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REVIEW ARTICLE

EFFECTS OF TELEHEALTH BY ALLIED HEALTH PROFESSIONALS AND NURSES IN RURAL AND REMOTE AREAS: A SYSTEMATIC REVIEW AND META-ANALYSIS

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Objective: **To describe telehealth interventions delivered by allied health professionals and nurses in rural and remote areas, and to compare the effects of telehealth interventions with standard face-to-face interventions.**

Data sources: **CINAHL, Embase, PsycINFO and PubMed databases were searched. The content of relevant journals and published articles were also searched.**

Study selection: **Studies examining the effectiveness of allied health and nursing telehealth interventions for rural and remote populations were included in descriptive analyses. Studies comparing telehealth intervention with standard face-to-face interventions grouped by type of intervention approach were used to examine between-groups effect sizes.**

Data extraction: **Methodological quality of studies was rated using the QualSyst critical appraisal tool and the National Health and Medical Research Council (NHMRC) Evidence Hierarchy levels.**

Data synthesis: **After quality ratings, 43 studies were included. A majority of studies had strong methodological quality. The disciplines of psychology and nursing were represented most frequently, as were studies using a cognitive intervention approach. Meta-analysis results slightly favoured telehealth interventions compared with face-to-face interventions, but did not show significant differences. Interventions using a combined physical and cognitive approach appeared to be more effective.**

Conclusion: **Telehealth services may be as effective as face-to-face interventions, which is encouraging given the potential benefits of telehealth in rural and remote areas with regards to healthcare access and time and cost savings.**

Key words: telemedicine; video conferencing; delivery of healthcare; treatment outcome; outcome assessment; rural population; rural health; remote consultation.

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Individuals who live in rural and remote areas worldwide experience poorer health outcomes compared with those living in metropolitan areas (1–6). These health disparities can be attributed to an array of complex factors, including lower socioeconomic status, shortage of healthcare providers, or reduced ability to access healthcare services, reluctance to seek required healthcare services, and increased exposure to healthcare risk factors (1, 7, 8). Therefore, health interventions and therapy outcomes in rural and remote areas may differ from those in metropolitan areas, and are likely to include target populations with distinct subject characteristics. Furthermore, as allied health services, such as therapy services, may be particularly difficult to access in rural and remote locations (9, 10), comparisons of health outcomes are needed between telehealth and face-to-face interventions.

Allied health services are health services provided by professionals who: (*i*) have university degrees in health or applied sciences (e.g. physiotherapists, occupational therapists, dieticians, speech and language pathologists, and psychologists); (*ii*) use an evidence-based paradigm that draws on an internationally recognized body of knowledge to protect, restore and maintain optimal physical, sensory, psychological, cognitive, social and cultural function; and (*iii*) have a direct role in patient care with application to broader public health outcomes (11). Traditionally, allied health services in rural and remote areas have relied heavily on non-resident visiting professionals (12) or the patients' capacity to travel long distances to access services (9, 10). In the last decade, telehealth has emerged as a means of providing greater access to allied health services in rural and remote locations (3, 4, 9, 13).

Telehealth involves the use of technology for communication between the patient and their healthcare provider (14, 15). Telehealth technologies include a range of telephone, video-conference and internet-based applications that allow consultations, assessments and intervention services to be provided over a distance (16, 17). Within the field of medical and allied health interventions, there is an expectation that interventions are evaluated according to current standards of evidence-based practice (18). While a number of studies exist examining the efficacy of telehealth for improving patient outcomes (19), systematic reviews are important in further examining the evidence for use

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of telehealth in the provision of allied health services in rural and remote locations (13, 20).

Previous reviews have examined the effectiveness of telehealth for the provision of rural and remote health services in general (4, 21); however, few systematic reviews have been published regarding the use of telehealth services provided by allied health professionals and nursing. Most existing reviews have been limited to: (*i*) reviews describing the application of telehealth interventions (22); (*ii*) reviews focusing on the effects of telehealth in selected clinical populations or areas of health service delivery (e.g. stroke care, voice and swallowing disorders, anxiety or depression) (13, 23–26); or (*iii*) reviews focusing on one particular discipline that excluded interdisciplinary allied health and nursing interventions (21, 27).

Most previous systematic reviews have been within the discipline of psychology (25, 28, 29), while a small number of reviews have reported on telehealth for specific aspects of speech pathology practise (21, 27). There are no identified reviews specifically targeting provision of physiotherapy or nursing interventions through telehealth, although 2 studies have examined interventions that may include these disciplines along with other disciplines (26, 30). No review could be identified that aimed specifically at occupational therapy interventions, although a recent scoping review described allied health research in eHealth in general, but only included Australian studies (31).

In addition, many previous systematic reviews have not reviewed the methodological quality of all the studies included in the review (20). This is important, as a previous systematic review investigating the methodological quality of studies examining internet-based methods of providing mental health interventions (32) reported a lack of studies with robust methodological quality. Of the 122 studies included in this review, only 25% were reported as being rated with strong methodological quality, 36% as having moderate quality, and 39% as having weak quality. Lack of participant and investigator blinding, participant selection bias, and high participant drop-out due to low intervention adherence were reported to be the most common challenges, with authors recommending that improvements are needed regarding the overall quality and rigour of trials. In summary, although previous reviews have been published, the information available needs to be expanded to provide evidence on the effectiveness of allied health and nursing interventions provided by telehealth to patients living in remote and rural areas.

