Received: 13 December 2022 | Accepted: 17 December 2022

DOI: 10.1002/msc.1727

RESEARCH ARTICLE

WILEY

The osteoarthritis knowledge scale

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Funding information

Open access publishing facilitated by University of Otago, as part of the Wiley - University of Otago agreement via the Council of Australian University Librarians.

Abstract

Objective: Accurate knowledge is central to effective self-care of osteoarthritis (OA). This study aimed to assess the measurement properties of the Osteoarthritis Knowledge Scale (OAKS) with versions for the hip and knee.

Methods: Participants with hip OA (n = 144), knee OA (n = 327), and no OA (n = 735) were recruited. Rasch analysis was conducted to assess psychometric properties using data from all participants with hip OA and 144 randomly selected participants with either knee OA or no OA. Test-retest reliability and measurement error were estimated among those with hip (n = 51) and knee (n = 142) OA.

Results: Four items from the draft scales were deleted following Rasch analysis. The final 11-item OAKS was unidimensional. Item functioning was not affected by gender, age, educational level, or scale version (hip or knee). Person separation index was 0.75. Test-retest intraclass correlation coefficient was 0.81 (95% CI 0.74, 0.86; hip version 0.66 [0.47, 0.79]; knee version 0.85 (0.79, 0.90)). Smallest detectable change was 9 points (scale range 11–55; hip OA version 11 points; knee OA version 8 points).

Conclusion: The OAKS is a psychometrically adequate, unidimensional measure of important OA knowledge that can be used in populations with and without hip and knee OA. Caution is needed when using with populations with only hip OA as test-retest reliability of the hip version did not surpass the acceptable range.

KEYWORDS

hip osteoarthritis, knee osteoarthritis, knowledge, patient-reported outcome measure, psychometrics, reproducibility of results

1 | INTRODUCTION

Accurate knowledge of a health condition and its treatment options helps people to understand their health and make informed choices about health interventions and behaviours (Ahola & Groop, 2013; McCorkle et al., 2011; Small et al., 2013). International consensus on important knowledge for people with hip or knee osteoarthritis (OA) was achieved through a Delphi process involving consumers, clinicians, and researchers (French et al., 2015). This Delphi study resulted in 21 key messages covering areas about: OA disease

knowledge; principles of management; exercise, physical activity and weight loss; drugs and surgery (French et al., 2015).

Education aims to improve knowledge and is a core treatment component recommended by all international OA management guidelines (Bannuru et al., 2019; Fernandes et al., 2013; Kolasinski et al., 2020; National Clinical Guideline Centre (UK), 2014). However, interventions to improve knowledge are rarely described explicitly and the impact of educational interventions on knowledge is rarely assessed. This gap is compounded by the lack of a valid instrument to measure OA knowledge. A valid measure of OA knowledge would enable: (1) clinicians to measure patients' knowledge about their OA and to identify opportunities to improve knowledge or to target educational interventions effectively; (2) researchers to assess public health information needs and to test and improve educational interventions designed to address this core aspect of care.

The Osteoarthritis Knowledge Scale (OAKS) was developed to assess important knowledge about hip and knee OA, including causation, diagnosis, symptom interpretation, management principles, treatment and self-care options (Darlow et al., 2021). Development of the OAKS followed COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN) recommendations (Mokkink et al., 2019). Hip and knee versions of the OAKS were developed by substituting 'hip' or 'knee' in item wording (the hip and knee versions are otherwise identical). Given the high lifetime incidence of symptomatic OA (up to 45% for knee OA; Murphy et al., 2008)), it is important that assessment of OA knowledge can also be undertaken in those who do not currently have the condition but are at risk of developing it. Consequently, OAKS items were worded in such a way that these could be answered by people with or without OA.

The measurement properties of the OAKS have not previously been tested. This study aimed to test the structural validity, internal consistency, measurement invariance, test-retest reliability, and measurement error of the OAKS.

2 | METHODS

OAKS development methods and the protocol for assessing instrument measurement properties have been described in detail previously (Darlow et al., 2021). The instrument was developed and refined following best-practice (COSMIN) guidelines with involvement of consumer research partners. The draft instrument contained 15 items. Each item presents a statement with a five-point Likert scale scored from 1 to 5. Respondents are asked to rate each statement as False (1), Possibly False (2), Unsure (3), Possibly True (4), or True (5).

Data from two cohorts were used to assess OAKS measurement properties: (1) a cohort of people with hip or knee OA as described in the protocol (the Osteoarthritis Knowledge Survey); (2) data from a second cohort of people without OA recruited as part of an online randomised controlled trial evaluating patient educational information and GP advice to exercise (Lawford et al., 2022).

2.1 | Cohort 1—People with hip or knee osteoarthritis

The Osteoarthritis Knowledge Survey (D20/301) was granted ethical approval by the University of Otago Ethics Committee.

