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ORIGINAL RESEARCH

Assessing the Smallest Detectable Change of the Kessler Psychological Distress Scale Score in an Adult Population in Japan

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Background: Psychological distress is prevalent worldwide and can lead to the development of mental conditions such as major depression and anxiety disorders. It is essential to assess the severity of patient-reported outcomes to provide effective treatment for psychological distress. The Kessler Psychological Distress Scale (K6) is one of the most widely used psychological distress scales. However, the smallest detectable change (SDC) of the K6 score has not been elucidated. Therefore, the current study aimed to determine the SDC of the K6 score in a Japanese adult population.

Methods: Participants aged 20–59 years who are native Japanese speakers were recruited from the panel list of a web research firm. The K6 score was assessed at baseline (T1) and at 2-week follow-up (T2). SDCs were calculated at the individual (SDC_{ind}) and group (SDC_{group}) levels. Intraclass correlation coefficient agreement ($ICC_{agreement}$) was calculated to assess test–retest reliability and Cronbach's alpha to evaluate internal consistency.

Results: A total of 3254 (1627 [50%] female) responded at T1 and T2. The mean (standard deviation) K6 scores were 5.71 (5.84) at T1 and 5.65 (5.83) at T2. The SDC_{ind} and SDC_{group} of the K6 score were 8.47 (35.31%) and 0.15 (0.63%), respectively. The $ICC_{agreement}$ was 0.73, and the Cronbach's alpha was 0.94.

Conclusion: Our study provided evidence on the reliability and interpretation of the K6 score. Calculating the SDC of the K6 score can help identify the significance of changes in psychological distress over time and can determine the efficacy of interventions for psychological distress.

Keywords: psychological distress, reliability, measurement error, mental health

Introduction

Psychological distress is characterized by different nonspecific symptoms including lack of enthusiasm, sleep issues, depression, and hopelessness about the future.[1–3] It is prevalent worldwide, and previous studies showed that 15.1–24.7% of the general population experience moderate psychological distress.[4,5] Moreover, 3.1–4.2% present with severe psychological distress,[4,5] which is associated with various issues such as low quality of life,[6–8] cognitive decline,[9] poor academic performance,[10–12] high medical costs,[13] unemployment,[14] and suicide.[15] Importantly, psychological distress reflects not only the severity but also the chronicity of depressive and anxiety symptoms.[16,17] Further, it may lead to the development of mental disorders such as major depression and anxiety disorders.[18,19] Considering these issues, reducing psychological distress is an important public health priority. Therefore, several intervention strategies have been developed to address psychological distress, and their efficacy is examined.[20–23] Previous studies have provided substantial evidence that interventions such as cognitive behavioral therapy and the use of smartphone

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applications are effective in improving psychological distress.[22–25] In addition to these interventions, the application of patient-reported outcome (PRO) may be important in facilitating more effective and appropriate interventions.

The use of PROs, which has numerous advantages, in clinical practice has currently become a topic of interest.[26–28] Several PROs have been utilized in clinical trials.[29] Moreover, the systematic monitoring of patient symptoms using PROs has improved patient–clinician communication and symptom assessment.[27–29] In addition, PRO-based care has better outcomes than the usual care.[28,29] Due to these advantages, the use of PROs in clinical settings is important as more effective interventions can be provided for psychological distress. However, considering patient burden and the busy clinical situation, PROs must be simple for the respondent, scorer, or interpreter.[30] Therefore, there is an urgent need to develop PROs that can identify early-stage psychological distress and can assess changes in disease severity among patients receiving treatment using a reliable and simple method.

The Kessler Psychological Distress Scale (K6) is an effective PRO tool for screening not only the presence but also changes in the severity of psychological distress.[31–33] In fact, the K6 score is used as a standardized measure in cases in which a more detailed severity assessment is not possible.[31] In addition, the K6 can be answered in approximately 2–3 min, and the result is easy to grade.[32,34] Therefore, it is simpler and less burdensome for respondents, scorers, or interpreters. Due to these advantages, the K6 is one of the most widely used psychological distress scales in both clinical and research settings.[4,5,33,35,36] Further, it has been translated in several countries, and its psychometric properties including reliability and validity have been evaluated.[31,32,34,35,37–40]

However, the smallest detectable change (SDC) of the K6 score must be identified to support its utility in research and clinical practice. SDC is the value that can be considered an actual change independent of measurement error, and any change that is smaller than the SDC can be interpreted as a result of measurement error.[41–43] That is, a change in scores can represent an actual change only if it is greater than the SDC. In addition, the SDC and original values are displayed in the same units. Therefore, establishing the SDC could resolve important issues in determining whether changes in scores are clinically significant or are caused by measurement errors. This can then provide clinicians and epidemiologists with useful information for interpreting changes in scores.[41,44] Due to these advantages, SDC can be an essential component of the K6 in research and clinical use. However, the SDC of the K6 score is not fully elucidated. Therefore, the current study aimed to determine the SDC of the K6 score in an adult population in Japan.