Study aim

The aim of this study is to provide a systematic review of literature describing the effectiveness of telehealth interventions delivered by allied health professionals and nursing in rural and remote areas. Studies conducted in metropolitan areas were considered beyond the scope of this review. This review will focus on single disciplinary as well as inter-professional or trans-disciplinary approaches. The methodological quality of studies examining the effectiveness of telehealth interventions will also be described. Where possible, the effects of the telehealth interventions will be compared with the effects of standard face-to-face treatment, using a meta-analysis.

METHODS

The methodology and reporting on this systematic review was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement and checklist. The PRISMA statement and checklist is designed to guide researchers in the essential and transparent reporting of systematic reviews (33, 34).

Eligibility criteria

To be eligible for inclusion in this systematic review, articles were required to describe a telehealth intervention as applied by allied health professionals: for example, physiotherapists, occupational therapists, speech pathologists, psychologists, social workers, dieticians, as well as nurses. Only synchronous service delivery (i.e. services that required professionals and participants to be online at the same time) was included in this review; all asynchronous services delivery (i.e. services delivered by web, email or message boards) were excluded. At least 50% of the clinicians involved in the intervention were required to be allied health professionals or nurses. Studies performed by medical doctors only were therefore not considered. Both single-disciplinary interventions as well as inter-professional or trans-disciplinary approaches are described in this review. Interventions conducted by phone only were not included. Pharmacological studies, cost-effectiveness studies and self-education or professional education using telehealth were outside the scope of this review. Study locations were restricted to rural and remote areas. If more than 50% of the participants were not located in rural and remote areas and data for the metropolitan vs rural and remote subgroups were not separated, studies were excluded. Only articles describing both pre- and post-intervention measurements in target populations of at least 5 participants were included. This review incorporated original articles. Conference abstracts, reviews, case reports, student dissertations and editorials were excluded. All studies had to be published in English. Articles had to meet all eligibility criteria to be included in the systematic review.

Data sources and search strategies

A literature search was performed in 4 different electronic databases: CINAHL, Embase, PsycINFO and PubMed. All publication dates up to 31 July 2016 were included. To identify the most recent publications, subject headings were supplemented by free-text words using a publication limit of 1 year earlier. Next, content lists of journals on telehealth were screened for further publications and all reference lists of the included articles were searched for additional literature. The search terms are listed in Table I.

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Table I. Search strategies per literature database

	Database and search terms	Limitations	Number of records
Subject headings	*CINAHL*: ((MH "Telehealth") OR (MH "Telemedicine") OR (MH "Telenursing") OR (MH "Videoconferencing") OR (MH "Teleconferencing")) AND ((MH "Outcome Assessment") OR (MH "Treatment Outcomes") OR (MH "Outcomes (Health Care)") OR (MH "Nursing Outcomes") OR (MH "Outcomes Research")) AND ((MH "Rural Health Centers") OR (MH "Hospitals, Rural") OR (MH "Rural Population") OR (MH "Rural Health Services") OR (MH "Australian Rural Nurses and Midwives") OR (MH "Rural Health Nursing") OR (MH "Rural Areas") OR (MH "Services for Australian Rural and Remote Allied Health") OR (MH "Rural Health") OR (MH "Rural Health Personnel"))	English language	59
	Embase: (teleconsultation/OR telediagnosis/OR telehealth/OR telemedicine/OR telemonitoring/OR teletherapy/OR Telenursing/OR videoconferencing/OR teleconference/OR health care delivery/) AND (treatment outcome/OR outcome assessment/OR health services research/OR therapy effect/) AND (rural health care/OR rural area/OR rural population/OR rural health nursing/OR rural hygiene/)	English language	546
	PsycINFO: ((DE "Telemedicine") OR (DE "Online Therapy")) AND (DE "Treatment Outcomes") AND((DE "Rural Environments")	NA	6
	PubMed: ("Telemedicine"[Mesh] OR "Telenursing"[Mesh] OR "Videoconferencing"[Mesh] OR "Delivery of Health Care"[Mesh]) AND ("Outcome Assessment (Health Care)"[Mesh] OR "Outcome and Process Assessment (Health Care)"[Mesh] OR "Patient Outcome Assessment"[Mesh] OR "Treatment Outcome"[Mesh]) AND ("Rural Population"[Mesh] OR "Rural Health Services"[Mesh] OR "Rural Health"[Mesh] OR "Remote Consultation"[Mesh] OR "Rural Nursing"[Mesh])	English language	1,159
Free-text words	*CINAHL*: (telehealth OR tele-health OR telemedicine OR tele-medicine OR telerehab* OR tele-rehab* OR telediagnos* OR tele-diagnos* OR teletreat* OR tele-treat OR teletherap* OR tele-therap* OR telemonitoring OR tele-monitoring OR teleintervention OR tele-intervention OR teletreatment OR tele-treatment OR telepractice OR tele-practice OR videoconference* OR video-conferenc* OR teleconference* OR tele-conference* OR webbased OR web-based OR internet-based OR (technology AND mediated) OR technology-mediated) AND (effect* OR outcome* OR efficienc* OR efficac*) AND (Rural* OR remote* OR Regional*)	Published date: 20150601–20160731	40
	Embase: As per CINAHL Free Text	Last year	640
	PsycINFO: As per CINAHL Free Text	As per CINAHL free text	109
	PubMed: As per CINAHL Free Text	As per CINAHL free text	567

All records were reviewed by 2 independent abstract reviewers. Differences of opinion about eligibility of articles were settled by consensus. A flowchart of the selection process according to PRISMA (33) is shown in Fig. 1.

