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Original Article

Developing a scale to evaluate the usability of telemedicine as a safe and useful communication channel and outpatient record

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Abstract

Aim: Telemedicine has been appreciated as a smart solution to bridge the gaps in healthcare delivery. Several questionnaires were developed worldwide and designed to evaluate the usability of telemedicine. However, they might be inappropriate or inadequate for all forms of telemedicine services. In this paper, we aim to report on the development and validation process of our telemedicine usability scale.
Materials and Methods: The scale was part of a self-administered online questionnaire developed and content validated by a panel of physicians to evaluate the usability of telemedicine from the primary healthcare physicians' perspective in Oman. The study employed convenient sampling of all eligible primary healthcare physicians, resulting in 143 completed questionnaires. We used the FACTOR software to run exploratory factor analysis on a polychoric matrix. The unweighted least squares extraction method was selected with promin rotation to fit the ordinal data. The psychometric properties, including the reliability measures, unidimensionality, and goodness-of-fit indices, were reported.
Results: A three-factor solution satisfied the concept of simple structure and explained about 53% of the total variance. The first factor represented the usability of telemedicine as a safe and useful service; the second factor represented the usability of telemedicine as an outpatient record; the third factor represented the usability of telemedicine as a communication channel. For all factors, Cronbach's alpha and McDonald's omega were greater than 0.85. The goodness-of-fit indices and measures of unidimensionality were acceptable for the three-factor solution. The same three-factor solution was also evident following the run of exploratory factor analysis on the Pearson correlation matrix.
Conclusion: The proposed scale is a multi-faceted scale that has been built on cumulative knowledge and developed according to the best-practice recommendations to ensure its reliability and validity for evaluating the usability of telemedicine from the physicians' perspective.

Keywords: Telemedicine usability, scale, factor analysis, validity, reliability

INTRODUCTION

The hopeful promise of the growing field of telemedicine has been recently appreciated as a smart solution to bridge the gaps in healthcare delivery and coverage (1-3). The implementation of this health service has been further accelerated in most of the world following the declaration of the Coronavirus Disease 2019 (COVID-19) pandemic in 2020 and the implementation of several restrictive measures that reduced people's social and physical contact and limited their transportation between and within countries (4-6).

Many countries like the Sultanate of Oman have found telephone-based consultation an attainable and acceptable form of telemedicine (7-9). Despite the plausible benefits of telemedicine, however, the usability of this service is not guaranteed unless other aspects are taken into account. That is because the usability of a service or a product is not an item that can be directly measured or quantified but rather a construct shaped by several features (10). Hajesmaeel Gohari and Bahaadinbeigy provided an excellent review of many questionnaires/scales employed to evaluate the usability and other aspects of telemedicine services (11).

However, an evaluation of the usability of telephone-based consultation may not be appropriate using the existing questionnaires/scales that are either very general to evaluate any service or very specific to evaluate the most advanced forms of telemedicine. In addition, most of the existing questionnaires use the agreement/disagreement response scale. In our opinion, such items are appropriate to reflect more of a respondent's attitude towards the service but do not capture a complete picture of the service quality. Thus, some items/questions that inquire about the frequency of encountering difficulties (Always/Never Response Scale), or the rate of satisfaction (Not at all satisfied/ Extremely satisfied Response Scale) might be more descriptive and informative. Moreover, user-centered design is an approach that implies the involvement of end-users throughout the development cycle of a product or service (12). Most existing questionnaires/scales were designed to get the patients' opinions. Yet, healthcare providers might be more reliable end-users to evaluate the usability of telemedicine service from different aspects as they encounter many patients while running the clinic on any day (13). Therefore, we find it imperative to develop and design a scale that specifically evaluates the usability of telephone-based consultation and explicitly identifies the gaps in service quality from the physicians' perspective.

Nevertheless, a decision to develop a new scale has to consider the reliability and validity of an evaluation tool as they play a crucial role in accepting the evaluation results and consequently making decisions. Such understanding was the motive behind this paper, which aims to document our adherence to the best-practice recommendations in developing our scale and reporting its psychometric properties.