2.1.1 | Participants

Potential participants were invited to participate through social media, arthritis consumer advocacy groups (Arthritis New Zealand, Arthritis Australia, Arthritis Research Canada), and invitations sent to people included in the University of Melbourne Centre for Health, Exercise, and Sports Medicine database of people with hip or knee OA (for which appropriate consent and approvals existed). Health professionals were contacted by social media, a BJSM blog post (Darlow, 2021), and researcher networks, and invited to place recruitment posters in their clinics. Potential participants followed a weblink to access information about the study and provide informed consent, before being screened for eligibility. No compensation or remuneration was provided.

People were eligible to participate in the OA Knowledge Survey if they were 18 years of age or older, able to read and write in the English language, and had a diagnosis of hip or knee OA made either by a health professional or by meeting UK National Institute for Health and Care Excellence (NICE) hip or knee OA diagnostic criteria (assessed by questionnaire) (National Clinical Guideline Centre [UK], 2014; Skou et al., 2020; Young et al., 2020). There were no exclusion criteria. People could participate if their hip or knee joint had been replaced due to OA. Beyond the eligibility criteria, there were no further quotas or restrictions on participation by country or other demographic groupings.

Participants with more than one eligible joint were asked to select their most troublesome joint and only complete the survey relative to this joint. The electronic survey adapted pain, function, and quality of life items to refer specifically to this joint.

2.1.2 | Data collection

Data were collected via a secure Qualtrics (Provo, Utah, USA) online survey. Survey settings ensured that only one survey could be submitted from a unique device to minimise multiple completions from one individual. To assess test-retest reliability, consent was sought in the initial survey to send an invitation to complete the OAKS a second time 1 week later. Those who were sent this retest invitation had up to 1 week to complete the second survey.

2.1.3 | Measures

The online survey consisted of the 15-item draft OAKS (adapted for hip or knee OA) (Darlow et al., 2021), the 12-item KOOS-12 or

HOOS-12 (Gandek et al., 2019), a self-rating item about OA knowledge (adapted from the Brief Illness Perception Questionnaire; Broadbent et al., 2006), and items exploring demographic and OA disease characteristics.

2.2 | Cohort 2—People without osteoarthritis

The online randomised controlled trial was approved by The University of Melbourne Human Ethics Committee and was prospectively registered at ClinicalTrials.gov (NCT04698655) (Lawford et al., 2022). It evaluated effects of an OA treatment option grid and general practitioner recommendation to exercise, compared to general information, on treatment beliefs and intentions in people 45 years or over without OA.

2.2.1 | Participants

Participants were recruited via Cint Pty Ltd, a consumer network for digital survey-based research which comprises pre-recruited people who have self-nominated to complete research surveys. Participants received a small financial incentive from Cint to compensate them for their participation.

Participants were eligible to participate if they lived in Australia, were aged 45 years or over, did not have OA in any joint in the body that had been diagnosed by a health professional, had not experienced any knee pain in the prior 3 months, had not had a knee/hip joint replacement, and did not have any health condition that made them unable to exercise.

2.2.2 | Data collection

When collecting data, participants were asked to consider a hypothetical scenario, namely that they were presenting to their GP for the first time with chronic knee pain for which they were seeking care. Participants completed the knee version of the OAKS at baseline only (prior to randomisation) via a single Qualtrics survey (Lawford et al., 2022).

2.2.3 | Measures

Participants completed the 15-item draft knee version of the OAKS (Darlow et al., 2021) and items exploring their demographic characteristics.

2.3 | Patient and public involvement

A research team member and author of this publication (JC) has lived experience of OA. They contributed to survey development and project design, data interpretation, reporting and communication with consumer groups. As a result of their input, changes were made to the participant information, survey flow and item wording, and reporting of results to participants.

2.4 | Analysis

The Osteoarthritis Knowledge Survey aimed to obtain at least 400 complete OAKS responses and 100 complete OAKS retest responses from people with hip or knee OA (Mokkink et al., 2019). Missing data were handled by conducting complete case analysis. Demographic and OA disease characteristics were analysed descriptively and presented separately for respondents with hip, knee, or without OA.

Data from participants with hip, knee, or without OA were pooled for measurement property analysis. Rasch analysis was conducted in an iterative fashion to assess structural validity, internal consistency and measurement invariance (Siegert et al., 2010) using the software RUMM2030 (Andrich et al., 2009). A satisfactory fit to the Rasch model was indicated by a non-significant ($p > 0.05$, Bonferroni adjusted) chi-square fit statistic for item-trait interaction. The acceptable range for fit residuals of individual items was −2.50 to 2.50 (Andrich et al., 2009). Items with severely disordered thresholds were deleted rather than re-scored to retain maximum usability of the scale in subsequent administration and scoring. At each iterative model fit, the residuals correlation matrix was inspected for evidence of local dependency (Christensen et al., 2017). The subtest approach allowed exploration of scale dimensionality. A unidimensional model indicated that local response dependency had been resolved and that there was no evidence of local trait dependency (Medvedev et al., 2018).