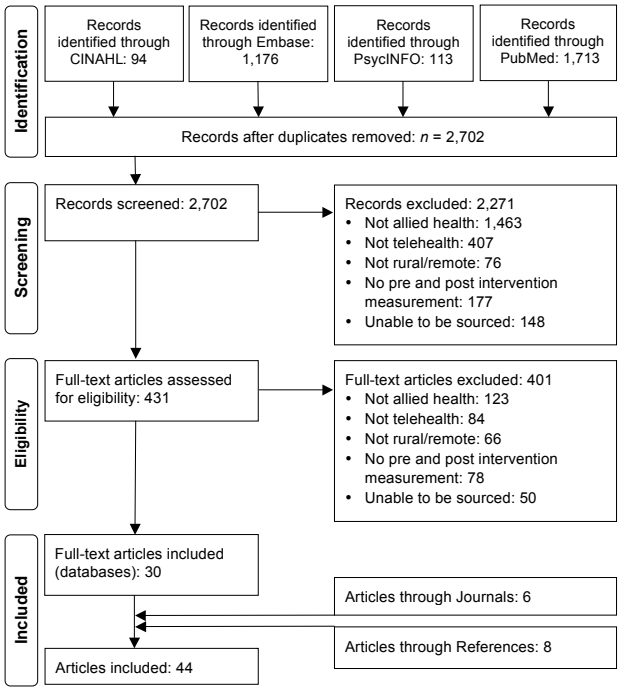


Fig. 1. Flow diagram of the review process according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Adapted from Moher et al. (34).

Methodological quality and level of evidence

The Qualsyst critical appraisal tool by Kmet et al. (35) and the National Health and Medical Research Council (NHMRC) Evidence Hierarchy levels of evidence (36) were used to assess the methodological quality of the included studies. The Qualsyst tool provides a systematic, reproducible and quantitative means of assessing the methodological quality of research over a broad range of study designs. A Qualsyst score >80% was interpreted as strong quality, 60–79% as good quality, 50–59% as adequate quality, and < 50% as poor methodological quality. Studies with poor methodological quality were excluded from further analysis.

Data extraction

After assessment of methodological quality, data from all remaining articles were extracted under the following categories: purpose of the study, intervention, allied health professional(s) and nursing, study population(s), outcome measure(s) and authors' main conclusions or key findings. Information on therapeutic approaches was categorized in physical, cognitive and/or social emotional approach in line with the authors' primary aims. Physical approaches target physical symptoms, whereas social emotional approaches target factors associated with quality of life. Cognitive approaches include behavioural and speech and language interventions.

Meta-analysis

Data were extracted from the included studies to enable a comparison of the effect sizes for the difference in outcome measurements between groups post-intervention for groups participating in a telehealth intervention and standard face-to-face treatment controls; a between-groups comparison was conducted for the potentially confounding variables of type of intervention approaches (i.e. cognitive, physical, social emotio-

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nal or a combination of these approaches). To compare effect sizes, post-means, standard deviations, and sample sizes were extracted or, if appropriate, non-events and sample sizes. When multiple outcome measures of telehealth vs standard treatment were reported, the measure that evaluated the primary aim of the study was extracted for analysis.

Extracted means, standard deviations, and sample sizes or non-events and sample sizes for post-measures were entered into Comprehensive Meta-Analysis, Version 3.070 (37) in order to compare telehealth vs standard face-to-face treatment grouped by type of intervention approach. A random effects model was used to generate effect sizes for between-groups analyses, as the included studies are not likely to have the same true effect, due to the variability in the sampling, intervention characteristics, skills targeted, and outcome measures utilized; thus a random effects model was deemed appropriate. The Hedges g formula for standardized mean difference (SMD) with a 95% confidence interval (95% CI) was used to report effect sizes. Given that a random effects model is based on the assumption that the included studies do not share a common effect size, calculations of heterogeneity were not conducted (38). Using Cohen's *d* convention for interpretation, an effect size ≤ 0.2 reflects negligible difference, between ≥ 0.2 and ≤ 0.49 was considered small; between ≥ 0.5 and ≤ 0.79 was considered moderate; and ≥ 0.8 was considered large (39).

Given that studies that report large and significant treatment effects are more likely to be selected for publication, it is possible that some low-effect or non-significant interventions are missing from the meta-analysis. The presence of publication bias was assessed using classic fail-safe N. The test calculates the number of additional studies that, if added to the analysis, would nullify the measured effect (N). If N is large it can be considered unlikely that there would be so many unpublished low-effect studies and it can be assumed that the meta-analysis is not compromised by publication bias.

