pubmed/26038214>
- Rand, S., Smith, N., Welch, E. et al. (2025). Use of the adult social care outcomes toolkit (ASCOT) in research studies: an international scoping review. *Quality of Life Research*, 34, 2437–2450. <https://doi.org/10.1007/s11136-025-03958-3>
- Rand, S., Towers, A. M., Allan, S., Webster, L., Palmer, S., Carroll, R., et al. (2024). Exploratory factor analysis and Rasch analysis to assess the structural validity of the adult social care outcomes toolkit proxy version (ASCOT-proxy) completed by care home staff. *Quality of Life Research*, 33, 1555–1567. <https://doi.org/10.1007/s11136-024-03631-1>
- Rand, S., Vadean, F., & Forder, J. (2020). The impact of social care services on carers' quality of life. *Int J Care Caring*, 4, 235–259.
- Scott, N. W., Fayers, P. M., Aaronson, N. K., Bottomley, A., de Graeff, A., Groenvold, M., et al. (2010). Differential item functioning (DIF) analyses of health-related quality of life instruments using logistic regression. *Health and Quality of Life Outcomes*, 8, 81. <https://doi.org/10.1186/1477-7525-8-81>
- Sen, A., & Nussbaum, M. (1993). *The quality of life*. Clarendon Press.
- Shea, T. L., Tennant, A., & Pallant, J. F. (2009). Rasch model analysis of the depression, anxiety and stress scales (DASS). *BMC Psychiatry*, 9, 1–10.
- Silarova, B., Brookes, N., Palmer, S., Towers, A. M., & Hussein, S. (2022). Understanding and measuring the work-related quality of life among those working in adult social care: A scoping review. *Health & Social Care in the Community*, 30, 1637–1664. <https://doi.org/10.1111/hsc.13718>
- Silarova, B., Rand, S., Towers, A. M., & Jones, K. (2023). Feasibility, validity and reliability of the ASCOT-proxy and ASCOT-Carer among unpaid carers of people living with dementia in England. *Health and Quality of Life Outcomes*, 21, 54. <https://doi.org/10.1186/s12955-023-02122-0>
- Skills for Care. The state of the adult social care sector and workforce in England 2024. 2024. Available from: <https://www.skillsforcare.org.uk/Adult-Social-Care-Workforce-Data/Workforce-intelligence/documents/State-of-the-adult-social-care-sector/The-state-of-the-adult-social-care-sector-and-workforce-in-England-2024.pdf>.
- Skills for Care. (2025). A workforce strategy for adult social care in England. <https://www.skillsforcare.org.uk/Workforce-Strategy/resources/Supporting-resources/A-Workforce-Strategy-for-Adult-Social-Care-in-England.pdf>
- Tennant, A., & Conaghan, P. G. (2007). The Rasch measurement model in rheumatology: What is it and why use it? When should it be applied, and what should one look for in a Rasch paper? *Arthritis Care Res*, 57, 1358–1362. <https://doi.org/10.1002/art.23108>
- Tennant, A., McKenna, S. P., & Hagell, P. (2004). Application of Rasch analysis in the development and application of quality of life instruments. *Value in Health*, 7, S22–S26. <https://doi.org/10.1111/j.1524-4733.2004.7s106.x>

- Tourangeau, R. (1984). Cognitive science and survey methods: A cognitive perspective. In T. Jabine, M. Straf, J. Tanur, & R. Tourangeau (Eds.), *Cognitive aspects of survey design: Building a bridge between disciplines* (pp. 73–100). National Academy Press.
- Van Laar, D., Edwards, J. A., & Easton, S. (2007). The work-related quality of life scale for healthcare workers. *Journal of Advanced Nursing*, 60, 325–333. <https://doi.org/10.1111/j.1365-2648.2007.04409.x>
- van Loon, M. S., van Leeuwen, K. M., Ostelo, R. W. J. G., Bosmans, J. E., & Widdershoven, G. A. M. M. (2018). Quality of life in a broader perspective: Does ASCOT reflect the capability approach? *Quality of Life Research*, 27, 1181–1189. <https://doi.org/10.1007/s11136-017-1756-5>
- Willis, G. (2005). *Cognitive interviewing: A tool for improving questionnaire design*. Sage.
- Zwick, R., Thayer, D. T., & Lewis, C. (1999). An empirical Bayes approach to mantel-Haenszel DIF analysis. *Journal of Educational Measurement*, 36, 1–28. <https://doi.org/10.1111/j.1745-3984.1999.tb00543.x>

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Authors and Affiliations

Stacey Rand¹  · Ann-Marie Towers²  · Stephen Allan¹  · Margaret Blake³ · Claire Lambert³



Stacey Rand

s.e.rand@kent.ac.uk

Ann-Marie Towers

ann-marie.towers@kcl.ac.uk

Stephen Allan

s.allan@kent.ac.uk

Margaret Blake

Margaret.Blake@ipsos.com

Claire Lambert

Claire.Lambert@ipsos.com

¹ University of Kent, Canterbury, UK

² Kings College London, London, UK

³ Ipsos London, London, UK