At each iterative step, dimensionality was tested using the method proposed by Smith (2002). Internal consistency reliability was estimated in terms of person separation index (PSI), which is interpreted as equivalent to Cronbach's alpha (Tennant & Conaghan, 2007). Differential item functioning (DIF) analyses investigated the extent to which items or subtests performed similarly by completion of hip or knee versions of the OAKS or by the personal factors: age (<50 years/50 to 70 years, >70 years); gender (male/female/gender diverse); educational attainment (school only/trade qualification/university); and group (hip OA/knee OA/no OA). When a suitable model was found, algorithms were generated that allow transformation of ordinal-level scores of the scale to interval-level scores. These increase precision of the scale and make it suitable for parametric statistical analyses (Tennant & Conaghan, 2007).

For the combined OAKS sample, and then separately for hip and knee subgroups, the intraclass correlation coefficient (ICC) was calculated with a 95% confidence interval using a two-way random effects model (ICC2,1 with absolute agreement) to investigate test-retest reliability (Mokkink et al., 2019). An ICC was considered acceptable if the lower bound of the 95% confidence interval was 0.75 or higher (Koo & Li, 2016). We used a Bland-Altman plot to report limits of agreement (Bland & Altman, 1986). From the ICC, we derived the standard error of measurement (SEM) and smallest

detectable change (SDC) for the OAKS (and again hip and knee versions).

Reliability analyses were conducted in R4.1 (R Institute, Vienna, Austria) using the irr package (Gamer et al., 2019).

A script is available for the R statistical computing environment from https://otago.ac.nz/oaks with functions to (a) score the OAKS scale based on responses to the 11-item scale (including reverse scoring for appropriate items); and (b) to perform the ordinal-to-interval-scale conversion. The webpage also includes scripts for import into REDCap (Research Electronic Data Capture, Vanderbilt University, Nashville, Tennessee) for using the scale in electronic data collection.

3 | RESULTS

3.1 | Cohort 1—People with hip or knee osteoarthritis

Between 21 October 2020 and 20 May 2021, 809 people followed the Osteoarthritis Knowledge Survey link, with 642 commencing the survey and passing initial eligibility criteria (over 18 years of age and able to read and write in the English language). Of these, 527 met OA eligibility criteria (n = 165 identified with hip OA, n = 362 with knee OA). The majority completed the scales (n = 471, hip OA subgroup n = 144, or knee OA subgroup n = 327). Retest was completed by 193 people (hip OA subgroup n = 51, knee OA subgroup n = 142). Figure 1 shows participant flow through the Osteoarthritis Knowledge Survey.

Participant demographic characteristics are shown in Table 1. Participants in the OA cohort were predominantly female (71%) and from a range of ages (range 21–93, median 63 years, IQR 54–69). Participants came from 16 countries, with almost half the sample resident in Australia (47%), followed by New Zealand (23%), UK (12%) and Canada (10%). Half of the sample were employed (48%) and 40% retired. The majority of the sample had a university qualification (67%), reported that it was not at all difficult to meet monthly expenses and bills (52%), and lived in a town or city with over 30,000 people (61%).

Clinical characteristics for participants with OA are shown in Table 2. The majority had received a diagnosis of OA from a health professional (86%), and 55% had pain for 2–10 years. Less than 5%