RESULTS

Study selection

A total of 2,702 records were retrieved from 4 different electronic databases: CINAHL, Embase, PsycINFO and PubMed. Two independent reviewers screened all records, and assessed 431 full-text articles for eligibility, of which 30 articles met the inclusion criteria. In addition, 6 studies were retrieved from screening journals in telehealth and 8 studies were identified after checking the reference lists of all included articles. A fnal total of 44 articles were included.

Quality assessment

The methodological quality of all 44 studies was assessed using the Qualsyst critical appraisal tool by Kmet et al. (35). The overall quality of the studies ranged from "good" to "poor". One study (40) ranked as "poor" was excluded from this systematic review, leaving 43 included articles. The methodological quality of 5 studies was ranked as "adequate", 13 as "good" and 25 as "strong". Based on the NHMRC Evidence Hierarchy (36), 6 studies were classified as level II evidence, 25 as level III evidence and 12 as level IV evidence. The ratings of all 43 included articles are listed in Table II.

Participants

Of the included studies, 11 (26%) had fewer than 20 participants, 15 (35%) had 20–49 participants, 5 (12%) had 50–99 participants and 12 (28%) had 100 or more participants. The smallest number of participants in a study was 6 (77) as only target populations of at least

Table II. Level of evidence and methodological quality ratings for the 43 included articles using the Qualsyst critical appraisal tool by Kmet et al. (35) and National Health and Medical Research Council (NHMRC) level (36)

Reference	Qualsyst score[1] (%)	Methodology quality	NHMRC Level of Evidence[2]
Ahrendt et al. (41)	21/22 (95)	Good	III–2
Balamurugan et al. (42)	16/28 (57)	Adequate	IV
Bradford et al. (43)	17/22 (77)	Strong	III–2
Carlson et al. (44)	17/26 (65)	Strong	III–2
Ciemins et al. (45)	16/24 (67)	Strong	III–2
Dalleck et al. (46)	20/26 (77)	Strong	III–2
Davis et al. (47)	19/26 (73)	Strong	III–1
Davis et al. (48)	23/24 (96)	Good	III–1
Davis et al. (49)	21/24 (88)	Good	III–1
Eriksson et al. (50)	20/26 (77)	Strong	III–2
Fortney et al. (51)	25/28 (89)	Good	II
Fortney et al. (52)	26/28 (93)	Good	II
Franklin et al. (53)	20/26 (76)	Strong	II
Gardner-Nix et al. (54)	17/26 (65)	Strong	III–2
Germain et al. (55)	18/26 (69)	Strong	III–2
Glueckauf et al. (56)	19/26 (73)	Strong	III–1
Goetter et al. (57)	16/22 (73)	Strong	IV
Gonzalez & Brossart (58)	18/22 (82)	Good	IV
Gray et al. (59)	17/22 (77)	Strong	IV
Griffiths et al. (60)	13/22 (59)	Adequate	IV
Grogan-Johnson et al. (61)	15/28 (54)	Adequate	III–1
Grogan-Johnson et al. (62)	20/26 (77)	Strong	III–2
Hassija & Gray (63)	17/22 (77)	Strong	IV
Heitzman-Powell et al. (64)	15/22 (68)	Strong	IV
Hepburn et al. (65)	20/26 (77)	Strong	III–3
Holmqvist et al. (66)	20/28 (71)	Strong	II
Irby et al. (67)	18/22 (82)	Good	III–2
Jelcic et al. (68)	23/28 (82)	Good	III–1
Juhn et al. (69)	17/26 (65)	Strong	III–2
Kearns et al. (70)	17/24 (71)	Strong	III–2
Levy et al. (71)	16/24 (67)	Strong	IV
Marhefka et al. (72)	21/26 (81)	Good	III–1
McCord et al. (73)	13/22 (59)	Adequate	IV
Paneroni et al. (74)	20/26 (77)	Strong	III–2
Richter et al. (75)	20/28 (71)	Strong	II
Shepherd et al. (76)	18/22 (82)	Good	IV
Simpson et al. (77)	14/22 (64)	Strong	III–3
Staton-Tindall et al. (78)	21/28 (75)	Strong	III–1
Tan et al. (79)	21/22 (95)	Good	IV
Taylor et al. (80)	17/22 (77)	Strong	IV
Tokuda et al. (81)	20/24 (83)	Good	III–2
Wood et al. (82)	18/22 (82)	Good	IV
Ziemba et al. (83)	14/26 (54)	Adequate	II

[1]Methodological quality: strong >80%; good 60–79%; adequate 50–59%; poor <50%.
[2]NHRMC hierarchy: Level 1 Systematic reviews; Level II Randomized control trials; Level III–1 Pseudo-randomized control trials; Level III–2 Comparative studies with concurrent controls and allocation not randomized (cohort studies), case control studies, or interrupted time series with a control group; Level III–3 Comparative studies with historical control, 2 or more single-arm studies, or interrupted time series without a control group; Level IV Case series.

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5 participants were included in this review, whilst the largest number of participants was 566 (75). Children were the target population in 10 (23%) studies, and adults were the target in 33 (76%) studies; with 1 (2%) study having a population of both adults and children. Close to half (51%) of the 43 included studies were conducted in the USA, 6 (14%) in Canada, 4 (9%) in Australia, 2 (5%) in Italy, 1 (2%) in the UK, and 1 (2%) in Sweden. In 7 (16%) studies, the nationality of the study site or participants was not clearly reported, although the authors indicated that the study was conducted in a rural area. A detailed summary of the 43 included studies is given in Table SI[1].

