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ORIGINAL ARTICLE

The usability of telephone-based telemedicine in primary healthcare: A quantitative evaluation and a hypothesized framework of determinants from the physicians' perspective in Oman

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Abstract

Telemedicine has been appreciated as a smart solution to bridge the gaps in the delivery and coverage of healthcare worldwide. With the great impetus to integrate this service into primary healthcare facilities, evaluating its usability should be an ongoing process. This study aimed to quantitatively evaluate the usability of telemedicine from the primary healthcare physicians' perspective in Oman. The evaluation was conducted using a cross-sectional study design. A self-administered online questionnaire was developed and validated as a scale to evaluate the usability of telemedicine as a safe and useful communication channel and outpatient record. Following a pilot study, the questionnaire was distributed to a sample of primary healthcare physicians who ran telemedicine clinics in Oman during 2020-2022. The questionnaire was completed by 143 primary healthcare physicians from different governorates. The total mean scale and subscale scores were computed. In addition, the frequency distribution of responses to each question was presented. The results showed that the total mean scale score of the usability of telemedicine in our clinics was 3.43/5.00. The subscale scores of the usability of telemedicine as a safe and useful service, the usability of telemedicine as a communication channel, and the usability of telemedicine as an outpatient record were 3.42/5.00, 3.23/5.00, and 3.99/5.00, respectively. In conclusion, the current telemedicine service in Oman's primary healthcare facilities has some usability features, but there is still much room for improvement. With logical reasoning, a framework of potential determinants was inferred and proposed to improve the usability of telemedicine services in the future and comply with the principles of biomedical ethics.

Keywords: Oman, physicians, primary healthcare, scale, telemedicine usability, usability determinants

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Introduction

The hopeful promise of the growing field of information and communication technology (ICT) has been recently appreciated as a smart solution to bridge the gaps in healthcare delivery and coverage. Accordingly, the WHO has greatly advocated and supported telemedicine for the last three decades and frequently iterated this innovation in its resolutions and recommendations [1-5].

In many countries, the implementation of restrictive measures that reduced people's social and physical contact and limited their transportation within and between cities to overcome the spread of Coronavirus Disease 19 (COVID-19) was the provoking event that led to the wide adoption of telemedicine as a structured healthcare service [6-8]. The situation in the Sultanate of Oman was not different [9-12]. Despite the growing impetus to widely integrate telemedicine in primary healthcare (PHC) facilities, this service – in its various forms – may not be used by all healthcare providers. Although it may not be an example of state-of-the-art telemedicine [13], telephone-based consultations may be the most appropriate form in many places where advanced forms of telemedicine are not feasible [3,4,14] or physicians and patients (especially females) have reservations about using audiovisual calls [15,16]. In May 2020, shortly after implementing restrictive measures to contain the spread of COVID-19 in Oman, Hasani et al. conducted a qualitative study to explore the perception of twenty-two PHC physicians on implementing telephone-based consultation in Muscat, the capital governorate of Oman [12]. The researchers found that although PHC physicians appreciated some of the telemedicine benefits, most showed concerns about the infrastructure, the technical and financial support, the patient-physician interaction, and the privacy and confidentiality of communication. Though not stated by the researchers, those perceptions imply that the usefulness of a health service does not guarantee its use. In other words, the usefulness is necessary but not sufficient to define the usability of a service [17].

The usability of service, though it has many definitions [17-20], is mainly determined by the extent to which specified users can completely and accurately achieve their goals or tasks (*i.e.*, effectiveness) in a reasonable time (*i.e.*, efficiency) without any discomfort (*i.e.*, satisfaction) in a specified context of use [21]. The overarching principle for any definition of usability, however, is the user-centered design approach in which the end-users are put at the center of the design process, and their needs, preferences, expectations, and constraints are taken into consideration [17,22]. In other words, this service is expected to be usable if it helps physicians contact and manage their patients effectively, efficiently, and satisfactorily. However, the usability of a service or a product cannot be directly measured or computed [17-21]. Still, it might be inferred from the responses to validated sets of questions designed to quantify its different aspects or features [17].

With all the above in mind, we find an opportunity to quantitatively evaluate the usability of our current telemedicine service in PHC facilities from the physicians' perspective at a national level using a newly developed and validated scale. In addition to providing a quantitative measure of telemedicine usability that can be compared at different times and places, the responses to the constituting questions uncover the proportion of physicians who have concerns about the current telemedicine service or encounter difficulties while running telemedicine clinics. Such an evaluation should raise decision-makers' awareness of the existing gaps in service provision and address the potential features to improve in the future.

Materials and Methods

A research proposal was prepared according to Oman's Ministry of Health Research Proposal Guideline, after which an ethical approval (MoH/CSR/21/24835) was issued by the Health Studies and Research Approval Committee at the Ministry of Health on August 12, 2021.

Study Setting

The Sultanate of Oman is a high-income Arab country [23]. It spans an area of approximately 309,500 square kilometers of varying topography

and comprises eleven governorates [24]. By the end of 2021, the total population of Oman was around 4.5 million (62% Omani, 38% Non-Omani), and about 80% of them were living in urban areas [25]. The main healthcare provider in Oman is the Ministry of Health. According to the Oman Ministry of Health, the total number of medical doctors working in Oman was 9058, and the number of medical doctors to 10,000 population was around 20 in 2020 [26]. Out of the total number of medical doctors, 5960 were working in MOH-led facilities, and out of those, 2178 were PHC physicians distributed over 238 PHC facilities led by MOH in 2020 (*i.e.*, MOH-led PHC facilities: 190 health centers, 18 polyclinics, and 30 local hospitals) [26].

Study Design

This cross-sectional study included PHC physicians from different governorates in the Sultanate of Oman to quantitatively evaluate the usability of telemedicine in PHC facilities.

Eligibility Criteria

Participants were considered eligible if they met the inclusion criteria without having any of the exclusion criteria. The inclusion criteria define the broad characteristics that are essential for the selection of participants. On the other hand, the exclusion criteria are the presenting features of the participants who meet the inclusion criteria but might not be accessible or bias the final results [27,28]. Based on these definitions, our inclusion and exclusion criteria were as follow:

Inclusion criteria: PHC physicians running telemedicine clinics in Oman during 2020 – 2022 (*i.e.,* from January 2020 to December 2021).

Exclusion criteria: PHC physicians running telemedicine clinics in Oman during 2020 – 2022 but used audio-visual consultation or working in non-MOH-led PHC facilities.

At the time of the study, nine governorates out of eleven in Oman had implemented telemedicine clinics in MOH-led PHC facilities, and out of 2178 physicians working in those facilities, only 186 (82% were female) were running telemedicine clinics (telephone-based consultation) during 2020 - 2022. Therefore, only 186 PHC physicians were eligible for participation in our study.

Developing a Questionnaire

From our literature review, we identified many questionnaires/scales developed to evaluate the usability of telemedicine [29-37]. However, we found several items in those questionnaires/scales inapplicable or inadequate to evaluate telephone-based consultation. Nevertheless, those questionnaires/scales were acknowledged as invaluable references to build our theoretical concept of usability and spur our questionnaire's development process.

Our questionnaire was developed following some best-practice recommendations for developing a validated scale [38]. Details are provided in a separate paper [39].

Sampling and Sample Size

The sample size calculation was estimated at around 140 participants to suffice the conservative sample size computed by Cochran's formula for proportion estimation from a finite population [40]. The calculated sample size also met the acceptable sample size to validate our questionnaire by exploratory factor analysis (EFA) and covered 75% of the eligible population. However, because of the expected low response rate to self-administered online questionnaires, all 186 PHC physicians who ran telemedicine clinics during 2020 – 2022 were considered for contact and invitation.

Questionnaire Administration

For several reasons, including the difficulty of sending and receiving on-paper questionnaires, the large number of healthcare facilities, and the large area of different governorates, the evaluation was planned to be conducted through a self-administered online questionnaire. Following a pilot study, the questionnaire was administered over two months (from September 2021 to November 2021) to all approached eligible participants. All approached physicians received an official communication and an agreed-on telephone call from the researcher to explain the purpose of the study and take verbal consent to e-mail the physician an information sheet and a link to an online self-administered questionnaire form.

Statistical Analyses

Statistical analyses were conducted with SPSS (Version 23). The distribution of descriptive characteristics of participants is presented as numbers and percentages. The questionnaire's validity and reliability are detailed elsewhere [39]. But in brief, EFA was conducted using FACTOR software (Version 12.01.02) to support the validity of the questionnaire as a summated scale and to identify the questions that can be combined under a common facet (*i.e.,* aspect). The unweighted least squares extraction method was selected because of its suitability for ordinal data with oblique promin rotation to provide more realistic solutions [41,42]. The results of EFA indicated three common facets or factors with very good internal consistency reliability (> 0.8). The first factor was saliently loaded by nine items (*i.e.,* questions) representing the usability of telemedicine as a *Safe and Useful* service. The second factor was saliently loaded by eleven items representing the usability of telemedicine as a *Communication Channel.* The third factor was saliently loaded by four items representing the usability of telemedicine as an *Outpatient Record*. The three facets/factors construct a summated scale named the *SUCCOR* scale (an acronym formed by the initial letters of the constituting facets).