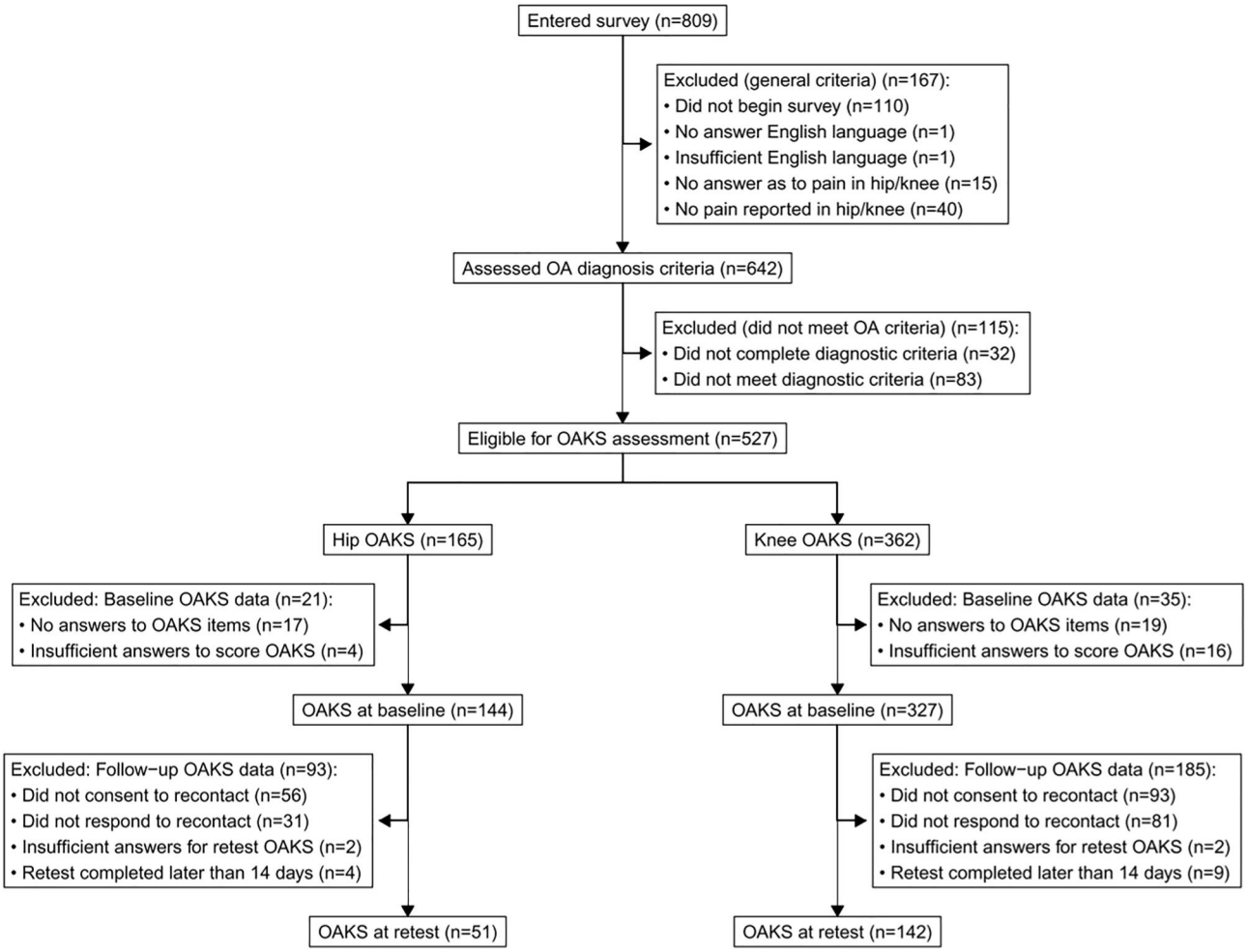

FIGURE 1 Flow of participants with hip or knee OA through the study. OA, Osteoarthritis; OAKS, Osteoarthritis Knowledge Scale.

TABLE 1 Osteoarthritis knowledge survey participant demographic characteristics

Characteristic[a] (*n* (%) or mean (range))	Total (*n* = 471)	Hip OA (*n* = 144)	Knee OA (*n* = 327)
Gender	444 (94.3)	137 (95.1)	307 (93.9)
Female	317 (71.4)	96 (70.1)	221 (72.0)
Male	117 (26.4)	38 (27.7)	79 (25.7)
Gender diverse	3 (0.7)	1 (0.7)	2 (0.7)
Prefer not to say	7 (1.6)	2 (1.5)	5 (1.6)
Age (mean (range))	61.8 (21–93)	60.7 (21–83)	62.3 (30–93)
Country of residence	435 (92.4)	131 (91.0)	304 (93.0)
Australia	203 (46.7)	51 (38.9)	152 (50.0)
Canada	43 (9.9)	18 (13.7)	25 (8.2)
Ireland	18 (4.1)	3 (2.3)	15 (4.9)
New Zealand	98 (22.5)	36 (27.5)	62 (20.4)
United Kingdom	53 (12.2)	16 (12.2)	37 (12.2)
United States	9 (2.1)	3 (2.3)	6 (2.0)
Other[b]	11 (2.5)	4 (3.1)	7 (2.3)
Highest education	392 (83.2)	118 (81.9)	274 (83.8)
School only	72 (18.4)	29 (24.6)	43 (15.7)
Trade/technical	47 (12.0)	10 (8.5)	37 (13.5)
University	263 (67.1)	74 (62.7)	189 (69.0)
Prefer not to answer	10 (2.6)	5 (4.2)	5 (1.8)
Occupation	394 (83.7)	119 (82.6)	275 (84.1)
Office-type worker	167 (42.4)	51 (42.9)	116 (42.2)
Manual-type worker	22 (5.6)	7 (5.9)	15 (5.5)
Not in workforce	38 (9.6)	17 (14.3)	21 (7.6)
Retired	159 (40.4)	42 (35.3)	117 (42.5)
Volunteer	4 (1.0)	0 (0.0)	4 (1.5)
Prefer not to answer	4 (1.0)	2 (1.7)	2 (0.7)
Socioeconomic circumstance[c]	395 (83.9)	120 (83.3)	275 (84.1)
1	206 (52.2)	67 (55.8)	139 (50.5)
2	59 (14.9)	18 (15.0)	41 (14.9)
3	49 (12.4)	12 (10.0)	37 (13.5)
4	23 (5.8)	8 (6.7)	15 (5.5)
5	24 (6.1)	7 (5.8)	17 (6.2)
Don't know/prefer not to answer	34 (8.6)	8 (6.7)	26 (9.5)
Rurality[d]	395 (83.9)	120 (83.3)	275 (84.1)
Live in town or city	239 (60.5)	70 (58.3)	169 (61.5)
<25 min	47 (11.9)	19 (15.8)	28 (10.2)
25–60 min	57 (14.4)	9 (7.5)	48 (17.5)

TABLE 1 (Continued)

Characteristic[a] (*n* (%) or mean (range))	Total (*n* = 471)	Hip OA (*n* = 144)	Knee OA (*n* = 327)
>60 min	42 (10.6)	18 (15.0)	24 (8.7)
Don't know/prefer not to answer	10 (2.5)	4 (3.3)	6 (2.2)

Abbreviation: OA, osteoarthritis.