Methods

Study Design

A prospective cohort study was conducted to examine the SDC, standard error of measurement (SEM), test–retest reliability, and internal consistency of the K6 score. Data were collected in December 2020 via an internet survey. The research was approved by the Ethical Review Board for Medical Research Involving Human Subjects of Gunma University (Approval no. HS2020-168) and was conducted in accordance with the Consensus-based Standards for the Selection of Health Measurement Instruments (COSMIN) initiative.[43]

Participants

The participants were recruited from the panel list (with over 3.5 million people) of a web research firm (Marketing Applications Inc.). A link to the website that provided information about the survey was sent to potential participants aged 20–59 years who are native Japanese speakers. The email included an option to provide an electronic informed consent. Those who provided consent by checking the "I agree" button participated in the survey. Participants who responded to the first internet survey (T1) completed the second internet survey (T2) after 2 weeks. The time interval between T1 and T2 was long enough to prevent recall bias.[45]

Outcomes

K6

The K6 is a six-item self-report tool for assessing psychological distress over the past 30 days.[31,32] Moreover, it is a five-point Likert scale (4 = all the time, 3 = most of the time, 2 = sometimes, 1 = a little of the time, and 0 = none of the time)

with a total score of 0–24. Higher scores indicate greater psychological distress. Previous studies have shown the reliability and validity of the K6.[31,32,34,35,37–40,46] Further, it has an excellent internal consistency (Cronbach's alpha = 0.85–0.90).[34,35] The Japanese version of the K6 was used in this study. The reliability and validity of the Japanese version of K6 have been verified in previous studies.[32,34,35,47]

Sample Size

According to the COSMIN initiative, a sample size of ≥ 100 is sufficient for achieving statistical power when assessing test–retest reliability, SDC, and internal consistency.[43] Therefore, the current study included > 100 participants.

Statistical Analysis

All analyses were performed using R (version 4.0.2 for Windows; The R Project for Statistical Computing, Vienna, Austria).

Test–Retest Reliability

Test–retest reliability indicates the stability of the instrument and its ability to produce similar scores on repeated measurements.[43] The irr package was used to calculate intraclass correlation coefficients ($ICC_{agreement}=\sigma^2_p/[\sigma^2_p + \sigma^2_m + \sigma^2_r]$) based on a two-way random effects model.[43,48] σ^2 refers to the variance component, where p = systematic difference between the participants' actual scores, m = error variance of the systematic difference between two measurements, and r = random error. The intraclass correlation coefficients were expressed as a value between 0 and 1, and values > 0.70 were acceptable.[43,48]

Smallest Detectable Change

SDC is the smallest change of the K6 score that is considered an actual change (ie, a change greater than the measurement error).[43] The individual-level SDC (SDC_{ind}) was calculated using the following formula: 1.96 x √2 x $SEM_{agreement}$.[45,49] In addition, the group-level SDC (SDC_{group}) was calculated using the following formula: $SDC_{ind}/\sqrt{n}$.[50,51] $SEM_{agreement}$ was calculated using the square root of the error component ($\sqrt{\sigma_m^2 - \sigma_r^2}$) of the $ICC_{agreement}$ formula.[43] Error variances were evaluated with the linear mixed models using the lmerTest package.

Internal Consistency

Internal consistency expresses the degree of interrelatedness between items.[43] Cronbach's alpha was used to assess the internal consistency of the K6 score. The Cronbach's alpha ranges from 0 to 1. If the interrelationship between items is higher, the alpha value is greater. A Cronbach's alpha of > 0.7 indicate a good consistency.[45] The psych package was used to evaluate Cronbach's alpha.

Results

Characteristics of the Participants

Of 135,848 people invited to visit the survey website, 6632 completed the survey at T1. Among them, 3254 completed the survey at T2. The final participation rate was 2.40% (3254 of 135,848). Table 1 shows the characteristics of the participants. In total, 1627 (50%) were women. Further, 823 (25.29%) were aged 20–29 years; 811 (24.92%), 30–39 years; 812 (24.95%), 40–49 years; and 808 (24.83%), 50–59 years.