A facet score was computed by summing each participant's responses to that facet's questions, then converted into a (1 – 5) scale by dividing over the number of that facet's questions (*i.e.,* mean subscale score). Similarly, the overall scale was computed by summing the responses to all questions, then converted into a (1 – 5) scale by dividing over the number of all questions to get the mean total scale score [43]. For a more intuitive scale, the mean subscale and total scale scores were converted into a (0 – 100) scale by a transformation formula [44]. Furthermore, the frequency distribution of responses to each question was presented as percentages to find the features that influence the total score or subscale scores. The mean scores were further compared based on gender, qualification, level of PHC facility, place of PHC facility, and the frequency of running telemedicine clinic.

Results

During the period 2020-2022, the telemedicine service was implemented in all governorates except Al-Wusta and South Sharqiya. Out of 186 PHC physicians who ran telemedicine clinics, 162 physicians were approached, and 143 physicians completed the questionnaire, reaching a response rate of 76.9% and a completion rate of 88.3% (Figure 1.a and 1.b).

The basic characteristics of respondents (Table 1) show that 62.2% of participants were in Muscat governorate, and about half (55.2%) were general practitioners. In addition, the majority of all respondents were female physicians (82.5%), worked in health centers (83.2%), ran telemedicine clinics three or more times a month (74.2%), and their last telemedicine clinic was within three months of the study period (92.3%).

The mean scores of telemedicine usability and its subscales are shown in Table 2. The overall mean score was 3.43/5.0 (equivalent to 60.7/100), denoting the weighted mean score of the three constructing subscales. The mean subscale score of the usability of telemedicine as a safe and useful service was 3.42/5.00, and the distribution of responses to the nine constituting items is shown in Table 2.a. The mean subscale score of the usability of telemedicine as a communication channel was 3.23/5.00, and the distribution of responses to the eleven constituting items is shown in Table 2.b. The mean subscale score of the usability of telemedicine as an outpatient record was 3.99/5.00, and the distribution of responses to the four constituting items is shown in Table 2.c.

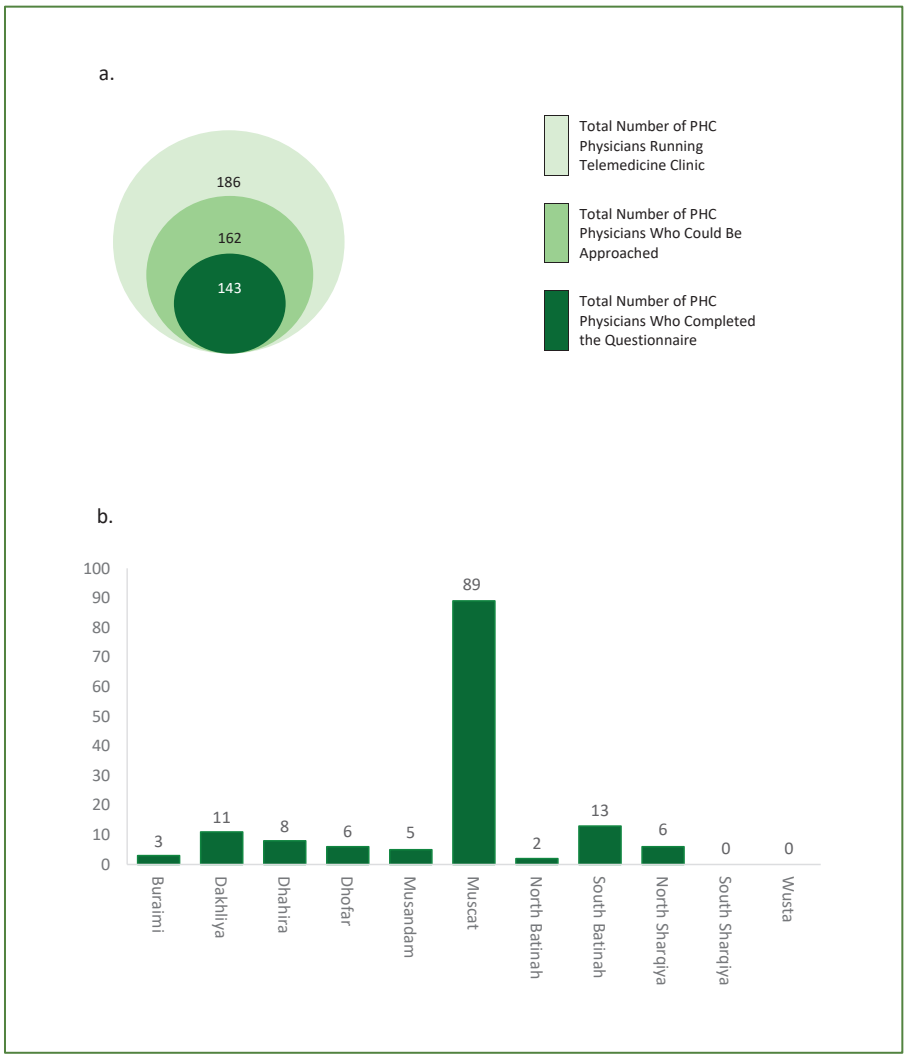


Figure 1. The total number of participants and their distribution by governorate. a. Out of all 186 eligible primary healthcare (PHC) physicians running telemedicine clinics, 162 could be approached, and out of those, only 143 physicians participated and completed the questionnaire. b. The distribution of participating PHC physicians by governorate.

Table 1. The basic characteristics of respondents. N= 143 (100%).

Category		Number (%)
Gender	Male. Female.	25 (17.5%) 118 (82.5%)
Governorate of Work	Muscat Governorate. Other Governorates.	89 (62.2%) 54 (37.8%)
Qualification	Specialist. General Practitioner.	64 (44.8%) 79 (55.2%)
Level of Primary Healthcare Facility	Health Center. Polyclinic and Local hospital.	119 (83.2%) 24 (16.8%)
Frequency of Running Telemedicine Clinic	Once a month. Twice a month. ≥ 3 times a month.	15 (10.5%) 22 (15.4%) 106 (74.1%)
Last Time of Running Telemedicine Clinic	Within this month. 1 – 3 months ago. > 3 months ago.	109 (76.2%) 23 (16.1%) 11 (7.7%)

Table 2. The mean scores of telemedicine usability scale and the distribution of responses to the constituting items. N= 143 (100%).

Usability Feature	(1 – 5) Scale		(0 – 100) Scale	
	Mean	SD	**Mean**	SD
Usability as a Safe and Useful Service	**3.42**	0.61	**60.5**	15.3
Usability as a Communication Channel	**3.23**	0.54	**55.7**	13.4
Usability as an Outpatient Record	**3.99**	0.81	**74.8**	20.2
Usability as a SUCCOR	**3.43**	**0.50**	**60.7**	**12.4**

a.	**Usability of Telemedicine as a Safe and Useful Service**			
The current telemedicine service is provided to the right patients (availability of criteria to categorize patients requiring virtual and non-virtual clinic).				
Not at all agree 1 (0.7%)	Slightly agree 12 (8.4%)	Somewhat agree 44 (30.8%)	Strongly agree 62 (43.4%)	Totally agree 24 (16.8%)
The current telemedicine service ensures privacy of patient information (availability of specified room).				
Not at all agree 11 (7.7%)	Slightly agree 24 (16.8%)	Somewhat agree 43 (30.1%)	Strongly agree 46 (32.2%)	Totally agree 19 (13.3%)
The current telemedicine service ensures patients' compliance.				
Not at all agree 5 (3.5%)	Slightly agree 28 (19.6%)	Somewhat agree 63 (44.1%)	Strongly agree 42 (29.4%)	Totally agree 5 (3.5%)
The current telemedicine service is legally protected (availability of standard operating procedure).				
Not at all agree 13 (9.1%)	Slightly agree 45 (31.5%)	Somewhat agree 52 (36.4%)	Strongly agree 29 (20.3%)	Totally agree 4 (2.8%)
The usefulness of the current telemedicine service in ensuring continuity of care.				
Not at all useful 1 (0.7%)	Slightly useful 16 (11.2%)	Somewhat useful 53 (37.1%)	Very useful 56 (39.2%)	Extremely useful 17 (11.9%)
The usefulness of the current telemedicine service in improving patients' condition.				
Not at all useful 3 (2.1%)	Slightly useful 16 (11.2%)	Somewhat useful 63 (44.1%)	Very useful 56 (39.2%)	Extremely useful 5 (3.5%)
The usefulness of the current telemedicine service in providing support for self-management.				
Not at all useful 2 (1.4%)	Slightly useful 15 (10.5%)	Somewhat useful 47 (32.9%)	Very useful 71 (49.7%)	Extremely useful 8 (5.6%)
The usefulness of the current telemedicine service in reducing the crowding in health facilities				
Not at all useful 2 (1.4%)	Slightly useful 10 (7.0%)	Somewhat useful 30 (21.0%)	Very useful 59 (41.3%)	Extremely useful 42 (29.4%)
The usefulness of the current telemedicine service in reducing the unnecessary consultation costs.				
Not at all useful 4 (2.8%)	Slightly useful 13 (9.1%)	Somewhat useful 27 (18.9%)	Very useful 63 (44.1%)	Extremely useful 36 (25.2%)
b.	**Usability of Telemedicine as a Communication Channel**			
The frequency of having difficulties in obtaining a device to contact patients (availability of landline or a phone) when running the telemedicine clinic.				
Always 3 (2.1%)	Usually 15 (10.5%)	Sometimes 60 (42.0%)	Rarely 40 (28.0%)	Never 25 (17.5%)
The frequency of having difficulties in reaching patients (i.e., the phone number was wrong or out of reach) when running the telemedicine clinic.				
Always 1 (0.7%)	Usually 21 (14.7%)	Sometimes 106 (74.1%)	Rarely 15 (10.5%)	Never 0 (0.0%)

Table 2. (continued) The mean scores of telemedicine usability scale and the distribution of responses to the constituting items. N= 143 (100%).