[a]These items were gathered after scale responses and were not mandatory.

[b]No other country had more than two participants.

[c]Difficulty covering monthly expenses and bills: OA samples 1 = not at all difficult, 5 = extremely difficult.

[d]Time taken to travel to nearest town or city with population over 30,000.

TABLE 2 Osteoarthritis knowledge survey participant clinical characteristics

Characteristic (*n* (%) or mean (SD))	Total (*n* = 471)	Hip OA (*n* = 144)	Knee OA (*n* = 327)
Diagnosis	471 (100.0)	144 (100.0)	327 (100.0)
Health professional	406 (86.2)	116 (80.6)	290 (88.7)
NICE diagnostic criteria	65 (13.8)	28 (19.4)	37 (11.3)
Duration of joint pain	468 (99.4)	143 (99.3)	325 (99.4)
<2 years	127 (27.1)	48 (33.6)	79 (24.3)
2–5 years	137 (29.3)	44 (30.8)	93 (28.6)
5–10 years	120 (25.6)	35 (24.5)	85 (26.2)
>10 years	84 (17.9)	16 (11.2)	68 (20.9)
Number of lower limb joints with OA	471 (100.0)	144 (100.0)	327 (100.0)
0	0	0	0
1	187 (39.7)	56 (38.9)	131 (40.1)
2	209 (44.4)	54 (37.5)	155 (47.4)
3	45 (9.6)	20 (13.9)	25 (7.6)
4	30 (6.4)	14 (9.7)	16 (4.9)
Joint replacement	471 (100.0)	144 (100.0)	327 (100.0)
Surveyed joint	22 (4.7)	8 (5.6)	14 (4.3)
Other hip/knee joint	69 (14.6)	24 (16.7)	45 (13.8)
No	380 (80.7)	112 (77.8)	268 (82.0)
Previous information about OA received[a]	395 (83.9)	120 (83.3)	275 (84.1)
None	22 (5.6)	10 (8.3)	12 (4.4)
Health professional	332 (84.1)	95 (79.2)	237 (86.2)
OA rehabilitation programme	23 (5.8)	6 (5.0)	17 (6.2)
Arthritis programme/support group	47 (11.9)	11 (9.2)	36 (13.1)
Lay people	87 (22.0)	21 (17.5)	66 (24.0)
Media	182 (46.1)	50 (41.7)	132 (48.0)
Publication	99 (25.1)	23 (19.2)	76 (27.6)
Professional training	6 (1.5)	1 (0.8)	5 (1.8)
Other	2 (0.5)	0 (0.0)	2 (0.7)
Prefer not to say	2 (0.5)	1 (0.8)	1 (0.4)

(Continues)

TABLE 2 (Continued)

Characteristic (*n* (%) or mean (SD))	Total (*n* = 471)	Hip OA (*n* = 144)	Knee OA (*n* = 327)
HOOS or KOOS[b]	52.0 (17.9)	51.5 (18)	52.2 (17.9)
Self-rated knowledge about OA[c]	6.1 (2.5)	6.0 (2.5)	6.2 (2.5)

Abbreviation: OA, osteoarthritis.

[a]Participants could select more than one response.

[b]Hip or Knee Osteoarthritis Outcome Score, 12 items, total (scaled) scores range from 0 to 100, higher scores represent greater pain, functional limitation, and reduced quality of life.

[c]Item wording 'How well do you feel you understand knee/hip osteoarthritis?' with response options from 0 (don't understand at all) to 10 (understand very clearly).

had received a joint replacement affecting the most troublesome joint. Most had received information about OA and had moderate levels of pain, impairment, and quality of life impact. Participants considered they had moderate OA knowledge levels (mean = 6.1 out of 10) based on a single self-report item.

3.2 | Cohort 2—People without osteoarthritis

Between 24 and 30 March, 2021, 1875 people were assessed for eligibility. Of these, 1137 were not eligible due to: not reading the plain language statement (*n* = 32); not consenting to participate (*n* = 128); being under 45 years of age (*n* = 43); having osteoarthritis (*n* = 465); experiencing knee pain in the last 3 months (*n* = 283); having had a joint replacement (*n* = 29); having a health condition preventing exercise (*n* = 75); or not completing the survey (*n* = 85). Data from 735 people were included in analysis.