SDC, $SEM_{agreement}$, and $ICC_{agreement}$ of the K6 Scores

Table 2 shows the mean and SD, mean change, $SEM_{agreement}$, SDC, and $ICC_{agreement}$ of the K6 scores. The mean (standard deviation) K6 scores were 5.71 (5.84) at T1 and 5.65 (5.83) at T2. The $ICC_{agreement}$ and $SEM_{agreement}$ of the K6 scores were 0.73 and 3.06, respectively. The SDC_{ind} of the K6 score was 8.47 (35.3%), and the SDC_{group} was 0.15 (0.6%).

Cronbach's Alpha

As depicted in Table 3, the Cronbach's alpha of the K6 score at T1 and T2 was 0.94, which indicated a good consistency.

Table 1 Characteristics of the Participants (N = 3254)

Characteristics	n	%
Sex		
Male	1627	50
Female	1627	50
Age (years)		
20–29	823	25.29
30–39	811	24.92
40–49	812	24.95
50–59	808	24.83
Marital status		
Not married	1626	49.97
Married	1628	50.03
Smoking habits		
Nonsmoker	2383	73.23
Smoker	871	26.77
Drinking habits		
Nondrinker	1739	53.44
Drinker	1515	46.56
Physical activity		
Yes	2012	61.83
No	1242	38.17
Education		
Without university degree	1942	59.68
With university degree	1312	40.32

Table 2 ICC, SEM, and SDC of the K6 Scores

	n	T1 Mean (SD)	T2 Mean (SD)	Changes Mean (SD)	$SEM_{agreement}$	SDC_{ind}	SDC_{ind} (%)	SDC_{group}	SDC_{group} (%)	$ICC_{agreement}$ (95% CI)
Both sexes	3254	5.71 (5.84)	5.65 (5.83)	−0.07 (4.32)	3.06	8.47	35.31%	0.15	0.63%	0.73 (0.71–0.74)
20–29	823	7.09 (5.72)	7.04 (5.85)	−0.05 (4.81)	3.40	9.42	39.25%	0.33	1.38%	0.66 (0.61–0.69)
30–39	811	6.36 (6.11)	6.20 (6.10)	−0.16 (4.78)	3.38	9.37	39.04%	0.33	1.38%	0.69 (0.66–0.73)
40–49	812	5.28 (5.92)	5.24 (5.87)	−0.04 (3.95)	2.79	7.73	32.21%	0.27	1.13%	0.78 (0.75–0.80)
50–59	808	4.09 (5.10)	4.07 (5.02)	−0.02 (3.62)	2.56	7.10	29.58%	0.25	1.04%	0.74 (0.71–0.77)
Male	1627	5.78 (5.78)	5.66 (5.72)	−0.12 (4.39)	3.11	8.62	35.92%	0.21	0.88%	0.71 (0.68–0.73)
Female	1627	5.65 (5.89)	5.63 (5.94)	−0.02 (4.25)	3.01	8.34	34.75%	0.21	0.88%	0.74 (0.72–0.76)

Abbreviations: K6, Kessler Psychological Distress Scale; ICC, Intraclass correlation coefficient; SEM, Standard error of measurement; SDC, Smallest detectable change; T1, At baseline; T2, At 2-week follow-up; SD, Standard deviation; CI, Confidence interval.

Table 3 Internal Consistency of the K6 Scores

	n	T1 Cronbach's Alpha Coefficient	T2 Cronbach's Alpha Coefficient
Both sexes	3254	0.94	0.94
20–29	823	0.93	0.93
30–39	811	0.95	0.95
40–49	812	0.95	0.94
50–59	808	0.94	0.94
Male	1627	0.94	0.94
Female	1627	0.94	0.94

Abbreviations: K6, Kessler Psychological Distress Scale; T1, At baseline; T2, At 2-week follow-up.