The frequency of having difficulties in talking to patients through the phone (quality of network) when running the telemedicine clinic.				
Always 1 (0.7%)	Usually 7 (4.9%)	Sometimes 59 (41.3%)	Rarely 64 (44.8%)	Never 12 (8.4%)
The frequency of having difficulties in hearing patients through the phone (quality of network) when running the telemedicine clinic.				
Always 0 (0.0%)	Usually 5 (3.5%)	Sometimes 48 (33.6%)	Rarely 65 (45.5%)	Never 25 (17.5%)
The frequency of spending a long time to contact patients when running the telemedicine clinic.				
Always 3 (2.1%)	Usually 31 (21.7%)	Sometimes 53 (37.1%)	Rarely 49 (34.3%)	Never 7 (4.9%)
The rate of satisfaction with contacting patients (obtaining a device, reaching, talking, hearing) using the current telemedicine service.				
Not at all satisfied 3 (2.1%)	Slightly satisfied 26 (18.2%)	Somewhat satisfied 61 (42.7%)	Very satisfied 52 (36.4%)	Extremely satisfied 1 (0.7%)
The frequency of having difficulties in taking proper history from patients through the phone when running the telemedicine clinic.				
Always 2 (1.4%)	Usually 16 (11.2%)	Sometimes 72 (50.3%)	Rarely 50 (35.0%)	Never 3 (2.1%)
The frequency of having difficulties in getting patients' measurements (e.g., blood pressure measurement, blood sugar profile) through the phone when running the telemedicine clinic.				
Always 22 (15.4%)	Usually 46 (32.2%)	Sometimes 42 (29.4%)	Rarely 32 (22.4%)	Never 1 (0.7%)
The frequency of having difficulties in managing patients through the phone when running the telemedicine clinic.				
Always 1 (0.7%)	Usually 11 (7.7%)	Sometimes 70 (49.0%)	Rarely 52 (36.4%)	Never 9 (6.3%)
The frequency of spending a long time to communicate with patients through the phone when running the telemedicine clinic.				
Always 2 (1.4%)	Usually 29 (20.3%)	Sometimes 66 (46.2%)	Rarely 42 (29.4%)	Never 4 (2.8%)
The rate of satisfaction with communication (taking proper history, getting patients' measurements and managing) using the current telemedicine services.				
Not at all satisfied 2 (1.4%)	Slightly satisfied 31 (21.7%)	Somewhat satisfied 72 (50.3%)	Very satisfied 35 (24.5%)	Extremely satisfied 3 (2.1%)
c.	**Usability of Telemedicine as an Outpatient Record**			
The frequency of having difficulties in opening telemedicine visits.				
Always 5 (3.5%)	Usually 5 (3.5%)	Sometimes 20 (14.0%)	Rarely 47 (32.9%)	Never 66 (46.2%)
The frequency of having difficulties in typing, editing and saving notes of telemedicine visits.				
Always 3 (2.1%)	Usually 2 (1.4%)	Sometimes 16 (11.2%)	Rarely 36 (25.2%)	Never 86 (60.1%)
The frequency of spending a long time to document the telemedicine visit notes.				
Always 5 (3.5%)	Usually 15 (10.5%)	Sometimes 36 (25.2%)	Rarely 47 (32.9%)	Never 40 (28.0%)
The rate of satisfaction with documentation (opening visits, typing, editing, saving notes) using telemedicine visits.				
Not at all satisfied 3 (2.1%)	Slightly satisfied 10 (7.0%)	Somewhat satisfied 37 (25.9%)	Very satisfied 69 (48.3%)	Extremely satisfied 24 (16.8%)

Discussion

Evaluating the usability of telemedicine is a multi-aspect inquiry that considers the effectiveness and efficiency of the service and the satisfaction of end-users. Physicians, the most frequent end-users and main service providers should be involved throughout the development cycle of any health service, and their perspective and experience should be taken into account to ensure the appropriateness and applicability of that service. This study was conducted using a scale developed and validated to quantitatively evaluate the usability of telephone-based consultations from the PHC physicians' perspective. Although the computed scores for the total usability scale and its subscales are not discouraging, the frequency distribution of responses to some questions calls for handling some challenges and strengthening some elements.

The Infrastructural and Technological Challenges

Knowing that a great percentage (45% - 90%) of respondents reported having difficulties in contact and communication with patients at least sometimes (*i.e.*, including sometimes, usually, and always) during telemedicine visits in addition to spending a long-time during telemedicine visits, raises the concern about the effectiveness and efficiency of the current telephone-based consultation as a communication channel between physicians and patients. Obviously, "one size does not fit all," and telephone-based consultation is not the right option for all conditions or patients. However, these findings also address the need for continuously improving our infrastructure and imply the demand for developing innovative technological solutions.

Telemedicine technology evolved many years before the beginning of the 21st century [45]. Several technological modalities, such as audio-visual visits, secure messaging, and remote patient monitoring, exist worldwide to overcome the limitations of telephone-based consultation [46]. Adding the visual component (*i.e.*, sight) to the audio component (*i.e.*, hearing) in virtual clinics makes the audio-visual visits more comparable to in-person visits than the telephone-based consultation. Where audio-visual technology is not preferred or non-available, telephone-based consultation may improve for some patients who can "store and forward" some measurement (e.g., weight, blood pressure, blood glucose level, or peak flow rate) or some pictures of body parts (e.g., skin lesion, swelling or visible abnormalities) to their physicians via a secure platform before or during telephone consultation to get clinical advice if an in-person visit is not required. With more advanced modalities, physicians can remotely monitor the patient's chronic conditions or vitals using wearable devices that can transmit data to healthcare providers' platforms using a wireless network [46].

However, it is important to note that the availability of more advanced telemedicine modalities does not guarantee its usability. In Turkey, about 60% of sampled family physicians indicated technical prerequisites as obstacles to using telemedicine in different scenarios [47]. Technical difficulties were also considered a common barrier by about 62% of responding medical specialists using various telemedicine forms, including audio-only phone calls, video calls, text chats, or e-mails in Malaysia [48]. In Quebec and Massachusetts, where both audio and audio-visual visits are implemented, Breton et al. documented similar difficulties, such as those found in our study, including reaching, hearing, understanding the patients, making proper diagnoses, and providing high-quality care [49]. Additionally, Heyer et al. cited divergent thoughts about the clinical effectiveness of audio-visual visits in the United States [50]. These common findings indicate the need to explore other barriers to implementing telemedicine.

The Financial and Organizational Challenges

Our study revealed that less than 10% of PHC physicians ran telemedicine clinics during 2020-2022. In addition, the study showed that telemedicine clinics varied in terms of their implementation in governorates. For example, more than 60% of respondents were from Muscat governorate, while Al-Wusta and South Sharqiyah were not approached as telemedicine

was not implemented. These figures may not necessarily mean a low service demand but rather a lack of resources. Being the capital of Oman and the most populated governorate [25], Muscat has the greatest number of specialized healthcare facilities and healthcare workers [26]. However, this fact should not deprive other governorates of development where the percentage of Omani doctors is small and the number of specialists per 10000 population is very low compared to Muscat [26]. Qualifying healthcare providers with the necessary skills to run telemedicine clinics is another fundamental requirement to ensure the proper delivery of healthcare via telemedicine if this service is planned to sustain [4,22,51]. At a minimum, such qualification or training has to target healthcare providers from all governorates to ensure equitable distribution and implementation of telemedicine clinics. Some experts, however, recommend earlier integration of telemedicine training into medical students' curricula [51-54].

In addition, the availability of adequate and sustainable financial support is a common challenge in many developing countries [55,56]. It was ranked the first among many barriers to implementing telemedicine in Saudi Arabia [57]. Many telemedicine projects have not succeeded or have not been sustained in some countries because of the high expenditure of its implementation, which includes the initial costs of purchasing and installing telemedicine equipment/devices as well as the ongoing costs that are required to maintain the equipment/devices and to pay for internet and electricity bills in addition to the salary of technical support staff [56].

The Regulatory or Legal Challenges

Many authors, including Shore et al. have addressed the privacy of patient data in telemedicine [58]. With less than 50% of respondents reporting that they agree that the current telemedicine services ensure the privacy of patient information (*i.e.*, strongly agreed and totally agreed), it makes patient privacy vulnerable. Moreover, Abd Ghani and Jaber highlighted patient privacy as a barrier to implementing telemedicine in Iraq [59]. At the same time, Alkraiji et al. raised ethical concerns surrounding the privacy and confidentiality of medical information in some Arabian Gulf countries [60]. Additionally, the lack of legal protection to deliver care through telemedicine, as perceived by more than 70% of respondents (*i.e.*, including respondents who not at all agreed, slightly agreed, and somewhat agreed), may negatively influence the physicians' acceptance of telemedicine as a safe service. The lack of a clear legal framework also concerned a considerable percentage of questioned doctors in Saudi Arabia [61] and Türkiye [47]. Therefore, developing a regulatory framework or standards is essential to support physicians in their care delivery and to maintain patients' trust in the provided service.