MATERIALS AND METHODS

This study was a part of a cross-sectional study that was conducted using a self-administered online questionnaire to quantitatively evaluate the usability of telemedicine in Oman from the PHC physicians' perspective (detailed in a separate paper). The study was approved by the Health Studies and Research Approval Committee of Oman's Ministry of Health (MoH/CSR/21/24835) on August 12, 2021.

The scale was developed in three stages following some recommended practices for developing and validating scales (14-17).

Stage – 1: Item Development and Content Validity

To identify the appropriate questions, we combined both inductive and deductive methods for questionnaire development (14). The inductive approach started with identifying the usability of telemedicine as a domain of interest and determining its facets (aspects or areas) from experts' opinions. Next, the deductive approach started with a literature review and assessment of the existing scales to generate sets of questions that can evaluate each of the proposed usability facets.

The final questionnaire was composed of two parts. The first part included a set of questions to categorize respondents according to some basic characteristics, which include: gender, qualification, level of PHC facility, place of PHC facility, the last time of running telemedicine clinic, and the frequency of running telemedicine clinic in a month. The second part comprised sets of Likert-item questions with a 5-point-unipolar response scale that evaluates the usability of telemedicine from different aspects. These included questions on the effectiveness, efficiency, and satisfaction with contacting and communicating with the patients using our current telemedicine service, questions on the effectiveness, efficiency, and satisfaction with documenting the telemedicine visit notes, in addition to questions on the perception of usefulness and safety of the current telemedicine service in PHC facilities.

Before any data collection, however, the content validity of the questionnaire was reviewed by a panel of physicians. The questionnaire was edited and modified several times to ensure the clarity, adequacy, relevance, and appropriateness of each question.

Stage – 2: Scale Administration

By 2020, about 2200 physicians were working in MOH-PHC facilities. Out of the total MOH-PHC physicians, only 186 were running telephone-based consultations during 2020-2022. Therefore, only 186 PHC physicians were considered eligible for participation in our study.

The sample size calculation was estimated at around 140 participants to meet the acceptable sample size for exploratory factor analysis (EFA) based on the participant to a variable ratio of five to one (14). However, because of the expected low response rate to a self-administered online questionnaire and the small target population, a convenient sampling method was employed, and all of the 186 PHC physicians who ran telemedicine clinics during 2020–2022 were considered for contact and invitation.

Based on the sample size formula for test-retest reliability studies (18), the pilot study included twenty-one PHC physicians from five governorates and lasted for about two weeks. All approached physicians received an official communication and an agreed-on telephone call from the researcher, who explained the purpose of the study and took verbal consent to e-mail the physician an information sheet and a link to an online self-administered questionnaire. In addition to explaining the need for measuring the test-retest reliability, the researcher invited the participating physicians to provide comments (if any) about the content and clarity of the questionnaire in a specified field before submitting their responses.

By the end of the pilot study, no change was made to the questionnaire as we received no comments about the content or clarity of the questionnaire, and the reliability of each question was acceptable. For those reasons and due to the small size of the target population, we decided to include the retest responses (refilled questionnaire) of the pilot study with the responses of

the main study and administer the questionnaire over two months (from September 2021 to November 2021) to all approached eligible participants.

Stage – 3: Scale evaluation

Exploratory factor analysis (EFA) was conducted to statistically identify the items (i.e., questions) that can be combined under a common facet and to empirically construct a theoretical model (17) of a usable telemedicine service. (Table 1) summarizes the steps of EFA and the decisions taken along with their indications.

Because EFA is based on a correlation matrix, identifying the appropriate correlation matrix is a fundamental step to avoiding biased analyses. Due to the ordinal nature of responses, the polychoric correlation matrix was preferred over the conventional Pearsonian correlation matrix (16,19,20).