Research designs

Of the 43 included studies, 14 (33%) describe one group of participants (i.e. case-series) and 29 (67%) used a design where 2 or more groups were compared, including one (77) where participants acted as their own controls (interrupted time series). Of the 29 studies comparing 2 or more groups, 22 compared a telehealth intervention with a face-to-face or "usual care" intervention, 4 with a control group not receiving intervention (waiting list) (41, 65, 72, 78), one with a web-based intervention (66) and 2 with an intervention by phone (49, 75); 3 studies had 3 comparison groups including one or more face-to-face intervention groups (54, 56, 68).

Interventions

Information on therapeutic interventions was categorized in physical, cognitive and/or social emotional approach. Thirty studies used only a single intervention approach (i.e. physical, cognitive or social emotional) in their design, whereas 13 studies used a combination of 2 or more intervention approaches. Of the 30 studies that used only a single intervention, a cognitive approach was used in 27 (90%) and the other 3 (10%) studies used a physical approach only. No studies solely used a social emotional approach. A minority of the studies included in this review (12; 28%) included long-term outcome measures in addition to outcome measures at the completion of intervention.

Allied health professions and nursing

The interventions were delivered by a range of allied health professionals and nurses, including: psychologists/psychology students (51%), nurses/nurse practitioners (26%), social workers (14%), dieticians (14%), physiotherapists/physical therapists (14%), pharmacists (9%), speech pathologists (7%) and exercise physiologists (7%). No studies included occupational therapists, whereas medical doctors were involved in the service provision in 8 studies (19%). In 7 of the studies (16%), the health profession was identified only in general terms, such as "clinician" or "counsellor".

Not all interventions delivered by allied health professionals and nursing, are considered rehabilitation. However, when using the definition of rehabilitation as formulated by the World Health Organization (WHO), most interventions included in this review fall within the scope of rehabilitation: "A set of measures that assist individuals who experience, or are likely to experience, disability to achieve and maintain optimal functioning in interaction with their environments". Therapy measures may include training, excises, and compensatory strategies, education, support and counselling, modifications to the environment, and provision of resources and assistive technology (84).

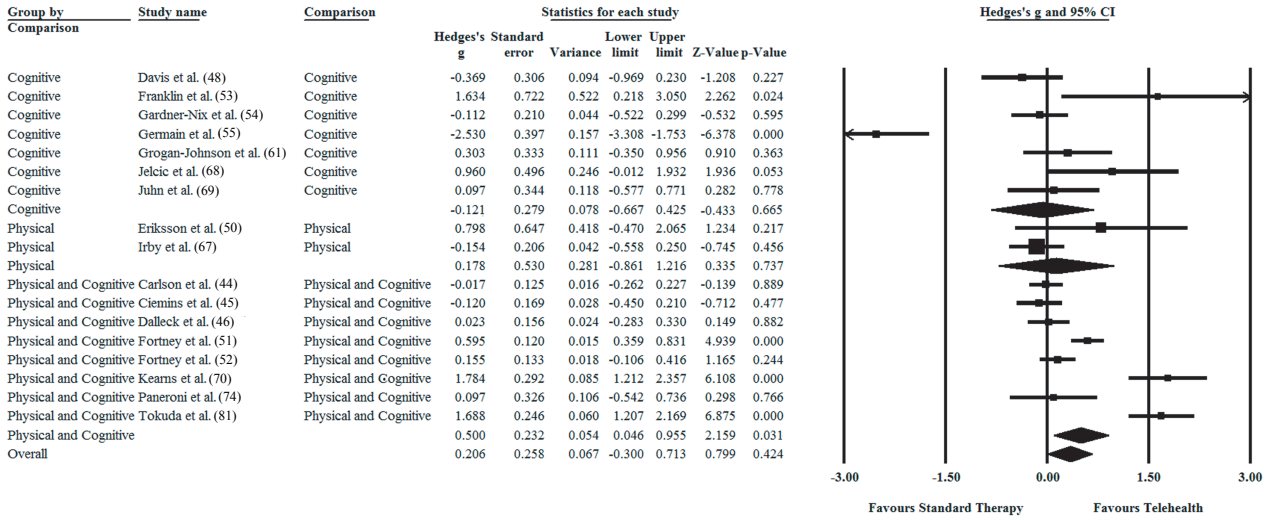
Meta-analysis: effects of interventions

Seventeen of the 43 studies were included in the meta-analysis. Twenty-six studies were excluded from the meta-analysis for the following reasons: 14 did not have control groups; 4 (41, 65, 72, 78) did not use any intervention (rather than standard face-to-face treatment) as a comparison group; 2 (49, 75) used a telephone intervention as a comparison group; 1 (66) used a web-based intervention as the comparison group; 1 (43) included standard face-to-face treatment in the telehealth group; and 4 (47, 56, 62, 83) did not report data required for calculations.

Risk of bias in studies. The fail-safe N-value calculated during meta-analysis was 75, meaning that as many nil effect studies would need to have been conducted and not published in order to negate the observed effect of the included studies. Such a large N-value indicates a low risk of publication bias.