Such regulatory or legal frameworks may not be uniform across countries. However, they can be built using the same elements [62]. A review of telemedicine regulatory frameworks developed by neighboring countries such as the United Arab Emirates [63] or the Kingdom of Saudi Arabia [64] should encourage the development of regulatory frameworks in culturally-similar countries. The regulatory framework should govern the licensure for service provision in healthcare facilities and the scope of permitted telemedicine services. In addition, it should describe the requirements for healthcare providers and their responsibilities. It should also govern the health information exchange and indicate the approved devices, equipment, technologies, or software applications. Furthermore, the insurance coverage of any telemedicine service or payment procedure should be clear and specified. More importantly, the regulation should address the patient's rights and consent as well as the privacy and confidentiality of information. Monitoring and evaluation should also be integral to telemedicine regulation by ensuring healthcare facilities and providers' compliance with the regulation. Reassuringly, the regulation of telemedicine services was not ignored in Oman. However, it was an internal policy on the use of telemedicine in PHC facilities located in the capital governorate only [65].

The Cultural and Environmental Challenges

More respondents felt that the current telemedicine services were useful in reducing crowding and unnecessary consultation costs (about 70%) than those reporting its usefulness in ensuring continuity of care, improving patients' conditions, and supporting self-management (43% to 55%). This warrants further examination of the current services in improving patients' clinical status to help establish mechanisms for improvement. Besides, we should not ignore the fact that telemedicine is a two-way communication process, and the complete readiness of healthcare facilities is insufficient to determine the usability of this service. In other words, the patients should also be ready in terms of the available basic infrastructure, devices, equipment, technologies, or software applications in addition to affordable and efficient network connectivity. Moreover, as patients' clinical status, needs, education levels, and preferences differ, we should avoid the pitfall of appointing virtual visits to patients who may find it challenging to use this new service [66] and consequently miss their appointments, relax their control, and slip into complications. Apart from that, educating the patients or caregivers about telemedicine services should be offered to more than just those who inquire about them. Rather, it should be presented to the public as alternative healthcare services with known benefits. This should make people appreciate the progress in advancing the provision, improving accessibility, and increasing the utilization of healthcare services.

Nevertheless, the geographical diversity in Oman has shaped the culture and lifestyle of its people. The Bedouin desert-bound and nomadic lifestyle in some areas of Oman, like those in Al-Wusta and South Sharqiya governorates [67,68], may not favor telemedicine to seek healthcare. Yet, with the government's directions to support the development of all citizens and empower them, many Bedouins started accepting some features of the urban lifestyle without abandoning their nature-loving standards or traditions-rich culture [68].

Encouragingly, the current coverage of the fourth generation (4G) of the wireless network in Oman that exceeds 90% of the population, and the launch of the fifth generation (5G) of wireless network that started in 2019 [69,70] in addition to the firm will to create sustainable smart cities with advanced technological infrastructure [71,72], furnish the environment for more advanced forms of telemedicine technologies in PHC facilities [73,74]. This exceptional development in ICT is an outcome of the Digital Oman Strategy, which has among its objectives the elimination of digital literacy and empowering all members of the society to communicate and interact electronically [75]. In fact, we have started witnessing the cultural acceptance of this transformation in healthcare delivery and the demand to sustain it [10,11]. In 2021, a survey to assess the accessibility and use of information technology and telecommunication showed that the percentage of those who owned smartphones and internet access was almost equal (around 94%) among respondents from different governorates in Oman [76]. Undoubtedly, this should make us more prepared and accountable to meet the expectation of our people and future generations.

IT-FORCE Framework: A Scheme to Improve the Usability of Telemedicine and Advance Healthcare

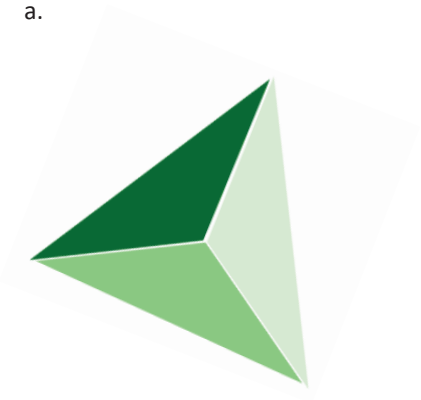
Based on our findings and context, the inferred challenges in our study (*i.e.*, Infrastructural & Technological, Financial & Organisational, Regulatory, Cultural & Environmental) can be organized in a hypothesized framework of determinants (IT-FORCE) that best explains our results, directs the improvement of our telemedicine service, and predicts its sustainable usability (Figure 2). Though our proposition is not unprecedented and comparable frameworks exist [77,78], our framework's peculiar feature lies in constructing a regular triangular pyramid (Figure 2.a) to visualize the concept of interdependence of telemedicine usability on the four inferred categories of determinants (Figure 2.b).

Thus, as four equilateral triangles of the same length are all – without exception – necessary to form a regular triangular pyramid, the four categories of usability determinants all –

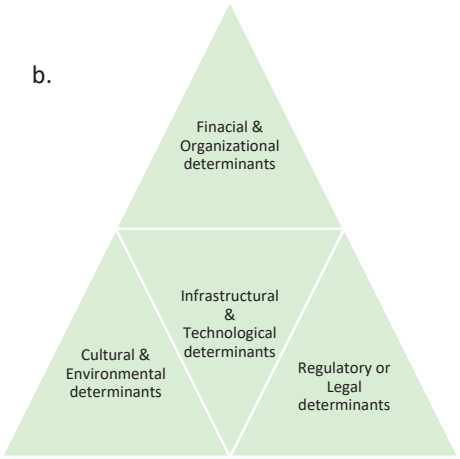
without exception – require interventions to improve the telemedicine usability features. In other words, setting up the infrastructure of healthcare facilities for the more advanced form of telemedicine does not guarantee the usability of telemedicine unless sufficient fund is allocated to maintain and sustain the service, qualified physicians are equitably distributed, a regulatory framework is approved and followed, the patient's environment is ready in terms of infrastructure, and the patients are fit, willing and equipped with the essential tools for the scheduled telemedicine visit.

Undeniably, one of the lessons learned during the COVID-19 pandemic was leveraging telemedicine services and sustaining them in the

a.



b.



c.

IT-FORCE	Interventions
Infrastructural & Technological	▪ Set up healthcare facilities to accommodate telemedicine clinic. ▪ Equip healthcare facilities with the appropriate and approved devices and software applications to run telemedicine clinic. ▪ Ensure high quality network and technical support.
Financial & Organizational	▪ Allocate sufficient budget to implement, maintain and sustain telemedicine clinic. ▪ Qualify physicians with the necessary skills to run telemedicine clinic. ▪ Increase the number of telemedicine clinics in all governorates.
Regulatory/Legal	▪ Develop a regulatory framework for telemedicine services.
Cultural & Environmental	▪ Empower people with digital knowledge and skills. ▪ Increase the people knowledge and awareness of the available telemedicine services and their benefits. ▪ Create technology-encouraging environment and improve network connectivity at national and subnational levels.

Figure 2. A hypothesized framework of determinants and interventions to improve telemedicine. a. A regular triangular pyramid, which requires all four triangular faces to join, is proposed to explain the dependence of telemedicine usability on all of the four categories of hypothesized determinants. b. The four categories of hypothesized determinants are displayed on the four triangular faces of a regular triangular pyramid. c. The four categories of the hypothesized determinants form the IT-FORCE acronym, which represents the framework of usability determinants. Each category can be governed by a set of interventions to improve the usability of telemedicine.

post-pandemic era [9,79-82]. Hence, developing a telehealth strategy is unnegotiable, and waiting for another pandemic or crisis to decide and react is unwise. Without exaggeration, telemedicine is highly anticipated to be a public demand and a common requirement for the future digitally-literate generations. Optimistically, with the rapid pace of ICT development and the future strategic direction to utilize technology in healthcare delivery, the diffusion of this "new normal" is not unexpected within the coming years in Oman and other countries.

Collectively, the interventions that are proposed to govern and control the inferred determinants (Figure 2.c) should improve the usability features of telemedicine service, which in turn will not only improve the accessibility and coverage of healthcare services but also build an inclusive, equitable and resilient healthcare system that is in alignment with future directions of Oman and the world (Figure 3) where healthy lives, well-being, and sustainable development are enjoyed by all [83-85].