Analyses were conducted with FACTOR software [Version 12.01.02] (21) following the steps of illustrative papers (19,20). The adequacy of the correlation matrix for factor analysis was determined by having a great number of items with correlation coefficients in the range of 0.30 – 0.90, a Kaiser-Meyer-Olkin (KMO) test of ≥ 0.60, and a significant Barlett's test of sphericity (16,17). Among the robust procedures to determine the number of factors, parallel analysis (PA) was selected after specifying the polychoric correlation matrix. Next, and after setting the number of factors advised by PA, the unweighted least squares (ULS) extraction method was selected because of its suitability for ordinal data (19,20). The default oblique promin rotation was kept unchanged as it provides more realistic solutions.

The criteria for determining factor adequacy were established according to literature recommendations (16,17). The factorial validity was established if a simple factor structure was formed, in which a set of items load saliently (the pattern coefficients ≥ 0.33) on their factor but do not cross-load heavily on other factors that construct the domain of interest. Complex loadings that were salient on more than one factor were retained if the higher loading had a theoretical justification.

In addition to the factor solution, the reliability measures (22), the goodness of fit indices (23), and unidimensionality measures (24) were computed for the hypothesized model.

Because the ordinal data were on a 5-point response scale, they might be treated as continuous (16). Therefore, it was interesting to re-run EFA based on a Pearsonian correlation matrix and compare the results with those based on the polychoric correlation matrix (Supplementary 1).

Post-hoc power analysis was run using the online semPower Shiny application to determine our achieved power to detect a misspecified model given the sample size of completed questionnaires, alpha error of 0.05, root mean square error of approximation of 0.05, and the degrees of freedom of the specified final model (25).

Table 1. The steps of exploratory factor analysis (EFA), decisions and indications

EFA Step	Decision	Indication
Selection of the correlation matrix	Polychoric correlation matrix	Ordinal Nature of Data
Selection of the matrix descriptives	Kaiser Meyer-Oklin (KMO) ≥ 0.60 Barlett's test of sphericity <0.05 Inter-item Correlations 0.30–0.90	Assessment of Factorability
Selection of the factor analysis model	Common Factor Analysis	Identifying the Underlying Construct
Selection of the factor extraction method	Unweighted Least Squares	Small Sample Ordinal Data
Selection of the factor-retaining method	Parallel Analysis	Better Performance for Ordinal Data
Selection of the factor rotation method	Promin Rotation	Correlated Factors Realistic Solution
Selection of the factor solution	Salient factor loadings ≥ 0.33	Configuration of a Simple Structure
	Cronbach's Alpha >0.70 McDonald's Omega >0.70	Assessment of Reliability
	Goodness of Fit Index (GFI) >0.90 Root Mean Square of Residuals (RMSR) <0.080	Assessment of Goodness of Fit
	Explained Common Variance (ECV) 0.70 – 0.85 Mean of Item Residual Absolute Loadings (MIREAL)<0.300	Assessment of Unidimensionality
	Theoretical Convergence	Interpretability

RESULTS

Out of 186 PHC physicians who ran telemedicine clinics, 162 were approached, and 143 completed the questionnaire. Hence, the response and completion rates were 77% and 88%, respectively.

The basic characteristics of respondents (Supplementary 2) indicated an almost homogenous group of participants (about 80% were female physicians, about 80% worked in health centers, about 75% ran telemedicine clinics three or more times a month, and more than 90% had their last telemedicine clinic within three months of the study period).

The descriptive statistics of responses (Table 2) showed no missing data or data entry errors. However, univariate non-normality (skewness and kurtosis >±1.0) was evident, though not severe, in the responses to some questions. In addition, multivariate non-normality was also indicated by significant multivariate kurtosis. These findings supported the use polychoric correlation matrix as an input for EFA.