Discussion

Our study provided evidence on the reliability and interpretation of the K6 score. The K6 is one of the most widely used psychological distress scales in both clinical and research settings because it is simple.[4,5,33,35,36] That is, it can be answered in 2–3 min, and the result is easy to grade.[32,34] However, if the K6 cannot measure changes over time, it may not be useful in clinical practice. Therefore, it must identify changes in the patient's condition even if with minimal changes in psychological distress. Calculating the SDC of the K6 score can help identify the significance of changes in psychological distress over time and can determine the efficacy of interventions for psychological distress.[41,44] In this research, the SDC of the K6 scores indicated that a change of at least 8.47 for SDC_{ind} and 0.15 for SDC_{group} is required to be 95% confident that the change in scores is caused by actual change rather than measurement error. Moreover, SDC_{ind} required a change of 35.3% of the full range of K6 scores, and SDC_{group} required a change of 0.6% of the full range of K6 scores. Since the K6 scores range from 0 to 24, SDC_{ind} may be perceived as a relatively significant measurement error. For PROs used in routine clinical practice, the measurement error must be extremely minimal.[43] This study found that the K6 score was more suitable at the population level (ie, clinical trials) than at the individual level. The large individual-level SDC values were common findings in self-reported questionnaires.[52] However, several studies have reported small individual-level SDC values.[53–55] This result might be explained by the differences in the methods used to calculate SEM. Previous studies that reported large SDCs used the same method utilized in this analysis.[56–59] There are several methods used to calculate SEM. The inclusion of both systematic and random errors as part of the error variance can yield a higher SEM compared with methods that do not include both components.[43] Therefore, our SEM and SDC could have been higher. However, to distinguish between actual changes caused by treatment and measurement error, systematic error must also be considered as a part of measurement error.[43] Therefore, if the SEM is not calculated with consideration of account systematic errors, the SDC cannot be calculated accurately. Our SEM considered systematic errors and, thus, should reflect a more accurate SDC.

The test–retest reliability (ICC) was 0.73 (0.71–0.74). Since the acceptable ICC is > 0.7, the K6 had an excellent test–retest reliability.[43,48] Previous studies have assessed the test–retest reliability of the K6 score. The ICC of the Bangladesh version is 0.80, which is similar to our results.[60] The test–retest reliability of the K6 scores in other countries, including China and Iran, are also identified.[46,61,62] However, the Pearson or Spearman correlation coefficient was used as a measure of test–retest reliability in these countries. When evaluating test–retest reliability, it is necessary to consider not only random errors but also systematic errors.[43,45] However, the Pearson or Spearman correlation coefficient is not an extremely rigorous parameter for evaluating test–retest reliability because it does not account for systematic errors.[43,45] However, the $ICC_{agreement}$ may indicate a more accurate test–retest reliability of the K6 score because it considers not only random errors but also systematic errors.

Internal consistency was evaluated using the standard Cronbach's alpha method. In this study, the Cronbach's alpha of the K6 score ranged from 0.94 to 0.95. The acceptable Cronbach's alpha is 0.7 or higher.[45] Based on our results, the K6 score had an excellent internal consistency. This finding is similar to the previously reported Cronbach's alpha (0.85–0.90) of the Japanese version of the K6 score.[34,35] The Cronbach's alpha in several countries (Vietnamese [0.86], Arabic [0.81], Bangladeshi [0.87–0.88], Chinese [0.84], and Persian [0.87] versions) was similar.[37,38,46,60,61] By contrast, Cronbach's alpha increases with the number of items on the scale.[43] In fact, previous studies have shown that the Cronbach's alpha of the K10 (Japanese version = 0.91, Persian version = 0.92) is higher than that of the K6 (Japanese version = 0.85, Persian version = 0.87).[34,46] Hence, the K6 assessed the same questions differently, and some items overlap.

This study had several limitations. First, it was challenging to calculate minimally important change (MIC) due to the study design. When interpreting changes in scores, particular attention should be paid to SDC and MIC. The MIC is the smallest change in score in the measured construct that the patient perceives as important.[43] To better interpret changes in PRO scores, both SDC and MIC must be identified. If the MIC is greater than the SDC, a change equivalent to the MIC can be considered as not only a measurement error but also a clinically important change.[43,52] However, if the MIC is smaller than the SDC, changes equivalent to the MIC are likely caused by measurement error.[43,52] Hence, it is difficult to distinguish the changed value from the measurement error. Therefore, higher-quality MIC studies must be conducted to better understand the significance of changes in K6 scores. Second, this study recruited participants from the panel members of a web research firm. This might have caused participant bias and other limitations. However, internet surveys

can allow participants to answer questions easily due to anonymity.[63] Therefore, a more accurate response could have been obtained. Third, the study only included individuals whose native language was Japanese. Therefore, the generalizability of our results to other national populations is limited, and our findings should be replicated in different countries. Fourth, the response rate for this study was low (2.40%), which may have caused selection bias. Possible reasons for the low response rate include low motivation to participate in the survey and panelists may not have been aware of the invitation and did not respond to the baseline or second questionnaire. Therefore, the results of this study should be interpreted in light of the possible selection bias.