IT-FORCE Framework and the Principles of Biomedical Ethics

Today, the clinical applications of telemedicine span the whole spectrum of medicine with different degrees of maturity [86,87]. Teleradiology and telepathology are considered the most mature applications in telemedicine. However, in the last few decades, other specialties such as telepsychiatry, teledermatology, telecardiology,

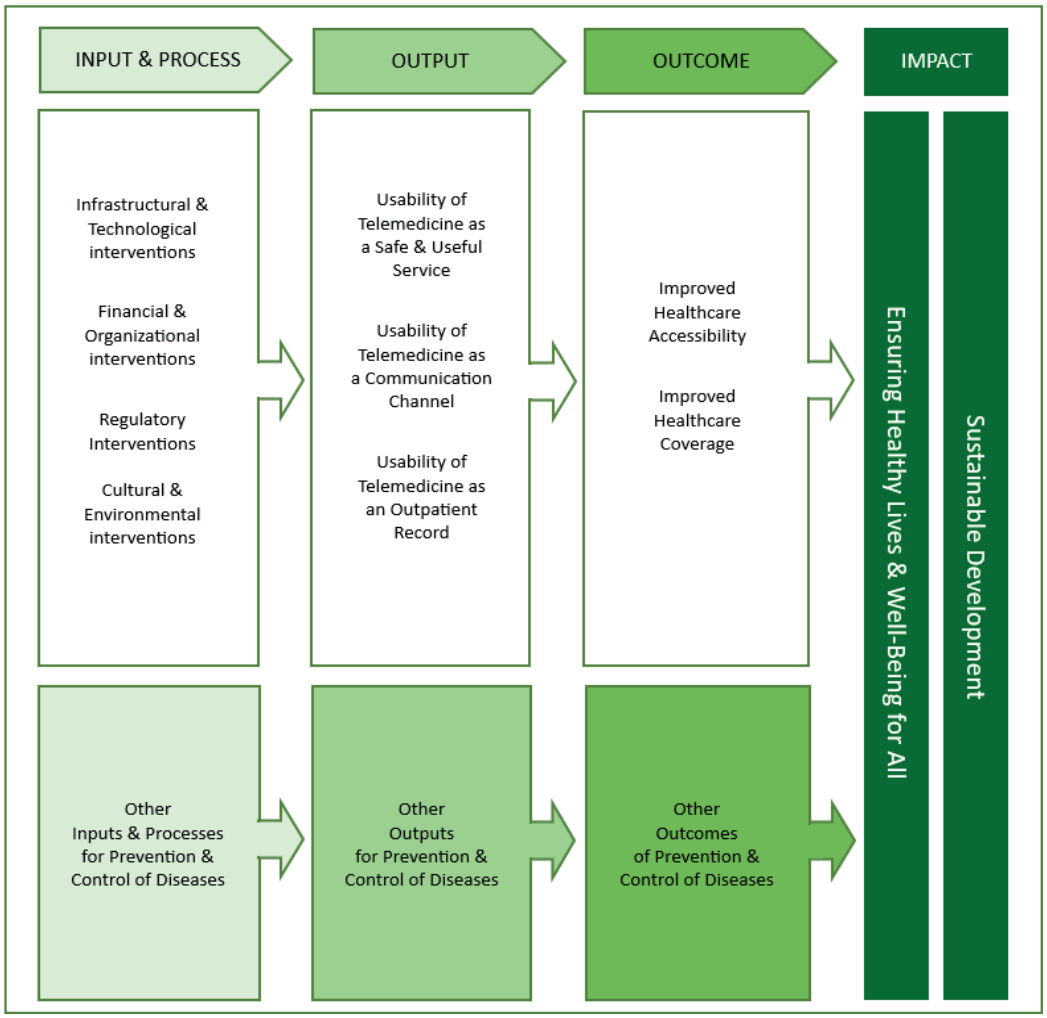


Figure 3. Promoting telemedicine as a means to achieve sustainable development. Ensuring healthy lives and well-being for all and achieving sustainable development depend on preventing and controlling diseases, including improving healthcare accessibility and coverage. This outcome might be achieved by improving its requirements and preconditions, including the usability of telemedicine and the hypothesized determinants.

and teleophthalmology have been recognized as maturing applications, while telesurgery is gently emerging [86,87]. This might be attributed to many factors, such as feasibility, quality, and cost [87]. Above all, however, the provision of telemedicine, like any healthcare service, should be guided by ethics. Beauchamp and Childress proposed four biomedical ethics principles: respect for autonomy, nonmaleficence, beneficence, and justice [88]. In simple words, a healthcare service is considered ethical if it is chosen by the patient (respect of autonomy), not expected to cause harm (nonmaleficence), intended to benefit the patient (beneficence), and provided to all who need it (justice). Our hypothesized IT-FORCE framework supports the fulfillment of these principles. Thus, the readiness of healthcare institutions and patients'

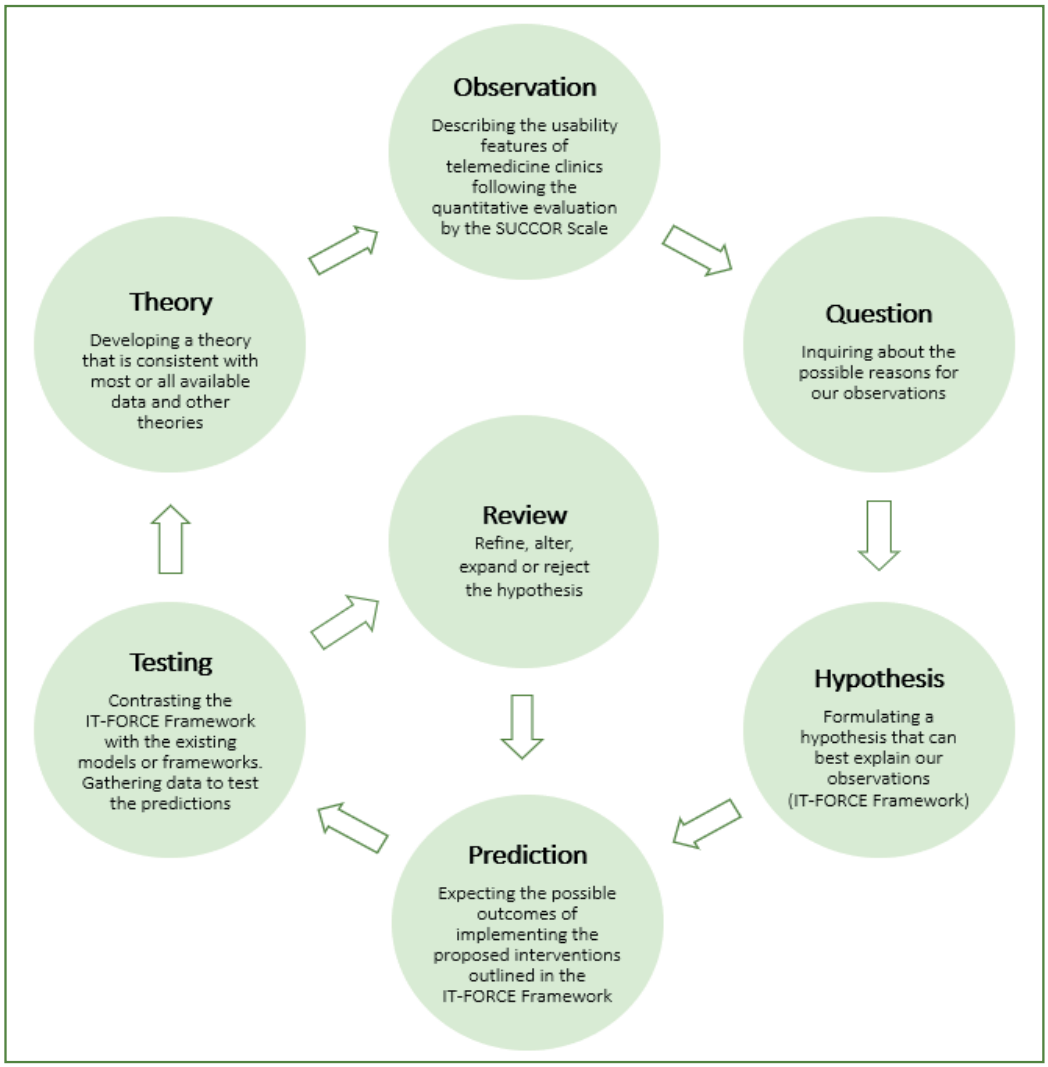


Figure 4. The scientific method in our study. The scientific method is an ongoing process. By answering our research question, we made our observation about the usability of our telemedicine clinics. This step was followed by inquiring about the possible reasons. With logical reasoning, we could formulate a hypothesized framework of determinants that join the infrastructural, technological, financial, organizational, regulatory, cultural, and environmental (IT-FORCE) determinants to explain our observations. Based on the level of imposed governance on the outlined determinants, the hypothesized framework may have a positive or negative influence on the usability of telemedicine. Evaluating the effectiveness of the implemented interventions is a future step to test the proposed predictions. Further studies might be required to refine, alter, expand or reject our hypothesis before drafting a theory. The last step will be the starting point for the subsequent development of a rigorous and reliable theory that precisely explains our observations.

The sketch of this Figure was inspired by Garland, cited by Dai and Boos [89].

homes to accommodate telemedicine conforms with equitable access to healthcare services and hence the principle of justice. By tackling the aforementioned determinants of usability, telemedicine might be considered an optional modality of delivering healthcare services equivalent to in-person visits where safety and satisfactory outcomes are expected, complying with the principles of nonmaleficence and beneficence. Having these standard features characterizing telemedicine services encourages people to prefer and autonomously request this type of healthcare service whenever possible. However, these principles might be integrated only if telemedicine services are mature enough and advanced to meet the same expectations as in-person visits or if the outcomes of both types of visits, when provided to the right patients, are not different.