Table 2. Descriptive summary of data responses

	Questions	Mean	Variance	Skewness	Kurtosis
1	Have you had any difficulty in obtaining a device to contact your patients (availability of landline or a phone) when you run telemedicine clinic?	3.483	0.935	-0.067	-0.381
2	Have you had any difficulty in reaching your patients (i.e., the phone number was wrong or out of reach) when you run a telemedicine clinic?	2.944	0.277	-0.355	1.567
3	Have you had any difficulty in talking to your patients through the phone (quality of network) when you run telemedicine clinic?	3.552	0.555	-0.181	0.290
4	Have you had any difficulty in hearing your patients through the phone (quality of network) when you run telemedicine clinic?	3.769	0.597	-0.033	-0.564
5	Overall, does it take you long time to contact your patients (obtaining a device, reaching, talking, hearing) when you run telemedicine clinic?	3.182	0.806	-0.134	-0.540
6	Overall, how do you rate your satisfaction with contacting your patients (obtaining a device, reaching, talking, hearing) using the current telemedicine service?	3.154	0.634	-0.452	-0.388
7	Have you had any difficulty in taking proper history from your patients through the phone when you run the telemedicine clinic?	3.252	0.538	-0.328	0.277
8	Have you had any difficulty in getting your patients' measurements (e.g., blood pressure measurement, blood sugar profile) through the phone when you run the telemedicine clinic?	2.608	1.035	0.004	-0.982
9	Have you had any difficulty in managing your patients through the phone when you run the telemedicine clinic?	3.399	0.561	-0.001	0.194
10	Overall, does it take you long time to communicate with your patients through the phone when you run the telemedicine clinic?	3.119	0.650	-0.059	-0.315
11	Overall, how do you rate your satisfaction with communication (taking proper history, getting patients' measurements and managing) using the current telemedicine services?	3.042	0.600	0.018	-0.162
12	Have you had any difficulty in opening telemedicine visits?	4.147	1.034	-1.303	1.384
13	Have you had any difficulty in typing, editing and saving your notes of telemedicine visits?	4.399	0.799	-1.702	2.952
14	Overall, does it take you long time to document your notes	3.713	1.184	-0.558	-0.388
15	Overall, how do you rate your satisfaction with documentation (opening visits, typing, editing, saving notes) using telemedicine visits?	3.706	0.809	-0.663	0.473
16	How do you rate the usefulness of the current telemedicine service in ensuring continuity of care?	3.503	0.753	-0.140	-0.357
17	How do you rate the usefulness of the current telemedicine service in improving patients' condition?	3.308	0.633	-0.443	0.279
18	How do you rate the usefulness of the current telemedicine service in providing support for self-management?	3.476	0.655	-0.598	0.237
19	How do you rate the usefulness of the current telemedicine service in reducing the crowding in your health facility?	3.902	0.900	-0.694	0.078
20	How do you rate the usefulness of the current telemedicine service in reducing the unnecessary consultation costs?	3.797	1.015	-0.782	0.192
21	To what extent do you agree that the current telemedicine service is provided to the right patients (availability of criteria to categorize patients requiring virtual and non-virtual clinic)?	3.671	0.766	-0.314	-0.252
22	To what extent do you agree that the current telemedicine service ensures privacy of patient information (availability of specified room)?	3.266	1.258	-0.300	-0.611
23	To what extent do you agree that the current telemedicine service could ensures patients' compliance?	3.098	0.760	-0.192	-0.183
24	To what extent do you agree that running the current telemedicine service is legally protected (availability of standard operating procedure)?	2.762	0.936	0.073	-0.518

The correlation matrix showed a great number of inter-item correlation coefficients ≥ 0.3, but none exceeded 0.90 (Figure 1). In addition, the results of Bartlett's test of sphericity indicated that the correlation matrix was not random, $\chi^2(276)=1533.1$, $p<.00001$, and the KMO statistic was 0.706, well above the minimum standard for conducting EFA. Therefore, the produced polychoric correlation matrix was adequate to run EFA.

The results of PA suggested retaining three factors. By choosing ULS as an extraction method, the three-factor solution explained about 53% of the total variance (Table 3a). The first factor accounted for 37.27% of the total variance and 69.9% of the common variance; the second factor accounted for 9.08% of the total variance and 17.0% of the common variance; the third factor accounted for 6.97% of the total variance and 13.1% of the common variance. The proportion of the common variance explained by the three-factor solution in each variable (communality) is shown in (Table 3b).