Conclusions

Our study provided evidence on the reliability and interpretation of the K6 score. Calculating the SDC of the K6 score can help identify the significance of changes in psychological distress over time and can determine the efficacy of interventions for psychological distress. Nevertheless, further studies must be conducted to assess MIC and SDC to better understand changes in K6 scores.

Data Sharing Statement

Data cannot be shared publicly because of the restrictions of the ethics committee. Data are available upon a reasonable request to the corresponding author for researchers who meet the criteria for access to confidential data.

Ethics Approval and Consent to Participate

The research was approved by the Ethical Review Board for Medical Research Involving Human Subjects of Gunma University (Approval no. HS2020-168). All participants gave their informed permission. The data were solely utilized for research reasons, and all information collected from the participants was kept strictly private. All procedures were followed in conformity with all applicable rules and regulations based on the Helsinki Convention.

Author Statement

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

None of the authors have any conflicts of interest to declare for this work.

References

1. Viertiö S, Kiviruusu O, Piirtola M, et al. Factors contributing to psychological distress in the working population, with a special reference to gender difference. *BMC Public Health*. 2021;21(1):611. doi:10.1186/s12889-021-10560-y
2. Lincoln KD, Taylor RJ, Watkins DC, Chatters LM. Correlates of psychological distress and major depressive disorder among African American Men. *Res Soc Work Pract*. 2011;21(3):278–288. doi:10.1177/1049731510386122
3. Decker FH. Occupational and nonoccupational factors in job satisfaction and psychological distress among nurses. *Res Nurs Health*. 1997;20(5):453–464. doi:10.1002/(SICI)1098-240X(199710)20:5<453::AID-NUR9>3.0.CO;2-N
4. Mojtabai R, Jorm AF. Trends in psychological distress, depressive episodes and mental health treatment-seeking in the United States: 2001–2012. *J Affect Disord*. 2015;174:556–561. doi:10.1016/j.jad.2014.12.039
5. Nishi D, Susukida R, Usuda K, Mojtabai R, Yamanouchi Y. Trends in the prevalence of psychological distress and the use of mental health services from 2007 to 2016 in Japan. *J Affect Disord*. 2018;239:208–213. doi:10.1016/j.jad.2018.07.016