Strengths and Limitations

In our study, we initiated the cyclic process of a scientific method (Figure 4) [89,90]. Thus, to answer our research question and quantify the usability of telemedicine service in our PHC facilities, we built and developed our instrument (The SUCCOR Scale) following a literature review and conceptual understanding of usable healthcare service. It was discernible that the descriptive numbers and statistics were not the end of our analysis or the core of our discussion but instead the door to enter the field of logical reasoning [91-93]. Interestingly, formulating a hypothesis that best explains the observations is a creative process combining knowledge and imagination [94]. Our explanatory hypothesis integrated the most plausible determinants of telemedicine usability in a conceptual framework (IT-FORCE). Using our framework of determinants, we can conceptually predict the outcomes of leveraging telemedicine or tackling its barriers and consequently plan our next steps. In addition to being in line with the existing models and frameworks, our framework has its unique analogy to mirror our perception of the interdependence of telemedicine usability on all of the hypothesized determinants and to support our argument for the need of multi-sectoral interventions. Following the implementation of the proposed interventions, testing our predictions to refine, alter or expand our hypothesis is recommended for subsequent development of the theory. The latter is not the end of the scientific method but the restart point of the cyclic process.

Similar to any study, however, limitations are innate. First, being evaluated from the perspective of PHC physicians, the usability results cannot be generalized to other healthcare facilities or specialties in which different forms of telemedicine might be used, and various challenges might be encountered. Nevertheless, we argue that the proposed framework of determinants is expected to help decision-makers monitor any form of telemedicine in any setting in the country. Second, measurement bias is not unexpected as the evaluation was based on a questionnaire requiring the respondents to recall their experiences. However, using Likert item questions with a 5-point-unipolar response scale should reduce measurement bias. Third, because of the small sample size, the study had a low power to detect any difference in the scores between different subgroups. Yet, the respondents were more representative of a national sample owing to the number and distribution of eligible participants at the time of the study.

Conclusion

Telemedicine service has some usability features in Oman, according to PHC physicians. However, there is still much room for improving this service by tackling some infrastructural, technological, financial, organizational, regulatory, cultural, and environmental challenges. This should qualify our telemedicine service as a safe and useful communication channel and outpatient record devoted to facilitating access to high-quality healthcare.

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Conflict of Interest

No conflict of interest declared.

Data Availability Statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

References

1. World Health Organization. The world health report 1998 - Life in the 21st century: a vision for all. Geneva, Switzerland: WHO; 1998. https://apps.who.int/iris/handle/10665/42065 [Accessed December 1, 2022].
2. World Health Organization Group Consultation on Health Telematics. A health telematics policy in support of WHO's Health-for-all strategy for global health development: report of the WHO Group Consultation on Health Telematics, 11-16 December 1997. Geneva, Switzerland: WHO; 1998. https://apps.who.int/iris/handle/10665/63857 [Accessed December 1, 2022].
3. World Health Organization Global Observatory for eHealth. Telemedicine: opportunities and developments in Member States: report on the second global survey on eHealth. Geneva, Switzerland: WHO; 2010. Available at: https://apps.who.int/iris/handle/10665/44497 [Accessed December 1, 2022].
4. World Health Organization. Global diffusion of eHealth: making universal health coverage achievable: report of the third global survey on eHealth. Geneva, Switzerland: WHO; 2016. https://apps.who.int/iris/handle/10665/252529 [Accessed December 1, 2022].
5. World Health Organization. WHO guideline: recommendations on digital interventions for health system strengthening. Geneva, Switzerland: WHO; 2019. https://www.who.int/publications/i/item/9789241550505 [Accessed December 1, 2022].
6. Alonso SG, Marques G, Barrachina I, Garcia-Zapirain B, Arambarri J, Cabo Salvador J, et al. Telemedicine and e-Health research solutions in literature for combatting COVID-19: A systematic review. Health Technol. 2021;11(2):257-66. doi: 10.1007/s12553-021-00529-7.
7. European Observatory on Health Systems and Policies, Fahy N, Williams GA. Use of digital health tools in Europe: before, during and after COVID-19. WHO Regional Office for Europe; 2021. https://apps.who.int/iris/handle/10665/345091 [Accessed December 1, 2022].
8. Koç Yekedüz M, Doğulu N, Sürücü Kara İ, Öncül Ü, Bakirarar B, Kullu P, et al. Pros and cons of telemedicine for inherited metabolic disorders in a developing country during the COVID-19 pandemic [published online ahead of print, 2022 Mar 30]. Telemed J E Health. 2022. doi: 10.1089/tmj.2021.0610.
9. Al Fannah J, Al Harthy H, Al Salmi Q. COVID-19 Pandemic: Learning lessons and a vision for a better health system. Oman Med J. 2020;35(5):e169. doi: 10.5001/omj.2020.111.
10. Al-Mahrouqi T, Al-Alawi K, Al-Alawi M, Al Balushi N, Al Ghailani A, Al Sabti H, et al. A promising future for tele-mental health in Oman: A qualitative exploration of clients and therapists' experiences. SAGE Open Med. 2022;10:1-13. doi: 10.1177/20503121221086372.
11. Alsaffar H, Almamari W, Al Futaisi A. Telemedicine in the era of COVID-19 and beyond: A new horizon. Sultan Qaboos Univ Med J. 2020;20(4):e277-e279. doi: 10.18295/squmj.2020.20.04.001.
12. Hasani SA, Ghafri TA, Al Lawati H, Mohammed J, Al Mukhainai A, Al Ajmi F, et al. The use of telephone consultation in primary health care during COVID-19 pandemic, Oman: Perceptions from physicians. J Prim Care Community Health. 2020;11:1-8. doi: 10.1177/2150132720976480.
13. Bashshur RL. Telemedicine and Health Care. In: Bashshur RL, Mandil SH, Shannon GW, eds. State-of-the-Art Telemedicine/Telehealth Symposium: An International Perspective. New York, NY: Mary Ann Liebert; 2002:5-12. https://www.researchgate.net/publication/235042598_State_of_the_Art_TelemedicineTelehealth [Accessed December 1, 2022].
14. Fakılı F, Bayram N. Anxiety levels, sleep quality and follow-up of obstructive sleep apnoea patients during the COVID-19 pandemic. J Turk Sleep Med. 2022;9:147-52. doi: 10.4274/jtsm.galenos.2021.76476.
15. Alodhayani AA, Hassounah MM, Qadri FR, Abouammoh NA, Ahmed Z, Aldahmash AM. Culture-specific observations in a Saudi Arabian Digital Home Health Care Program: Focus group discussions with patients and their caregivers. J Med Internet Res. 2021;23(12):e26002. doi: 10.2196/26002.

16. Feroze K. Teledermatology in India: practical implications. Indian J Med Sci. 2022;62(5):208-14. doi: 10.4103/0019-5359.40988.
17. Rubin J, Chisnell D. Handbook of Usability Testing: How to Plan, Design, and Conduct Effective Tests. 2nd ed. Indianapolis, IN: Wiley Publishing; 2008. https://docplayer.net/78863249-Handbook-of-usability-testing.html [Accessed December 1, 2022].
18. Alonso-Ríos D, Vázquez-García A, Mosqueira-Rey E, Moret-Bonillo V. Usability: A critical analysis and a taxonomy. Int J Hum-Comput Int. 2010;26(1):53-74. doi: 10.1080/10447310903025552.
19. Abran A, Khelifi A, Suryn W, Seffah A. Usability meanings and interpretations in ISO standards. Softw Qual J. 2003;11(4):325-38. doi: 10.1023/A:1025869312943.
20. Haron SN, Hamida Y, Talib A. Towards healthcare service quality: An understanding of the usability concept in healthcare design. Procedia Soc Behav Sci. 2012;42:63-73. doi: 10.1016/j.sbspro.2012.04.167.
21. International Organisation for Standardization. ISO 9241-11 Ergonomic requirements for office work with visual display terminals (VDTs) - Part 11: Guidance on usability. Geneva, Switzerland: ISO; 1998. doi: 10.3403/01879403.
22. Schug S, Atzori W, Lange M, Sanna L. Renewing Health User Requirement Reference Framework. D4.2 v1.0. Regions of Europe Working Together for Health; 2012. https://www.eu-patient.eu/globalassets/projects/renewing-health/renewing-health-user-requirement-ref-framework.pdf [Accessed December 1, 2022].
23. World Bank Country and Lending Groups. The World Bank. https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups Published 2021. [Accessed December 1, 2022].
24. Oman Ministry of Information. Oman a vision of future. Sultanate of Oman: Ministry of Information; 2021. https://www.omaninfo.om/library/47 [Accessed December 1, 2022].
25. Oman National Centre for Information and Statistics. Population Statistics 2021. Sultanate of Oman: National Centre for Information and Statistics; 2021. https://www.ncsi.gov.om/Elibrary/LibraryContentDoc/bar_Population%202022.%20Issue%2012_acd27374-e060-4eb7-a125-7cbaa4958e47.pdf [Accessed December 1, 2022].
26. Oman Ministry of Health. Human Resources for Health. In: Annual Health Report 2020. Sultanate of Oman: Department of Information & Statistics; 2020.
27. Garg R. Methodology for research I. Indian J Anaesth. 2016;60(9):640-5. doi: 10.4103/0019-5049.190619.
28. Patino CM, Ferreira JC. Inclusion and exclusion criteria in research studies: definitions and why they matter. J Bras Pneumol. 2018;44(2):84. doi: 10.1590/s1806-37562018000000088.
29. Bakken S, Grullon-Figueroa L, Izquierdo R, Lee N-J, Morin P, Palmas W, Teresi J, et al. Development, validation, and use of English and Spanish versions of the telemedicine satisfaction and usefulness questionnaire. J Am Med Inform Assoc. 2006;13(6):660-7. doi: 10.1197/jamia.M2146.
30. Brooke J. SUS-A quick and dirty usability scale. In: Jordan PW, Thomas B, Weerdmeester BA, McClelland AL, eds. Usability Evaluation in Industry. London, UK: Taylor and Francis; 1996:189-94. doi: 10.1201/9781498710411-35.
31. Davis FD. User Acceptance of information technology: System characteristics, user perceptions and behavioral impacts. Int J Man Mach Stud. 1993;38:475-87. doi: 10.1006/IMMS.1993.1022.
32. Hirani SP, Rixon L, Beynon M, Cartwright M, Cleanthous S, Selva A, et al. Quantifying beliefs regarding telehealth: Development of the whole systems demonstrator SUTAQ - service user technology acceptability questionnaire (WSD-SUTAQ). J Telemed Telecare. 2017;23(4):460-9. doi: 10.1177/1357633X16649531.
33. Lewis JR. Psychometric evaluation of the post-study system usability questionnaire: The PSSUQ. Proceedings of the Human Factors Society 36th annual meeting. 1992;36(16):1259-60. doi: 10.1177/154193129203601617.
34. Lund A. Measuring Usability with the USE Questionnaire. Usability and User Experience Newsletter of the STC Usability Special Interest Group. 2001;8. https://www.researchgate.net/publication/230786746_Measuring_Usability_with_the_USE_Questionnaire [Accessed December 1, 2022].
35. Morgan DG, Kosteniuk J, Stewart N, O'Connell ME, Karunanayake C, Beever R. The telehealth satisfaction scale: Reliability, validity, and satisfaction with telehealth in a rural memory clinic population. Telemed J E Health. 2014;20(11):997-1003. doi: 10.1089/tmj.2014.0002.
36. Parmanto B, Lewis AN, Jr Graham KM, Bertolet MH. Development of the telehealth usability questionnaire (TUQ). Int J Telerehabilitation. 2016;8(1):3-10. doi: 10.5195/ijt.2016.6196.