Table 3. The total variance explained by the three-factor solution and the distribution of communalities for each variable following unweighted least square extraction method

a.	**Total Variance Explained**	
Factor	**Variance (Eigenvalue)**	**% of Total Variance**
1	8.945	37.27%
2	2.178	9.08%
3	1.673	6.97%
Total†	12.796	53.32%

b.	**Distribution of communalities**			
Variables	**Factors**			**Communality**
	1	**2**	**3**	
Q1	0.296	0.103	-0.220	0.147
Q2	0.485	0.436	-0.194	0.463
Q3	0.596	0.131	-0.277	0.449
Q4	0.618	0.183	-0.372	0.554
Q5	0.646	0.311	-0.345	0.633
Q6	0.744	0.186	-0.195	0.626
Q7	0.661	0.225	0.008	0.487
Q8	0.689	0.110	-0.033	0.488
Q9	0.753	-0.036	-0.063	0.572
Q10	0.614	0.072	-0.336	0.496
Q11	0.826	0.141	-0.056	0.704
Q12	0.477	-0.651	-0.105	0.662
Q13	0.499	-0.721	-0.113	0.782
Q14	0.445	-0.547	-0.335	0.609
Q15	0.553	-0.654	-0.064	0.737
Q16	0.753	-0.006	0.102	0.577
Q17	0.727	0.084	0.200	0.576
Q18	0.707	0.105	0.332	0.621
Q19	0.631	-0.020	0.498	0.647
Q20	0.546	-0.076	0.563	0.621
Q21	0.204	-0.027	0.268	0.114
Q22	0.478	0.025	0.199	0.269
Q23	0.779	0.098	0.236	0.672
Q24	0.479	-0.029	0.248	0.291
Total				**12.797**

Input Matrix: Polychoric Correlation Matrix. Extraction Method: Unweighted Least Square. † The % of the Total Variance is computed by dividing the Sum of Extracted Eigenvalues (or the Sum of Communalities) by the Total Number of Variables: 12.796/24 x 100% = 53.32%

Table 4. The results of factor extraction and rotation method. (unweighted least square extraction with promin rotation)

a.	Pattern matrix after robust unweighted least square extraction method and promin rotation	Factor		
	Pattern matrix	1	2	3
1	Have you had any difficulty in obtaining a device to contact your patients (availability of landline or a phone) when you run telemedicine clinic?	-0.153	0.021	**0.456**
2	Have you had any difficulty in reaching your patients (i.e., the phone number was wrong or out of reach) when you run a telemedicine clinic?	-0.029	-0.303	**0.760**
3	Have you had any difficulty in talking to your patients through the phone (quality of network) when you run telemedicine clinic?	-0.098	0.069	**0.700**
4	Have you had any difficulty in hearing your patients through the phone (quality of network) when you run telemedicine clinic?	-0.209	-0.050	**0.843**
5	Overall, does it take you long time to contact your patients (obtaining a device, reaching, talking, hearing) when you run telemedicine clinic?	-0.160	-0.089	**0.918**
6	Overall, how do you rate your satisfaction with contacting your patients (obtaining a device, reaching, talking, hearing) using the current telemedicine service?	0.070	0.014	**0.738**
7	Have you had any difficulty in taking proper history from your patients through the phone when you run the telemedicine clinic?	0.296	-0.110	**0.514**
8	Have you had any difficulty in getting your patients' measurements (e.g., blood pressure measurement, blood sugar profile) through the phone when you run the telemedicine clinic?	0.252	0.031	**0.494**
9	Have you had any difficulty in managing your patients through the phone when you run the telemedicine clinic?	0.239	0.208	**0.461**
10	Overall, does it take you long time to communicate with your patients through the phone when you run the telemedicine clinic?	-0.169	0.155	**0.731**
11	Overall, how do you rate your satisfaction with communication (taking proper history, getting patients' measurements and managing) using the current telemedicine services?	0.282	0.033	**0.613**
12	Have you had any difficulty in opening telemedicine visits?	0.047	**0.819**	-0.065
13	Have you had any difficulty in typing, editing and saving your notes of telemedicine visits?	0.044	**0.900**	-0.093
14	Overall, does it take you long time to document your notes	-0.258	**0.777**	0.218
15	Overall, how do you rate your satisfaction with documentation (opening visits, typing, editing, saving notes) using telemedicine visits?	0.132	**0.823**	-0.066
16	How do you rate the usefulness of the current telemedicine service in ensuring continuity of care?	**0.450**	0.123	0.314
17	How do you rate the usefulness of the current telemedicine service in improving patients' condition?	**0.566**	-0.009	0.263
18	How do you rate the usefulness of the current telemedicine service in providing support for self-management?	**0.728**	-0.078	0.132
19	How do you rate the usefulness of the current telemedicine service in reducing the crowding in your health facility?	**0.905**	-0.015	-0.161
20	How do you rate the usefulness of the current telemedicine service in reducing the unnecessary consultation costs?	**0.950**	-0.006	-0.311
21	To what extent do you agree that the current telemedicine service is provided to the right patients (availability of criteria to categorize patients requiring virtual and non-virtual clinic)?	**0.430**	-0.018	-0.173
22	To what extent do you agree that the current telemedicine service ensures privacy of patient information (availability of specified room)?	**0.458**	0.004	0.084
23	To what extent do you agree that the current telemedicine service could ensures patients' compliance?	**0.635**	-0.026	0.264
24	To what extent do you agree that running the current telemedicine service is legally protected (availability of standard operating procedure)?	**0.519**	0.046	-0.001