6. Oh PJ, Cho JR. Changes in fatigue, psychological distress, and quality of life after chemotherapy in women with breast cancer: a prospective study. *Cancer Nurs*. 2020;43(1):E54–e60. doi:10.1097/NCC.0000000000000689
7. Nguyen TH, Hoang DL, Hoang TG, et al. Quality of life among district hospital nurses with multisite musculoskeletal symptoms in Vietnam. *J Occup Health*. 2020;62(1):e12161. doi:10.1002/1348-9585.12161
8. Awick EA, Ehlers DK, Aguiñaga S, Daugherty AM, Kramer AF, McAuley E. Effects of a randomized exercise trial on physical activity, psychological distress and quality of life in older adults. *Gen Hosp Psychiatry*. 2017;49:44–50. doi:10.1016/j.genhosppsych.2017.06.005
9. Freire ACC, Pondé MP, Liu A, Caron J. Anxiety and depression as longitudinal predictors of mild cognitive impairment in older adults. *Can J Psychiatry*. 2017;62(5):343–350. doi:10.1177/0706743717699175
10. El Hangouche AJ, Jniene A, Aboudrar S, et al. Relationship between poor quality sleep, excessive daytime sleepiness and low academic performance in medical students. *Adv Med Educ Pract*. 2018;9:631–638. doi:10.2147/AMEP.S162350
11. Krys S, Otte KP, Knipfer K. Academic performance: a longitudinal study on the role of goal-directed rumination and psychological distress. *Anxiety Stress Coping*. 2020;33(5):545–559. doi:10.1080/10615806.2020.1763141
12. Ts J, Rani A, Menon PG, et al. Psychological distress among college students in Kerala, India-Prevalence and correlates. *Asian J Psychiatr*. 2017;28:28–31. doi:10.1016/j.ajp.2017.03.026
13. Chiu M, Lebenbaum M, Cheng J, de Oliveira C, Kurdyak P. The direct healthcare costs associated with psychological distress and major depression: a population-based cohort study in Ontario, Canada. *PLoS One*. 2017;12(9):e0184268. doi:10.1371/journal.pone.0184268
14. Perreault M, Power N, Touré EH, Caron J. Transitional employment and psychological distress: a longitudinal study. *Psychiatr Q*. 2020;91(3):735–747. doi:10.1007/s11126-020-09739-0
15. Tanji F, Tomata Y, Zhang S, Otsuka T, Tsuji I. Psychological distress and completed suicide in Japan: a comparison of the impact of moderate and severe psychological distress. *Prev Med*. 2018;116:99–103. doi:10.1016/j.ypmed.2018.09.007
16. Phillips MR. Is distress a symptom of mental disorders, a marker of impairment, both or neither? *World Psychiatry*. 2009;8(2):91–92.
17. Cuijpers P, Smits N, Donker T, ten Have M, de Graaf R. Screening for mood and anxiety disorders with the five-item, the three-item, and the two-item mental health inventory. *Psychiatry Res*. 2009;168(3):250–255. doi:10.1016/j.psychres.2008.05.012
18. Faessler L, Perrig-Chiello P, Mueller B, Schuetz P. Psychological distress in medical patients seeking ED care for somatic reasons: results of a systematic literature review. *Emerg Med J*. 2016;33(8):581–587. doi:10.1136/emermed-2014-204426
19. Lavoie KL, Joseph M, Bacon SL. Psychological distress and occupational asthma. *Curr Opin Allergy Clin Immunol*. 2009;9(2):103–109. doi:10.1097/ACI.0b013e32832498c1
20. Katsuki F, Takeuchi H, Inagaki T, et al. Brief multifamily Psychoeducation for family members of patients with chronic major depression: a randomized controlled trial. *BMC Psychiatry*. 2018;18(1):207. doi:10.1186/s12888-018-1788-6
21. Imamura K, Furukawa TA, Matsuyama Y, et al. Differences in the effect of internet-based cognitive behavioral therapy for improving nonclinical depressive symptoms among workers by time preference: randomized controlled trial. *J Med Internet Res*. 2018;20(8):e10231. doi:10.2196/10231
22. Imamura K, Kawakami N, Furukawa TA, et al. Effects of an Internet-based cognitive behavioral therapy (iCBT) program in Manga format on improving subthreshold depressive symptoms among healthy workers: a randomized controlled trial. *PLoS One*. 2014;9(5):e97167. doi:10.1371/journal.pone.0097167