37. Yip MP, Chang AM, Chan J, MacKenzie AE. Development of the telemedicine satisfaction questionnaire to evaluate patient satisfaction with telemedicine: a preliminary study. J Telemed Telecare. 2003;9(1):46-50. doi: 10.1258/135763303321159693.
38. Hinkin TR, Tracey JB, Enz CA. Scale construction: Developing reliable and valid measurement instruments. J Hosp Tour Res. 1997;21(1):100-20. doi: 10.1177/109634809702100108.
39. Gharbal A, Al-Lawati NA, Al-Sumri NH, Al-Raisi SS. Developing a scale to evaluate the usability of telemedicine as a safe and useful communication channel and outpatient record. Atlantic J Med Sci Res. 2023;3(1):7-16. doi: 10.55358/atjmed.2022.12.022
40. Barlett JE, Kotrlik, Higgins C. Organizational research: Determining appropriate sample size in survey research. Inf Technol Learn Perform J. 2001;19(1):43-50.
41. Beavers AS, Lounsbury JW, Richards JK, Huck SW, Skolits GJ, Esquivel SL. Practical considerations for using exploratory factor analysis in educational research. Pract Assess Res Evaluation. 2013;18:6. doi: 10.7275/qv2q-rk76.
42. Rogers P. Best practices for your exploratory factor analysis: A Factor tutorial. Rev Adm Contemp. 2021. "in press". doi: 10.1590/1982-7849rac2022210085.en.
43. DiStefano C, Zhu M, Mîndrilã D. Understanding and using factor scores: Considerations for the applied researcher. Pract Assess Res Evaluation. 2009;14(20):1-11. doi: 10.7275/da8t-4g52.
44. Ware JE, Snow KK, Kosinski M, Gandek B. SF36 Health Survey: Manual and Interpretation Guide. Boston, MA: New England Medical Center Hospitals; 1993. https://www.researchgate.net/publication/247503121_SF36_Health_Survey_Manual_and_Interpretation_Guide [Accessed December 1, 2022].
45. Ackerman MJ, Craft RL, Ferrante FE, Kratz M, Mandil S, Sapci HA. Telemedicine Technology. In: Bashshur RL, Mandil SH, Shannon GW, eds. State-of-the-Art Telemedicine/Telehealth Symposium: An International Perspective. New York, NY: Mary Ann Liebert; 2002:71-78. https://www.researchgate.net/publication/235042598_State_of_the_Art_TelemedicineTelehealth [Accessed December 1, 2022].
46. American Academy of Family Physicians. A Toolkit for Building and Growing a Sustainable Telehealth Program in Your Practice. AAFP; 2020. https://www.aafp.org/dam/AAFP/documents/practice_management/telehealth/2020-AAFP-Telehealth-Toolkit.pdf [Accessed December 1, 2022].
47. Erbayraktar A, Koc EM, Pamuk G. Evaluation of possible telehealth scenarios in Turkey by family medicine residents in Izmir. Med Science. 2022;11(1):280-4. doi: 10.5455/medscience.2021.11.374.
48. Thong HK, Wong DKC, Gendeh HS, Saim L, Athar PPBSH, Saim A. Perception of telemedicine among medical practitioners in Malaysia during COVID-19. J Med Life. 2021;14(4):468-80. doi: 10.25122/jml-2020-0119.
49. Breton M, Sullivan EE, Deville-Stoetzel N, McKinstry D, DePuccio M, Sriharan A, et al. Telehealth challenges during COVID-19 as reported by primary healthcare physicians in Quebec and Massachusetts. BMC Fam Pract. 2021;22:192. doi: 10.1186/s12875-021-01543-4.
50. Heyer A, Granberg RE, Rising KL, Binder AF, Gentsch AT, Handley NR. Medical oncology professionals' perceptions of telehealth video visits. JAMA Netw Open. 2021;4(1):e2033967. doi: 10.1001/jamanetworkopen.2020.33967.
51. Al-Samarraie H, Ghazal S, Alzahrani AI, Moody L. Telemedicine in Middle Eastern countries: Progress, barriers, and policy recommendations. Int J Med Inform. 2020;141:104232. doi: 10.1016/j.ijmedinf.2020.104232.
52. Bali S. Barriers to Development of Telemedicine in Developing Countries. In: Heston TF, ed. Telehealth. London, UK: IntechOpen; 2018. doi: 10.5772/intechopen.81723.
53. Alaboudi A, Atkins A, Sharp B, Balkhair A, Alzahrani M, Sunbul T. Barriers and challenges in adopting Saudi telemedicine network: The perceptions of decision makers of healthcare facilities in Saudi Arabia. J Infect Public Health. 2016;9(6):725-33. doi: 10.1016/j.jiph.2016.09.001.
54. Galpin K, Sikka N, King SL, Horvath KA, Shipman SA, AAMC Telehealth Advisory Committee. Expert Consensus: Telehealth Skills for Health Care Professionals. Telemed J E Health. 2021;27(7):820-4. doi: 10.1089/tmj.2020.0420.
55. Pathipati AS, Azad TD, Jethwani K. Telemedical education: Training digital natives in telemedicine. J Med Internet Res. 2016;18(7):e193. doi: 10.2196/jmir.5534.
56. Pourmand A, Ghassemi M, Sumon K, Amini SB, Hood C, Sikka N. Lack of telemedicine training in academic medicine: Are we preparing the next generation? Telemed J E Health. 2021;27(1):62-7. doi: 10.1089/tmj.2019.0287.

57. Stovel RG, Gabarin N, Cavalcanti RB, Abrams H. Curricular needs for training telemedicine physicians: A scoping review. Med Teach. 2020;42(11):1234-42. doi: 10.1080/0142159X.2020.1799959.

58. Shore JH, Yellowlees P, Caudill R, Johnston B, Turvey C, Mishkind M, et al. Best practices in videoconferencing-based telemental health April 2018. Telemed J E Health. 2018;24(11):827-32. doi: 10.1089/tmj.2018.0237.

59. Abd Ghani MK, Jaber MM. The effect of patient privacy on telemedicine implementation in developing countries: Iraq case study. Res J Appl Sci Eng Technol. 2015;11(11):1233-7. doi: 10.19026/rjaset.11.2230.

60. Alkraiji A, El-Hassan O, Amin F. Health informatics opportunities and challenges: Preliminary study in the Cooperation Council for the Arab States of the Gulf. J Health Inform Dev Ctries. 2014;8(1):36-45. https://www.jhidc.org/index.php/jhidc/article/view/115/159 [Accessed December 1, 2022].

61. Kaliyadan F, Al Ameer MA, Al Ameer A, Al Alwan Q. Telemedicine practice in Saudi Arabia during the COVID-19 Pandemic. Cureus. 2020;12(12):e12004. doi: 10.7759/cureus.12004.

62. Stapic Z, Vrček N, Hajdin G. Legislative framework for telemedicine. Paper presented at: Central European Conference on Information and Intelligent Systems; September, 2008. Varaždin, Croatia. doi: 10.13140/2.1.3461.1200.

63. Abu Dhabi Department of Health / Strategic Affairs. DOH Standard on Tele-Medicine. Abu Dhabi: Department of Health; 2020. https://www.doh.gov.ae/en/resources/standards [Accessed December 1, 2022].