b.	Intercorrelation between extracted factors		
	Factor correlation matrix		
Factor	1	2	3
1	1.000	0.429	0.647
2	0.429	1.000	0.404
3	0.647	0.404	1.000

Factor 1: Usability as a Safe and Useful Service. Factor 2: Usability as an Outpatient Record. Factor 3: Usability as a Communication Channel. Input Matrix: Polychoric Correlation Matrix. Extraction Method: Unweighted Least Square. Rotation: Promin. Salient loadings (≥ 0.33) are in bold black

Table 5. The reliability of the extracted factors

Reliability measures	Factors			Three-factor solution
	1	2	3	
Cronbach's alpha	0.870	0.892	0.903	0.926
McDonald's omega	0.874	0.894	0.906	0.926

Table 6. The goodness of model-data fit and the unidimensionality of the three-factor solution

a.	Goodness of model-data fit indices	Results	Cut-off values
-	Goodness of Fit Index (GFI)	0.978	>0.900
-	Root Mean Square of Residuals (RMSR)	0.065	<0.080
b.	**Closeness to unidimensionality**	**Results**	**Cut-off values**
-	Explained Common Variance (ECV)	0.789	0.700-0.850
-	Mean of Item Residual Absolute Loadings (MIREAL)	0.226	<0.300

Following promin rotation, the first factor was saliently loaded by nine items representing the usability of telemedicine as a safe and useful service. The second factor was saliently loaded by four items representing the usability of telemedicine as an outpatient record. The third factor was saliently loaded by eleven items representing the usability of telemedicine as a communication channel (Table 4a). In addition to the above, the three factors were moderately correlated (Table 4b).

As shown in Table 5, each of the three factors exceeded the cut-off values (>0.70) of reliability measures (Cronbach's alpha and McDonald's omega).

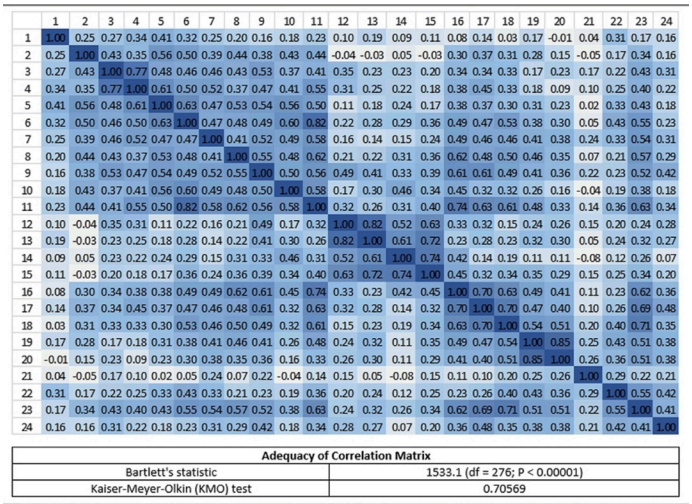
The adequacy of the three-factor solution was also compared to four-factor and five-factor solutions as the explained variance based on eigenvalues >1 suggested retaining five factors. However, the four-factor and five-factor solutions were inadequate because some factors were loaded by less than three variables, the cross-loading of variables, non-theoretical relevance among some of the loaded variables, or the low internal consistency of one of the factors. Only the three-factor solution, as suggested by the parallel analysis, satisfied the adequacy and the concept of simple structure.