Comparing the effects of telehealth vs standard face-to-face interventions on post-intervention outcomes grouped by type of intervention approach. There were no significant differences for interventions using a cognitive approach between telehealth and standard treatment, with effects slightly favouring standard treatment ($z(6) = -0.433$, $p = 0.665$, Hedge's $g = -0.121$, 95% confidence interval (95% CI) = –0.667–0.425). Similarly, there were no significant differences for interventions adopting a physical approach between telehealth and standard treatment ($z(1) = 0.335$, $p = 0.737$, Hedge's $g = 0.178$, 95% CI = –0.861–1.216). Conversely, there were significant differences for interventions using a combination of cognitive and physical approaches between telehealth and standard treatment, with a

[1]http://www.medicaljournals.se/jrm/content/?doi=10.2340/16501977-2297



Group by Comparison	Study name	Comparison	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Cognitive	Davis et al. (48)	Cognitive	-0.369	0.306	0.094	-0.969	0.230	-1.208	0.227
Cognitive	Franklin et al. (53)	Cognitive	1.634	0.722	0.522	0.218	3.050	2.262	0.024
Cognitive	Gardner-Nix et al. (54)	Cognitive	-0.112	0.210	0.044	-0.522	0.299	-0.532	0.595
Cognitive	Germain et al. (55)	Cognitive	-2.530	0.397	0.157	-3.308	-1.753	-6.378	0.000
Cognitive	Grogan-Johnson et al. (61)	Cognitive	0.303	0.333	0.111	-0.350	0.956	0.910	0.363
Cognitive	Jelcic et al. (68)	Cognitive	0.960	0.496	0.246	-0.012	1.932	1.936	0.053
Cognitive	Juhn et al. (69)	Cognitive	0.097	0.344	0.118	-0.577	0.771	0.282	0.778
Cognitive			-0.121	0.279	0.078	-0.667	0.425	-0.433	0.665
Physical	Eriksson et al. (50)	Physical	0.798	0.647	0.418	-0.470	2.065	1.234	0.217
Physical	Irby et al. (67)	Physical	-0.154	0.206	0.042	-0.558	0.250	-0.745	0.456
Physical			0.178	0.530	0.281	-0.861	1.216	0.335	0.737
Physical and Cognitive	Carlson et al. (44)	Physical and Cognitive	-0.017	0.125	0.016	-0.262	0.227	-0.139	0.889
Physical and Cognitive	Ciemins et al. (45)	Physical and Cognitive	-0.120	0.169	0.028	-0.450	0.210	-0.712	0.477
Physical and Cognitive	Dalleck et al. (46)	Physical and Cognitive	0.023	0.156	0.024	-0.283	0.330	0.149	0.882
Physical and Cognitive	Fortney et al. (51)	Physical and Cognitive	0.595	0.120	0.015	0.359	0.831	4.939	0.000
Physical and Cognitive	Fortney et al. (52)	Physical and Cognitive	0.155	0.133	0.018	-0.106	0.416	1.165	0.244
Physical and Cognitive	Kearns et al. (70)	Physical and Cognitive	1.784	0.292	0.085	1.212	2.357	6.108	0.000
Physical and Cognitive	Paneroni et al. (74)	Physical and Cognitive	0.097	0.326	0.106	-0.542	0.736	0.298	0.766
Physical and Cognitive	Tokuda et al. (81)	Physical and Cognitive	1.688	0.246	0.060	1.207	2.169	6.875	0.000
Physical and Cognitive			0.500	0.232	0.054	0.046	0.955	2.159	0.031
Overall			0.206	0.258	0.067	-0.300	0.713	0.799	0.424

Fig. 2. Meta-analysis: standard therapy vs telehealth comparing intervention approach subgroups. Hedge's g interpreted as per Cohen's d conventions: ≤0.2 = negligible difference, 0.2–0.49 = small, 0.5–0.79 = moderate, ≥0.8 = large. Physical approaches vs cognitive approaches vs combined physical and cognitive approaches

moderate effect favouring telehealth-delivered interventions ($z(7)=2.159$, $p=0.031$, Hedge's $g=0.500$, 95% CI = 0.046–0.955) (see Fig. 2 for more detail). However, considering the heterogeneity of outcome data between studies, the results of meta-analysis should be interpreted with caution, as bias may have been introduced by pooling of data.

DISCUSSION

This systematic review set out to describe the telehealth interventions delivered by allied health professionals and nurses in rural and remote areas and to conduct a meta-analysis comparing the effects of the telehealth interventions with standard face-to-face treatments; the group comparisons examined were largely comparisons between telehealth and a similar intervention provided face-to-face, with few studies comparing different forms of telehealth interventions. The results of meta-analysis indicate that telehealth is not less effective compared with face-to-face interventions, which is a finding consistent with previous studies (13, 20). Given that people in rural and remote areas have limited or no access to face-to-face interventions, these results support telehealth as an important alternative treatment modality for allied health and nursing services in rural and remote areas. However, it is acknowledged that the interpretation of the meta-analysis results should be interpreted with caution due to heterogeneity in study outcomes and that more research is needed to further examine specific interventions and specific groups. It is possible that intervention effectiveness may depend on a range of factors, such as severity of health conditions, type of interventions provided, and factors associated with the healthcare provider (13, 14, 58). For example, one previous study identified that telehealth interventions may be effective for reducing anxiety, but not depression (25). There is also a need for further research examining the long-term maintenance of treatment effects of telehealth interventions.