64. Saudi Arabia National Health Information Centre. The governing rules of Telehealth in the kingdom of Saudi Arabia. Kingdom of Saudi Arabia: Saudi Health Council; 2021. https://nhic.gov.sa/Initiatives/Documents/The%20Executive%20Rules%20of%20Telehealth.pdf [Accessed December 1, 2022].

65. Oman Ministry of Health / Department of Primary Health Care in Muscat. Policy on Tele-medicine service in primary health care. Sultanate of Oman: Directorate General of Health Services in Muscat; 2021.

66. Mehta SJ. Telemedicine's potential ethical pitfalls. Virtual Mentor. 2014;16(12):1014-7. doi: 10.1001/virtualmentor.2014.16.12.msoc1-1412.

67. Oman Ministry of Heritage and Tourism. Press Kit 2021. Sultanate of Oman. Ministry of Heritage and Tourism; 2021. https://www.experienceoman.om/wp-content/uploads/2021/06/OMAN-TOURISM-PRESS-KIT-ENGLISH_2021.pdf [Accessed March 9, 2023].

68. Hardan A, Amzat IH. Bedouins status in Oman: Development and education towards cultural beliefs. OIDA Int J Sustain Dev. 2012;3(9):41-52. https://www.researchgate.net/profile/Ismail-Amzat-3/publication/255698813_Bedouins_Status_in_Oman_Development_and_Education_Towards_Cultural_Beliefs/links/597816c00f7e9b277721d7ad/Bedouins-Status-in-Oman-Development-and-Education-Towards-Cultural-Beliefs.pdf [Accessed March 9, 2023].

69. Omantel. Management Discussion & Analysis Report. Sultanate of Oman: Oman Telecommunications Company SAOG; 2020. https://www.omantel.om/wcm/connect/35c541a5-e2eb-4284-8229-9588ccde9162/Management+Discussion+%26+Analysis.pdf?MOD=AJPERES&CONVERT_TO=URL&CACHEID=ROOTWORKSPACE-35c541a5-e2eb-4284-8229-9588ccde9162-nwLWh3K [Accessed December 1, 2022].

70. Ooredoo. Financial Report 2021. Sultanate of Oman: Omani Qatari Telecommunications Company SAOG; 2021. https://www.ooredoo.om/Portals/0/pdf/IR/Financial_Report_2021_E.pdf [Accessed December 1, 2022].

71. Catapult. Towards Oman's First National Smart Cities Stack. London, UK: Connected Places Catapult; 2021. https://www.ita.gov.om/itaportal/Data/English/DocLibrary/202172911511454/Oman%E2%80%99s%20First%20National%20Smart%20Cities%20Stack.pdf [Accessed December 1, 2022].

72. Oman Ministry of Transport, Communications and Information Technology. Future Opportunities for Artificial Intelligence Applications and Advanced Technologies in the Sultanate of Oman. Sultanate of Oman: Ministry of Transport, Communications and Information Technology; 2021. https://www.ita.gov.om/itaportal/Data/English/DocLibrary/202161395323666/Future%20Opportunities%20for%20Artificial%20Intelligence%20(AI)%20Applications%20in%20the%20Sultanate%20of%20Oman%202.pdf [Accessed December 1, 2022].

73. Gupta P, Ghosh M. Revolutionizing healthcare with 5G. Telecom Business Review. 2019;12(1):41-5. https://www.scribd.com/document/519581818/Revolutionizing-Healthcare-With-5G [Accessed December 1, 2022].

74. Janjua MB, Duranay AE, Arslan H. Role of wireless communication in healthcare system to cater disaster situations under 6G vision. Front Comms Net. 2020;1:610879. doi: 10.3389/frcmn.2020.610879.
75. Oman Information Technology Authority. E-OMAN. Sultanate of Oman: Ministry of Transport, Information Technology Authority; 2008. https://www.ita.gov.om/itaportal/Data/English/DocLibrary/FID2010921144034803/ITA_e.oman_eng_new.pdf [Accessed December 1, 2022].
76. Oman National Centre for Information and Statistics. Poll Access measurement and use of ICT 2021. Sultanate of Oman: National Centre for Information and Statistics; 2021. https://www.ncsi.gov.om/Elibrary/LibraryContentDoc/bar_Poll%20Access%20measurement%20and%20use%20of%20ICT%202021_6a924572-80d9-4832-8251-54ced1aff13a.pdf [Accessed March 9, 2023].
77. Alaboudi AA, Atkins AS, Sharp BA. Holistic framework for assisting decision makers of healthcare facilities to assess telemedicine applications in Saudi Arabia. Paper presented at: eTELEMED 2015: The Seventh International Conference on eHealth, Telemedicine, and Social Medicine; February 22-27, 2015. Lisbon, Portugal: IARIA; 2015: 203-208. Available at: http://eprints.staffs.ac.uk/2184/1/Alaboudi%20paper%20lisbon%202015.pdf [Accessed December 1, 2022].
78. Jaber MM, Abd Ghani MK, Burhanuddin MA, Mohammed MA, Abdullah I. Inferring on the factors that influence the use of telemedicine in developing Countries: Toward developing countries telemedicine framework. Eur J Sport Sci. 2015;2(1):1-17. Available at: http://nabujournals.com/web/articles/2015%20UPDATED.pdf [Accessed December 1, 2022].
79. Butler SM. After COVID-19: Thinking differently about running the health care system. JAMA. 2020;323(24):2450-1. doi: 10.1001/jama.2020.8484.
80. Hoffer-Hawlik MA, Moran AE, Burka D, Kaur P, Cai J, Frieden TR, et al. Leveraging telemedicine for chronic disease management in low- and middle-income countries during Covid-19. Glob Heart. 2020.15(1):63. doi: 10.5334/gh.852.
81. Kumar P, Huda F, Basu S. Telemedicine in the COVID-19 era: The new normal. Eur Surg. 2020;52(6):300-1. doi: 10.1007/s10353-020-00666-9.
82. Malhotra N, Sakthivel P, Gupta N, Nischal N, Ish P. Telemedicine: A new normal in COVID era; perspective from a developing nation. Postgrad Med J. 2022;98:e78-e80. doi: 10.1136/postgradmedj-2020-138742.
83. Oman Ministry of Economy. Oman Vision: Moving Forward with Confidence. Sultanate of Oman: Ministry of Economy; 2020. https://isfu.gov.om/2040/Vision_Documents_En.pdf [Accessed December 1, 2022].
84. Merrell RC, Doarn CR. Sustainable development goals and telemedicine. Telemed J E Health. 2016;22(10):787-8. doi: 10.1089/tmj.2016.29013.rcm.
85. Palozzi G, Schettini I, Chirico A. Enhancing the sustainable goal of access to healthcare: Findings from a literature review on telemedicine employment in rural areas. Sustainability. 2020;12(8):3318. doi: 10.3390/su12083318.
86. Jafarzadeh F, Rahmani F, Azadmehr F, Falaki M, Nazari M. Different applications of telemedicine assessing the challenges, barriers, and opportunities a narrative review. J Family Med Prim Care. 2022;11:879-86. doi: 10.4103/jfmpc.jfmpc_1638_21.
87. Krupinski E, Nypaver M, Poropatich R, Ellis D, Safwat R, Sapci H. Clinical applications in telemedicine/telehealth. In: Bashshur RL, Mandil SH, Shannon GW, eds. State-of-the-Art Telemedicine/Telehealth Symposium: An International Perspective. New York, NY: Mary Ann Liebert; 2002:13-34. https://www.researchgate.net/publication/235042598_State_of_the_Art_TelemedicineTelehealth [Accessed March 9, 2022].
88. Beauchamp TL and Childress JF. Principles of Biomedical Ethics. 7th ed. New York, USA: Oxford University Press; 2013.
89. Garland T Jr. The scientific method as an ongoing process. Cited by: Dai L, Boos M. How Much Sharing Is Enough? Cognitive Patterns in Building Interdisciplinary Collaborations: Interdisciplinary Approaches and Case Studies. In: Fu X, Jar-Der L, Boos M, eds. Social Network Analysis. Boca Raton, FL: CRC Press; 2017:41-70. doi: 10.1201/9781315369594.
90 Lexis L, Julien B. Researching science using the scientific method. In: Lexis L, Julien B, eds. How to do science: A guide to researching human physiology. Melbourne, Australia: La Trobe University; 2017:16-29. doi: 10.26826/1001.
91. Walton D. Abductive Reasoning. Alabama, USA: The University of Alabama Press; 2005. https://www.academia.edu/39530375/Douglas_Walton_Abductive_Reasoning [Accessed December 1, 2022].
92. Nunez-Moscoso J. Abductive reasoning: A contribution to knowledge creation in

education. Cad Pesqui. 2019;49(171)308-29. doi. 10.1590/198053145255.

93. Flach PA, Kakas AC. Abductive and Inductive Reasoning: Background and Issues. In: Flach PA, Kakas AC, eds. Abduction and Induction. Dordrecht, Netherlands: Springer; 2000:1-27. doi: 10.1007/978-94-017-0606-3_1.

94. Copi IM, Cohen C, McMahon K. Science and Hypothesis. In: Copi IM, Cohen C, McMahon K, eds. Introduction to Logic. 14th ed. London, UK: Pearson Education Limited; 2014:559-585. https://dorshon.com/wp-content/uploads/2018/03/Introduction-to-Logic.pdf [Accessed December 1, 2022].