Moreover, the three-factor solution showed the goodness of model-data fit (Table 6a) and demonstrated acceptable unidimensionality by different indices (Table 6b).

Interestingly, re-analysis using the conventional method (the Pearsonian-based EFA) showed similar results (Supplementary 1), adding more supportive evidence for the constructed three-factor solution.

Post-hoc power analysis showed that our sample of 143 participants had a power of 96% to reject a misspecified model (Supplementary 3).

The above findings underscore our contribution to literature from different aspects. First, we theoretically developed a scale to quantitatively evaluate the usability of telemedicine service (especially telephone-based consultation) from the physician's perspective. Second, we statistically validated this novel tool and uncovered a multi-item multi-faceted scale that characterizes a usable telemedicine service as a safe and useful communication channel and outpatient record (SUCCOR Scale). Third, the logic and sequential steps that we followed and documented in the development and validation process of the SUCCOR Scale can serve as an educational example of scale development in general and the use of EFA in particular.



Adequacy of Correlation Matrix	
Bartlett's statistic	1533.1 (df = 276; P < 0.00001)
Kaiser-Meyer-Olkin (KMO) test	0.70569

Figure 1. Polychoric correlation matrix of responses and its adequacy for exploratory factor analysis. The correlations between the ordinal responses are presented by a polychoric correlation matrix. As the correlation increases, the colour becomes darker. Among the criteria that determine the adequacy of a correlation matrix for exploratory factor analysis are the great number of items with correlation coefficients in the range of 0.30 – 0.90, a Kaiser-Meyer-Olkin test of ≥ 0.60, and a significant Barlett's test of sphericity

DISCUSSION

Developing a reliable and valid measurement tool is a need-driven innovation and a science-based art that requires intellectual skills and adherence to some standards. In this paper, we determined our need to develop a reliable and valid scale that specifically

evaluates our telemedicine service and identifies its gaps.

Despite being inapplicable or inadequate to evaluate the usability of our telemedicine service (i.e., telephone-based consultation), the known existing questionnaires and scales [e.g., System Usability Scale (SUS) by Brooke (26), Post-Study System Usability Questionnaire (PSSUQ) by Lewis (27), Technology Acceptance Model (TAM) by Davis (28), Usefulness, Satisfaction and Ease of Use (USE) Questionnaire by Lund (29), Telemedicine Satisfaction Questionnaire (TSQ) by Yip et al. (30), Telemedicine Satisfaction and Usefulness Questionnaire (TSUQ) by Bakken et al. (31), Telehealth Satisfaction Scale (TeSS) by Morgan et al. (32), Service User Technology Acceptability Questionnaire (SUTAQ) by Hirani et al. (33), and Telemedicine Usability Questionnaire (TUQ) by Parmanto et al. (34) were invaluable references to build our theoretical concept of usable service. Accordingly, finding similarities between our scale and other questionnaires and scales is unsurprising. For instance, the safety of service is a common aspect with SUTAQ; the usefulness of service is a common aspect with TAM, TSQ, TSUQ, SUTAQ, TUQ, and USE; the effectiveness of the service is a common aspect with PSSUQ, SUS, TSUQ, TAM, TSQ, USE, TeSS, and TUQ; the efficiency of the service is a common aspect with PSSUQ, TAM, TeSS, TSQ, TSUQ, and USE; the satisfaction is a common aspect with PSSUQ, TSUQ, SUTAQ, TUQ, TSQ, and USE. However, the major difference between our scale and others is how we phrased and asked our questions. Furthermore, most of the scales and questionnaires mentioned above evaluate telemedicine as a single-step action, but we found it more appropriate to evaluate this service as a multi-step process that includes contact, communication, and documentation.