23. Kageyama K, Kato Y, Mesaki T, et al. Effects of video viewing smartphone application intervention involving positive word stimulation in people with subthreshold depression: a pilot randomized controlled trial. *J Affect Disord*. 2021;282:74–81. doi:10.1016/j.jad.2020.12.104
24. Jiang X, Luo Y, Chen Y, et al. Comparative efficacy of multiple therapies for the treatment of patients with subthreshold depression: a systematic review and network meta-analysis. *Front Behav Neurosci*. 2021;15:755547. doi:10.3389/fnbeh.2021.755547
25. Newby J, Robins L, Wilhelm K, et al. Web-based cognitive behavior therapy for depression in people with diabetes mellitus: a randomized controlled trial. *J Med Internet Res*. 2017;19(5):e157. doi:10.2196/jmir.7274
26. Lewis CC, Boyd M, Puspitasari A, et al. Implementing Measurement-Based Care in Behavioral Health: a Review. *JAMA Psychiatry*. 2019;76(3):324–335. doi:10.1001/jamapsychiatry.2018.3329
27. Valderas JM, Kotzeva A, Espallargues M, et al. The impact of measuring patient-reported outcomes in clinical practice: a systematic review of the literature. *Qual Life Res*. 2008;17(2):179–193. doi:10.1007/s11136-007-9295-0
28. Snyder CF, Aaronson NK, Choucair AK, et al. Implementing patient-reported outcomes assessment in clinical practice: a review of the options and considerations. *Qual Life Res*. 2012;21(8):1305–1314. doi:10.1007/s11136-011-0054-x
29. Basch E, Barbera L, Kerrigan CL, Velikova G. Implementation of patient-reported outcomes in routine medical care. *Am Soc Clin Oncol Educ Book*. 2018;38:122–134. doi:10.1200/EDBK_200383
30. Toussaint A, Hüsing P, Gumz A, et al. Sensitivity to change and minimal clinically important difference of the 7-item Generalized Anxiety Disorder Questionnaire (GAD-7). *J Affect Disord*. 2020;265:395–401. doi:10.1016/j.jad.2020.01.032
31. Kessler RC, Andrews G, Colpe LJ, et al. Short screening scales to monitor population prevalences and trends in non-specific psychological distress. *Psychol Med*. 2002;32(6):959–976. doi:10.1017/S0033291702006074
32. Furukawa TA, Kawakami N, Saitoh M, et al. The performance of the Japanese version of the K6 and K10 in the World Mental Health Survey Japan. *Int J Methods Psychiatr Res*. 2008;17(3):152–158. doi:10.1002/mpr.257
33. Mitchell CM, Beals J. The utility of the Kessler screening scale for psychological distress (K6) in two American Indian communities. *Psychol Assess*. 2011;23(3):752–761. doi:10.1037/a0023288
34. Sakurai K, Nishi A, Kondo K, Yanagida K, Kawakami N. Screening performance of K6/K10 and other screening instruments for mood and anxiety disorders in Japan. *Psychiatry Clin Neurosci*. 2011;65(5):434–441. doi:10.1111/j.1440-1819.2011.02236.x
35. Nishi A, Noguchi H, Hashimoto H, Tamiya N. Scale development of health status for secondary data analysis using a nationally representative survey. *Environ Health Prev Med*. 2012;17(3):252–257. doi:10.1007/s12199-011-0240-z
36. Nishi D, Imamura K, Watanabe K, et al. Psychological distress with and without a history of depression: results from the World Mental Health Japan 2nd Survey (WMHJ2). *J Affect Disord*. 2020;265:545–551. doi:10.1016/j.jad.2019.11.089
37. Easton SD, Safadi NS, Wang Y, Hasson RG. The Kessler psychological distress scale: translation and validation of an Arabic version. *Health Qual Life Outcomes*. 2017;15(1):215. doi:10.1186/s12955-017-0783-9
38. Kawakami N, Thi Thu Tran T, Watanabe K, et al. Internal consistency reliability, construct validity, and item response characteristics of the Kessler 6 scale among hospital nurses in Vietnam. *PLoS One*. 2020;15(5):e0233119. doi:10.1371/journal.pone.0233119