Intervention approaches utilizing telehealth show promise, particularly for interventions that adopt a combined physical and cognitive approach. However, the findings consistently show that interventions that are delivered via telehealth are not significantly less effective, regardless of the intervention approach being adopted. The finding that interventions adopting a cognitive approach slightly favour standard face-to-face delivery may be skewed due to one study (55) having a large effect size in favour of standard treatment. A majority of interventions adopting a cognitive approach (5 of 8) favoured mental health interventions being delivered via telehealth. Future studies may strengthen the preliminary results as identified by the current meta-analyses.

Despite the growing evidence that telehealth services may be as effective as face-to-face interventions, a lack of uptake in use of these technologies by allied health professionals and nurses is noted (4, 31). This may be due to a range of factors, such as: lack of clinician skill with technology, lack of availability of resources or high-quality internet services, concerns with insurance and liability, as well as negative attitudes towards telehealth in clinicians, clients and service providers (15, 31). Previous studies have indicated acceptability and service satisfaction from clients who use telehealth (13),

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although other studies have commented on the high participant drop-out noted in telehealth studies generally, which may indicate that telehealth interventions may not be an appropriate choice for all clients (14). Literature identifies that further research is required to determine the cost-effectiveness of telehealth (14, 20) taking into account variability due to type of technology used and location of services (i.e. in home or from a local health centre). Currently available literature suggests that, while initial set-up costs may be a deterrent (5, 85), in rural and remote areas where large geographical distances exist in terms of travel for either clients or clinicians, there is potential for significant long-term cost-savings in terms of service delivery (86).

A majority of the 43 studies included in this review were identified as having "strong" ratings for methodological quality. This is a positive finding in light of a previous study which found a higher proportion of publications rated as "weak" methodological quality (32). In addition, most studies had a group comparison design, with 6 recent studies identified as being randomized controlled trials. Of these 6 studies, 3 showed "good" or "strong" methodological quality and included over 100 participants. This is another promising finding as previous reviews examining telehealth have identified low numbers of studies with experimental designs (4). As all 6 of the randomized controlled trials included in this study were published since 2013, this number may reflect a trend towards studies with higher levels of evidence and study quality in recent times. Despite this improvement, 40% of the studies included in this review had single-group research designs.

When summarizing the type of allied health professionals and nursing involved in this review, psychology was the most frequent discipline in delivering the telehealth interventions, followed by nursing. Only a few studies involved the disciplines of social work, dietetics, physiotherapy and exercise physiology, and speech-pathology and no studies included occupational therapy. This may have been the result of the eligibility criteria used in this study. For example, the exclusion of studies conducted outside of rural and remote populations and validation studies of assessments used in telehealth has restricted the final number of studies included; thus, possibly excluding studies from disciplines that now are under-represented in this current review. However, other recent telehealth reviews have identified that, although many studies are interdisciplinary, there is a trend for telehealth studies to focus predominantly on medical interventions rather than allied health and nursing. Within allied health disciplines, most studies were conducted in psychology, followed by speech pathology, physiotherapy and occupational therapy (4, 31). In this current review, 7 studies did not fully describe or explain the background or qualifications of the allied health professionals involved, using generic terms such as "counsellor" or "community therapist", which creates difficulty in generalizing findings to clinical settings.

With regard to the intervention approaches adopted, of the studies identified in this review, most examined interventions with a cognitive approach, compared with interventions with a physical or socio-emotional approach. This may be in line with the fact that many studies included the discipline of psychology, which may use cognitive and behavioural approaches more frequently (87).

Another reason for differences between allied health professionals and nursing in frequency of using telehealth may be related to the varying type of interventions. Chedid et al. (88) interviewed occupational therapists working in rural New South Wales (NSW), Australia and found telehealth was primarily used for client contact, professional development and professional networking, rather than intervention delivery. The barriers to using telehealth in intervention delivery were categorized as: (*i*) individual (e.g. age, knowledge, and personal preference); (*ii*) workplace (e.g. support, resource availability and training); and (*iii*) community (e.g. infrastructure, therapist perception of clients' acceptance of telehealth intervention). Our finding that telehealth was used more frequently in psychology and nursing compared with speech pathology, physiotherapy and occupational therapy was consistent with international studies on the use of telehealth. Studies found limitations in using telehealth interventions when physical interaction between the client and health professional was required during service delivery (20, 89).

Similar reasoning may account for the preferences of using telehealth in adults over children. Many adult interventions in allied health include a range of cognitive approaches, whereas in paediatric populations, given the age and condition of the patients, interventions are likely to include a range of intervention approaches that require physical contact. Another added complexity when using telehealth interventions for children is being reliant on the parents' capacity to facilitate a child's learning and functioning on behalf of the therapist. Still, there is emerging research into telehealth use in behavioural intervention for children with autism spectrum disorders, where parents are trained to deliver applied behaviour analysis interventions. Therefore, future studies in this area may find an increase in the use of telehealth interventions in paediatric populations in allied health (90, 91).

A wide variety of study designs was used, with most group comparison studies comparing telehealth

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intervention with standard face-to-face intervention control groups or control groups that did not receive the same type of intervention as the telehealth group, or who received no intervention. To more fully compare the effectiveness of interventions, however, previous studies have commented on the need for more studies comparing existing face-to-face interventions with the same intervention delivered via telehealth (29).