All of the sample without OA were from Australia. Participants identified as female (*n* = 382; 52%), male (*n* = 351; 48%) or gender diverse (*n* = 2; 0.2%). Ages ranged from 45 to 90 years (median 60 years). Participants had a range of educational attainment: school only (*n* = 245; 33%); trade or technical qualification (*n* = 168; 23%); university degree (*n* = 322; 43.6%). Participants had diverse socio-economic position: very comfortably off (40; 5.4%); quite comfortably off (*n* = 244; 33%); able to manage without much difficulty (*n* = 168; 22%); have to be careful with money (*n* = 246; 33%); find it a strain to get by from week to week (54; 7%); prefer not to answer (*n* = 9; 1%).

3.3 | Rasch analysis

For Rasch analysis, a sample was created that contained equal number of participants from each sample. For the smallest of these samples, the hip OA (*n* = 144), all participants were retained. The baseline model with all 15 candidate items was inadequate as it exhibited a significant item-trait interaction (χ^2 (75) = 499.25, $p < 0.01$). Item 3 was deleted first as the fit residual (10.76) was clearly outside the acceptable range of −2.50 to 2.50. The resulting fit was improved but still showed significant item-trait interaction (χ^2 (70) = 267.09, $p < 0.01$). At this stage, three items had elevated fit residuals: Item 2 (3.91), 9 (4.22), and 10 (−2.67). When these items were deleted, model fit was still significant (χ^2 (55) = 140.72, $p < 0.01$). As there were no more misfitting items, the residual correlation matrix was inspected for sources of misfit. The subsequent model was run to address local dependency across items by creating a subtest consisting of Items 6, 8, and 12. The resulting model no longer showed significant item-trait interaction (χ^2 (45) = 56.62, $p = 0.11$), and Smith's Test (2000) indicated that this solution was unidimensional (Smith, 2002). As there was no DIF by age, gender, education, and sample group (hip, knee, no OA), this solution was considered as final. Scale characteristics are presented in Table 3. Appendix 1 contains the final hip and knee versions of the final OAKS, scoring instructions, and a table illustrating how ordinal scores can be converted to interval-scale scores for participants who have no missing data.

3.4 | Reliability

The PSI of the final instrument was 0.75. Test-retest reliability and measurement error data for the OAKS for the full sample and for the hip and knee OA subgroups are presented in Table 4. The reliability of the hip version was lower than for the knee version. The Bland-Altman plot showed reasonable limits of agreement between test and retest scores for the OAKS and the knee version (Figure 2). While the SDC is reported to one decimal place, the SDC should be considered as rounded-up to the next integer because the scale is scored as whole numbers (11 for hip version, 8 points for knee version).

4 | DISCUSSION

This study evaluated measurement properties of the OAKS among people with hip OA, knee OA, or no OA. Rasch analysis identified a unidimensional 11-item solution with adequate structural validity and internal consistency. Item functioning was not affected by gender, age, educational level, or sample group, indicating that these OA knowledge scales have broad applicability across those with or without hip or knee OA. The OAKS demonstrated adequate reliability; however, sufficient reliability was not demonstrated amongst people with hip OA.

TABLE 3 Scale characteristics

	Combined			Hip OA			Knee OA			No OA		
Scale version	**Mean**	**SD**	**95% CI**	**Mean**	**SD**	**95% CI**	**Mean**	**SD**	**95% CI**	**Mean**	**SD**	**95% CI**
Draft OAKS (all items)[a]	52.0	7.8	51.3, 52.7	52.0	8.0	50.7, 53.4	51.9	7.7	51.1, 52.8	47.13	4.9	46.8, 47.5
Final OAKS (11 item)[b]	37.8	6.9	37.2, 38.5	37.6	6.7	36.5, 38.8	37.9	7.0	37.1, 38.7	34.22	4.2	33.9, 34.5

Abbreviation: OA, osteoarthritis.

[a]Draft Osteoarthritis Knowledge Scale, 15 items, total score ranges from 15 to 75, higher scores indicate greater knowledge about osteoarthritis.

[b]Final Osteoarthritis Knowledge Scale, 11 items, total score ranges from 11 to 55, higher scores indicate greater knowledge about osteoarthritis.

TABLE 4 Reliability data

Characteristic	OAKS (n = 193)	Hip version (n = 51)	Knee version (n = 142)
ICC (95% CI)	0.81 (0.74, 0.86)	0.66 (0.47, 0.79)	0.85 (0.79, 0.90)
SEM	3.0	3.9	2.7
SDC	8.4	10.9	7.4

Abbreviations: ICC, intraclass correlation coefficient (2.1); OA, osteoarthritis; SDC, smallest detectable change; SEM, standard error of the mean.