39. Chan SM, Fung TCT. Reliability and validity of K10 and K6 in screening depressive symptoms in Hong Kong adolescents. *Vulnerable Child Youth Stud*. 2014;9(1):75–85. doi:10.1080/17450128.2013.861620
40. Lace JW, Merz ZC, Grant AF, Emmert NA, Zane KL, Handal PJ. Validation of the K6 and its depression and anxiety subscales for detecting nonspecific psychological distress and need for treatment. *Curr Psychol*. 2020;39(5):1552–1561. doi:10.1007/s12144-018-9846-2
41. Steffen T, Seney M. Test-retest reliability and minimal detectable change on balance and ambulation tests, the 36-item short-form health survey, and the unified Parkinson disease rating scale in people with parkinsonism. *Phys Ther*. 2008;88(6):733–746. doi:10.2522/ptj.20070214
42. Beckerman H, Roebroeck ME, Lankhorst GJ, Becher JG, Bezemer PD, Verbeek AL. Smallest real difference, a link between reproducibility and responsiveness. *Qual Life Res*. 2001;10(7):571–578. doi:10.1023/A:1013138911638
43. De Vet HC, Terwee CB, Mokkink LB, Knol DL. *Measurement in Medicine: A Practical Guide*. Cambridge university press; 2011.
44. Gärtner FR, Nieuwenhuijsen K, van Dijk FJ, Sluiter JK. Interpretability of change in the Nurses Work Functioning Questionnaire: minimal important change and smallest detectable change. *J Clin Epidemiol*. 2012;65(12):1337–1347. doi:10.1016/j.jclinepi.2012.06.013
45. Terwee CB, Bot SD, de Boer MR, et al. Quality criteria were proposed for measurement properties of health status questionnaires. *J Clin Epidemiol*. 2007;60(1):34–42. doi:10.1016/j.jclinepi.2006.03.012
46. Hajebi A, Motevalian A, Amin-Esmaeili M, et al. Adaptation and validation of short scales for assessment of psychological distress in Iran: the Persian K10 and K6. *Int J Methods Psychiatr Res*. 2018;27(3):e1726. doi:10.1002/mpr.1726
47. Hirao K, Takahashi H, Kuroda N, Uchida H, Tsuchiya K, Kikuchi S. Differences in center for epidemiologic studies depression scale, generalized anxiety disorder-7 and Kessler screening scale for psychological distress scores between smartphone version versus paper version administration: evidence of equivalence. *Int J Environ Res Public Health*. 2023;20(6). doi:10.3390/ijerph20064773
48. Storheim K, Brox JI, Løchting I, Werner EL, Grotle M. Cross-cultural adaptation and validation of the Norwegian version of the Core Outcome Measures Index for low back pain. *Eur Spine J*. 2012;21(12):2539–2549. doi:10.1007/s00586-012-2393-x
49. de Vet HC, Terwee CB, Ostelo RW, Beckerman H, Knol DL, Bouter LM. Minimal changes in health status questionnaires: distinction between minimally detectable change and minimally important change. *Health Qual Life Outcomes*. 2006;4:54. doi:10.1186/1477-7525-4-54
50. Busija L, Osborne RH, Nilsdotter A, Buchbinder R, Roos EM. Magnitude and meaningfulness of change in SF-36 scores in four types of orthopedic surgery. *Health Qual Life Outcomes*. 2008;6:55. doi:10.1186/1477-7525-6-55
51. de Vet HC, Bouter LM, Bezemer PD, Beurskens AJ. Reproducibility and responsiveness of evaluative outcome measures. Theoretical considerations illustrated by an empirical example. *Int J Technol Assess Health Care*. 2001;17(4):479–487. doi:10.1017/S0266462301107038
52. Terwee CB, Roorda LD, Knol DL, De Boer MR, De Vet HC. Linking measurement error to minimal important change of patient-reported outcomes. *J Clin Epidemiol*. 2009;62(10):1062–1067. doi:10.1016/j.jclinepi.2008.10.011
53. Grønset CN, Thygesen LC, Berg SK, et al. Measuring HRQoL following heart valve surgery: the HeartQoL questionnaire is a valid and reliable core heart disease instrument. *Qual Life Res*. 2019;28(5):1245–1253. doi:10.1007/s11136-018-02098-1
54. Schreitmüller J, Apfelbacher C, Sheikh A, Loerbroks A. The Patient Needs in Asthma Treatment (NEAT) questionnaire: further evidence on its psychometric properties. *Allergy*. 2019;74(8):1511–1521. doi:10.1111/all.13782
55. Geerinck A, Locquet M, Bruyère O, Reginster JY, Beaudart C. Evaluating quality of life in frailty: applicability and clinimetric properties of the SarQoL(®) questionnaire. *J Cachexia Sarcopenia Muscle*. 2021;12(2):319–330. doi:10.1002/jcsm.12687
56. Takada K, Takahashi K, Hirao K. Measurement error in the Liebowitz social anxiety scale: results from a general adult population in Japan. *Int J Psychiatry Clin Pract*. 2018;22(4):289–295. doi:10.1080/13651501.2018.1426772
57. Ohno S, Takahashi K, Inoue A, et al. Smallest detectable change and test-retest reliability of a self-reported outcome measure: results of the center for epidemiologic studies depression scale, general self-efficacy scale, and 12-item general health questionnaire. *J Eval Clin Pract*. 2017;23(6):1348–1354. doi:10.1111/jep.12795
58. Sierevelt IN, Beimers L, van Bergen CJA, Haverkamp D, Terwee CB, Kerkhoffs G. Validation of the Dutch language version of the foot and ankle outcome score. *Knee Surg Sports Traumatol Arthrosc*. 2015;23(8):2413–2419. doi:10.1007/s00167-014-3017-2
59. Heidemann CH, Godballe C, Kjeldsen AD, Johansen EC, Faber CE, Lauridsen HH. The Otitis Media-6 questionnaire: psychometric properties with emphasis on factor structure and interpretability. *Health Qual Life Outcomes*. 2013;11:201. doi:10.1186/1477-7525-11-201
60. Khan A, Uddin R, Alam N, Sultana S, Alam M-U, Ahmed R. Psychometric properties of the bangla version of the Kessler psychological distress scale (K6). *Global Psychiatry*. 2019;2(2):183–194. doi:10.2478/gp-2019-0016
61. Kang YK, Guo WJ, Xu H, et al. The 6-item Kessler psychological distress scale to survey serious mental illness among Chinese undergraduates: psychometric properties and prevalence estimate. *Compr Psychiatry*. 2015;63:105–112. doi:10.1016/j.comppsych.2015.08.011
62. Lee S, Tsang A, Ng KL, et al. Performance of the 6-item Kessler scale for measuring serious mental illness in Hong Kong. *Compr Psychiatry*. 2012;53(5):584–592. doi:10.1016/j.comppsych.2011.10.001
63. Roder-DeWan S, Gage AD, Hirschhorn LR, et al. Expectations of healthcare quality: a cross-sectional study of internet users in 12 low- and middle-income countries. *PLoS Med*. 2019;16(8):e1002879. doi:10.1371/journal.pmed.1002879