Outcome measures also varied widely between the included studies, both between and within the same disciplines, thus introducing the risk of bias when performing meta-analyses. Previous reviews have also commented on the lack of consistency between studies with regards to outcome measures and how results were interpreted (26). Furthermore, almost three-quarters of studies in this review only reported on outcomes at the completion of intervention, without longer term follow-up on client outcomes to assess maintenance of treatment effects. This lack of evidence for long-term outcomes of telehealth interventions is also recognized in previous reviews (20, 29, 87).

A large number of different terms related to telehealth were utilized within the literature, even within similar countries and disciplines. For example, general terms, such as "eHealth", "telepractise", "telecare", "telemedicine" and "telehealth", are used interchangeably, without making clear distinction between the meanings of the terminology used. In addition, terms that are more specific to disciplines or services are used, such as "telerehabilitation", "tele-nursing" and "telepsychology". This inconsistent use of terminology may create potential difficulty in sharing and disseminating telehealth research across countries and disciplines. In this current review all allied health and nursing interventions using technology for patient communication in rural and remote areas were included, except where telephone were the only technology used.

Half of the studies in this review were conducted in the USA, followed by a smaller number of studies conducted in Canada and Australia. A likely explanation is the large geographical distances that exist between metropolitan areas and rural and remote areas in these countries. As such, the impetus for adopting a telehealth approach to service delivery and conducting studies to provide evidence base for its use are greater in these countries. Differences exist as to how geographical boundaries are defined and thus classify areas as "rural or remote" across different countries, which may have influenced how study sites were described in literature and thus included or excluded in this review.

Study limitations

This systematic review sourced studies from 4 databases, which were selected for their likelihood to include studies in this topic area. However, there may be studies that exist outside of the scope of this search. In addition, although every effort was made to source all relevant studies, the wide variation in the telehealth terminology that is used in research studies is a potential limiting factor. Furthermore, as outcome data in the meta-analysis are heterogeneous, findings should be interpreted with caution. As such, meta-analysis was performed comparing intervention outcomes grouped by type of intervention approach only, thus reducing heterogeneity between included studies. It should also be noted that this review included only studies that specified use of telehealth with rural and remote populations; studies in which this eligibility criterion was not met were excluded. No contact was sought with authors to enquire about unreported data.

Future direction for research

Currently, research regarding the efficacy of telehealth interventions support telehealth as being as efficacious as face-to-face interventions; however, further research with studies with high methodological quality, research design and adequate sample sizes are required to improve the evidence. In particular, research is needed to examine the effectiveness of interventions provided by allied health disciplines, such as dietetics, physiotherapy, exercise physiology, physiotherapy, speech pathology and occupational therapy, as well as interventions for specific client groups and conditions. More studies are needed to examine the effectiveness of telehealth with different intervention approaches, such as those that have a social-emotional treatment approach. Furthermore, more research is needed to identify and understand factors hindering the uptake of telehealth in rural and remote areas, such as clinicians' attitudes towards telehealth or lack of availability of adequate resources or telehealth technologies.

There is also an urgent need for research in which standard face-to-face interventions are closely matched with telehealth-delivered interventions, in terms of treatment techniques used, dosage and duration, in order to gain a better understanding of underlying factors that may influence treatment outcomes. In particular, since individuals living in rural and remote areas may have limited access to face-to-face treatment, telehealth may offer allied health services at higher frequencies over a longer period compared with face-to-face interventions. Higher dosage and duration of telehealth interventions may support more optimal client outcomes. Furthermore, as most studies did not provide data on how the interdisciplinary clinical team was managed, future studies should include more detailed descriptions of the location of all clinicians involved and how communication and collaboration between clinical team members

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were organized. Studies comparing different telehealth delivery modes, but addressing the same outcomes, are also needed. With the growing potential of telehealth services in the provision of evidenced-based health services to diverse populations, further research is required to understand the most effective uses for telehealth in relation to quality of healthcare, access to services, cost-savings (5) and identifying strategies to improve the effectiveness and sustainability of telehealth services (4). Furthermore, the effects of telehealth interventions delivered by allied health professionals and nursing in metropolitan areas should be studied and compared with interventions delivered in rural and remote areas.

Conclusion

This systematic review described allied health professionals and nursing interventions delivered by telehealth to rural and remote populations. The studies included in this review were predominantly from the disciplines of psychology or nursing and focused on cognitive intervention, rather than physical, approaches; social-emotional intervention approaches were the least common. Few studies examined long-term outcomes of interventions. Further research is needed to examine the use of telehealth with regards to different intervention approaches, different allied health disciplines and for the achievement of long-term outcomes.

Overall, studies in this review were of strong methodological quality, and indicated that telehealth interventions may be as effective as face-to-face interventions, with a small, but not statistically significant, advantage for telehealth-delivered interventions compared with standard face-to-face-delivered treatments. These are promising findings given the potential benefits of telehealth interventions in rural and remote areas with regards to improving healthcare access and reducing travel time and healthcare costs (4, 31). Nonetheless, given the study heterogeneity in outcomes between interventions, the results of this meta-analysis should be interpreted with caution.

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