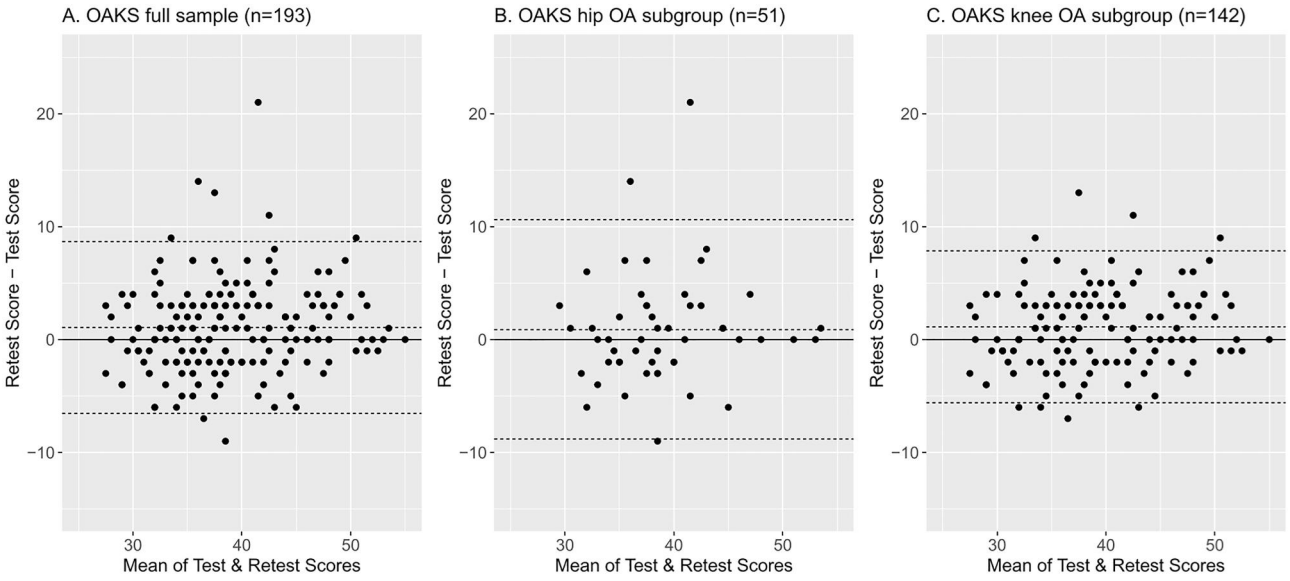

FIGURE 2 Bland–Altman plot: intraindividual differences on test and retest, plotted against the average of the two scores for the: (a) Osteoarthritis Knowledge Scale (OAKS) full sample (n = 193); (b) hip osteoarthritis subgroup (n = 51); and (c) knee osteoarthritis subgroup (n = 142). The central line represents the mean difference, and the dashed lines display the 95% limit of agreement.

Four items from the draft scales were deleted through Rasch analysis due to misfit. Three of these (Item 2. *Everyone gets osteoarthritis as they get older*, Item 3. *Osteoarthritis affects all parts of the knee, including the muscles*, and Item 9. *It is generally not harmful to your joint to do things that increase your knee pain*) performed poorly across all groups. A fit could be found for item 10 (*Exercise is important for everyone who has osteoarthritis*) in the hip and knee OA samples, but not the sample without OA. Irrespective of this, item 10 did not strengthen scale properties. We preferred broad applicability to heterogenous samples of participants over creating separate scales for different population groups. Although all deleted items represented important OA knowledge, many of the concepts these explored (especially items 2, 9, and 10) were adequately covered by remaining items. The knowledge that OA is not just a cartilage disease but affects the whole joint (including muscles and ligaments) is not covered by other items; future studies could explore the development of an item to measure this knowledge.

OAKS measurement properties were assessed in populations with hip, knee, and no OA by drawing on data from two studies. The hip and knee versions of the OAKS contain the same items with the only difference being the replacement of 'hip' with 'knee'. This is consistent with the knowledge consensus from which the instruments were constructed relating to hip and knee OA (French et al., 2015), and may improve ease of use amongst populations with hip and knee OA. To assess DIF across the hip, knee OA and no OA, samples included in Rasch analysis were restricted to the size of the

hip OA cohort ($n = 144$). The total sample size this provided for Rasch analysis ($n = 432$) exceeded the COSMIN recommendation of a sample exceeding 400 participants (Mokkink et al., 2019).

Consistent with global prevalence estimates for OA, 79% of the OA sample had knee OA. The smaller retest sample size of those with hip OA resulted in a wide confidence interval and uncertain test-retest reliability results for the hip version of the OAKS that did not meet our a priori threshold for acceptable reliability. It is possible that differences specific to hip OA, such as later onset, condition variability, or disease course affect interpretation of OAKS items. Further reliability assessment of the hip version of the OAKS with a larger sample should be conducted before the scale is used in populations with hip OA. The knee version of the OAKS demonstrated excellent test re-test reliability and SDC of eight points (rounded up from calculated SDC of 7.4 points). Test-retest data were not collected for those with no OA; this should be assessed through future studies.

Internal consistency was assessed with the PSI (equivalent to Cronbach's alpha and interpreted similarly) (Tennant & Conaghan, 2007). PSI values of at least 0.70 are recommended for a scale to be used for reliable group comparisons, and values above 0.85 for individual use. The PSI of 0.75 for the OAKS indicates that this is robust for group-level analyses, but within-participant changes should be interpreted with caution. The OAKS may be useful for clinicians to assess patient knowledge and the need for education, but may not be appropriate for assessing changes over time.