Although our sample was not large enough, it was sufficient for conducting EFA and reaching an acceptable solution (16). More importantly, the reliability and validity of our scale were verified throughout the development process that started with ascertaining the content validity and test-retest reliability and arrived at demonstrating the factorial validity, composite reliability, goodness of fit, and unidimensionality.

Our scale (The SUCCOR scale) is a composite of twenty-four Likert-type questions across three facets, namely: the usability of telemedicine as a safe and useful service (nine questions); the usability of telemedicine as a communication channel (eleven questions); and the usability of telemedicine as an outpatient record (four questions). Before rotation, the three-factor solution explained 53% of the total variance, which might be considered an acceptable percentage (35). Compared to the existing scales and questionnaires, the reported total explained variances in TSQ, TSUQ, SUTAQ, and TeSS were 68%, 63.6%, 60.7%, and 52.1%, respectively. However, those figures were extracted by principal component analysis, which tends to produce biased and greater values than EFA (15).

The proposed scale is a product of implementing the recently recommended EFA techniques, which many researchers might not come across. Yet, we reached a similar solution by employing the conventional EFA methods (Supplementary 1). However, this should under no circumstances be taken as an excuse to abandon the recommended practice, but instead considered as a complementary to support the hypothesized solution (36).

Like many other existing questionnaires/scales, the SUCCOR scale is summated. In our scale, the response to all questions should give a total scale score that falls in the range of [24–120] after straightforward summation or in the range of [1–5] after dividing the summated score by the total number of all questions (37). Likewise, the score for each of the three facets (i.e., subscale) can be computed using the sum or mean. In addition, these scores can be converted into a more intuitive scale, such as the [0–100] scale, using the transformation formula: 100 [Actual raw score – lowest possible raw score] / [Possible raw score range] (38). Thus, a total raw score of 100/120 is equivalent to 4.17 on a [1–5] scale and 79.17 on a [0–100] scale. Whether the sum, mean, or transformed score, these scores present an overall picture of the respondent's experience. However, to take corrective actions and improve the overall picture, it might be helpful to have a descriptive analysis of each question made up of the scale or its subscales. For this reason, the frequency distribution of responses to each question may help find the areas for future service improvement and its usability score.

It might be argued that the SUCCOR scale with 24 questions is not only moderately long but also composed of several questions that are very specific to telephone consultation and might not apply to all telemedicine settings (e.g., the use of smart applications and audio-visual consultation). However, many existing questionnaires (e.g., USE-30 items by Lund (29); SUTAQ-22 items by Hirani et al. (33); TUQ-21 items by Parmanto et al. (34)) are also long and designed to evaluate specific forms of telemedicine. The SUCCOR scale was developed not to replace but to complement the previous efforts.

Coincidently, the derived scale's acronym, "SUCCOR," is an English word that implies delivering help and assistance in times of need or distress (39). Telemedicine has been advocated to play such a role, and the COVID-19 pandemic was one but not the only example.

LIMITATIONS

The evaluation process of the SUCCOR scale has not come to an end. Because of the small size of our sample and target population, we could not perform confirmatory factor analysis to complement our EFA results and objectively test our model. In addition, further validity evidence can be accomplished by demonstrating a strong correlation of the scale with other scales designed to evaluate similar constructs (convergent validity) and a weak correlation with different scales designed to evaluate dissimilar constructs (discriminant validity) (14).

CONCLUSION

The SUCCOR scale is a multi-faceted scale that has been built on cumulative knowledge and developed according to some of the best-practice recommendations to ensure its reliability and validity for evaluating the usability of telemedicine from the physicians' perspective.

Conflict of interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
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Ethical approval
The study was approved by the Health Studies and Research Approval Committee of Oman's Ministry of Health (MoH/CSR/21/24835) on August 12, 2021.

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