There is no gold standard for assessing OA knowledge. We believe this is the first tool developed following COSMIN guidelines that attempts to assess knowledge; consequently, we could not test construct validity. This could be assessed by comparing scores in populations reasonably assumed to hold different levels of knowledge (such as OA researchers, clinicians, and the public) or following interventions that increase knowledge. The knee version of the OAKS has been used in three clinical trials that have assessed knowledge change following an educational intervention (Darlow et al., 2022; Egerton et al., 2022; Lawford, Bennell, Hall, Egerton, et al., 2022). These trials observed improvement in knee OAKS scores in the groups receiving the intervention information compared to groups receiving control information. These findings provide support for the construct validity of the knee OAKS.

Our study collected data about socioeconomic circumstance and rurality, and findings demonstrated that a diverse range of participants were recruited. However, most were affluent and from towns or cities. Although people from 16 countries took part, almost 70% of the OA samples were recruited from Australia and New Zealand, and the entire no OA sample was recruited from Australia; this limited the ability to analyse cross-cultural validity. Given that most of the team that developed the OAKS are based in Australia and New Zealand, future studies should confirm the measurement properties of these scales in other countries, languages, and regions with different levels of economic development. The scales are currently only available in English, with further translations and cross-cultural adaptations planned.

Knowledge is not set in stone, and what is considered important knowledge for people with OA may evolve over time. This notion may necessitate alterations to the OAKS. In addition, not all aspects of OA knowledge could be assessed, particularly in relation to management options that many people with knee OA may not have encountered (such as arthroscopy) or medications for which evidence is still uncertain.

In conclusion, the OAKS is a psychometrically adequate, unidimensional measure of important OA knowledge that can be used in populations with and without hip and knee OA. The OAKS may be used clinically or in surveys to assess knowledge about OA or in studies assessing the impact of interventions designed to affect OA knowledge. Caution is needed when using with cohorts that have only hip OA as test-retest reliability of the hip version did not surpass the acceptable range.

AUTHOR CONTRIBUTIONS

All authors have made substantial contributions to the conception and design of the study, or acquisition of data, or analysis and interpretation of data. **Ben Darlow**: conceptualisation; investigation; methodology; project administration; writing—original draft preparation (lead). **Chris Krägeloh**: conceptualisation; data curation; formal analysis (Rasch); methodology; visualisation; writing—original draft preparation. **J. Haxby Abbott**: conceptualisation; methodology; Writing—Review & Editing. **Kim Bennell**: conceptualisation; methodology; Writing—Review & Editing. **Andrew M. Briggs**: conceptualisation; methodology; Writing—Review & Editing. **Melanie Brown**: conceptualisation; methodology; Writing—Review & Editing. **Jane Clark**: conceptualisation; methodology; Writing—Review & Editing. **Sarah Dean**: conceptualisation; methodology; Writing—Review & Editing. **Simon French**: conceptualisation; methodology; Writing—Review & Editing. **Rana S. Hinman**: conceptualisation; methodology; Writing—Review & Editing. **Belinda J. Lawford**: investigation; Writing—Review & Editing. **Dr Daniel O'Brien**: conceptualisation; methodology; Writing—Review & Editing. **Jackie L. Whittaker**: conceptualisation; methodology; Writing—Review & Editing. **James Stanley**: conceptualisation; data curation; formal analysis (statistical); methodology; visualisation; writing—original draft preparation. All authors contributed to draughting the article or revising it critically for important intellectual content and approved the submitted version. Ben Darlow (ben.darlow@otago.ac.nz) takes responsibility for the integrity of the work as a whole, from inception to finished article.

ACKNOWLEDGEMENTS

We thank the clinicians, members of the public, and arthritis consumer advocacy groups (Arthritis New Zealand, Arthritis Australia, Arthritis Research Canada) that shared the invitation to join the survey.

This study did not receive any funding. Kim Bennell is supported by a National Health and Medical Research Council Investigator Grant (#11744319). Sarah Dean's time is partly supported by the National Institute for Health and Care Research Applied Research Collaboration South West Peninsula. The views expressed in this publication are those of the author(s) and not necessarily those of the National Institute for Health and Care Research or the Department of Health and Social Care.

Open access publishing facilitated by University of Otago, as part of the Wiley - University of Otago agreement via the Council of Australian University Librarians.

CONFLICT OF INTEREST

All authors report no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

The Osteoarthritis Knowledge Survey (D20/301) was granted ethical approval by the University of Otago Ethics Committee.

The online randomised controlled trial was approved by The University of Melbourne Human Ethics Committee, Melbourne, Australia and was prospectively registered at ClinicalTrials.gov (NCT04698655).

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Darlow, B., Krägeloh, C., Abbott, J. H., Bennell, K., Briggs, A. M., Brown, M., Clark, J., Dean, S., French, S., Hinman, R. S., Lawford, B. J., O'Brien, D., Whittaker, J. L., & Stanley, J. (2023). The osteoarthritis knowledge scale. *Musculoskeletal Care*, *21*(2), 516–526. https://doi.org/10.1002/msc.1727