Original Article

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Impact of Internet-based interventions on caregiver mental health: meta-analysis

Abstract

Background:
The health of informal caregivers of adults with chronic conditions is increasingly vital since caregivers comprise a large proportion of supportive care to family members living in the community. Due to efficiency and reach, internet-based interventions for informal caregivers have the potential to mitigate the negative mental health outcomes associated with caregiving.

Objectives:
The objective of this systematic review and meta-analysis was to examine the impact of internet-based interventions on caregiver mental health outcomes, as well as the impact of different types of internet-based intervention programs.

Methods:
Medline, EMBASE, CIHAHL, PsychInfo, Cochrane and Ageline were searched from January 1995 to April 2017 for randomized controlled trials or controlled clinical trials that compared internet-based intervention programs with no or minimal internet-based interventions for caregivers of adults with at least one chronic condition. The inclusion criteria were studies that included (1) adult informal caregivers (18 years of age or older) of adults living in the community with a chronic condition; (2) an internet-based intervention program to deliver education, support or monitoring to informal caregivers; and (3) outcome(s) of mental health. Title and abstract, and full-text screening were completed in duplicate. Data were extracted by a single reviewer and verified by a second reviewer, and risk of bias assessments were completed accordingly. Where possible, data for mental health outcomes were meta-analyzed.
Results:

The search yielded 7,923 unique citations of which 290 studies were screened at full-text. Of those, 13 studies met the inclusion criteria; 11 were randomized controlled trials, one study was a controlled clinical trial, and one study comprised both study designs. Beneficial effects of any internet-based intervention program resulted in a mean decrease of 0.48 points (95% CI: -0.75 to -0.22) for stress/distress and a mean decrease of 0.40 points (95% CI: -0.58 to -0.22) for anxiety among caregivers. For studies that examined internet-based information/education and internet-based information/education plus professional psychosocial support, the meta-analysis results showed small to medium effect sizes for the mental health outcomes of depression, stress/distress and anxiety. Some suggestion of a beneficial effect on overall health for the use of information/education plus combined peer and professional support was also shown. Overall, many studies were of poor quality and were rated at high risk of bias.

Conclusions:

The review found evidence for the benefit of internet-based intervention programs on mental health for caregivers of adults living with a chronic condition, particularly for the outcomes of caregiver depression, stress/distress and anxiety. The types of interventions that predominated as efficacious included information/education with or without professional psychological support, and to a lesser extent, with combined peer and psychological support. Further high-quality research is needed to inform the effectiveness of interactive, dynamic, and multi-component internet-based interventions.

Trial Registration: PROSPERO CRD42017075436

KEYWORDS: Internet, support, education, mental health, caregivers, chronic conditions
Introduction

The number of adults living with chronic conditions is increasing globally [1]. Many adults with chronic conditions rely on informal caregivers for support [2]. In Canada, it is reported that more than one-quarter of individuals provided support and care for a friend or family member with a long-term health condition, disability or age-associated issue in a given year [3]. Informal caregivers supporting family members living with chronic conditions and who need assistance with day-to-day functioning play an essential role for families but also for the health care system, as they provide up to 90% of the medical and supportive care needs for their care recipients [4, 5]. While there are many benefits to caregiving for a family member, there are also detrimental emotional and mental health impacts of caregiving which are increasingly being identified and for which practical solutions are urgently needed [3, 6, 7].

Recognizing the negative health impacts of caregiving has led to studies to examine effective interventions to support these individuals. While a variety of interventions have been evaluated for their impact on improving the health of caregivers, with beneficial effects [8], there is great interest in the use of technology as a means of achieving positive outcomes. Eysenbach suggests that efficiency of health care delivery through internet interventions may lead to a reduction in health care costs [9]. Further, internet and e-health may be more accessible to caregivers, especially those in remote and rural areas, resulting in increased equity to access health care [9].

There have been 15 recent systematic or other reviews of technology interventions (e.g., internet, telephone) to support informal caregivers of adults with chronic conditions in the community [10-24]. Among them, there were eight reviews focused on internet-based interventions designed specifically for caregivers [12, 17, 19-24]. All of these reviews provided evidence of improvements in caregivers' health as a result of internet-based programs. A number of the
reviews focused on care recipients having single conditions including dementia [12, 21, 22],
cancer [17, 23], or a broad mix of care recipients including children [19]. Among prior
systematic reviews on dementia, they included studies of variable quality [12] and have led to
weak conclusions due to the heterogeneity of research studies [22].
Including only high-quality study designs, a recent rapid evidence review evaluated the impact of
internet-based interventions on mental health, general caregiving outcomes and general health
for informal caregivers of persons with chronic conditions living in the community [24]. The
strongest findings showed positive effects on mental health outcomes including depressive
symptoms, stress or distress, and anxiety for any type of internet-based intervention [24].
Specific components of internet-based interventions on caregiver-specific outcomes including
mental health were also recently reviewed with results showing that efficacious internet-based
interventions were those that included interactive components, peer or professional support, and
behaviour change [20]. Limitations of these studies were that a meta-analysis was not performed
to quantify the magnitude of effect across studies and determine clinical relevance therefore the
impact of internet-based interventions on mental health outcomes of caregivers is still not clear.
The primary objective of this study was to conduct a systematic review and meta-analysis to
assess the impact of internet-based interventions, of any type, compared to no or minimal
internet-based interventions on the mental health of informal caregivers of adults with at least
one chronic condition living in the community. The secondary objective was to examine whether
specific types of internet-based interventions had a beneficial effect on caregiver mental health.

Methods
This systematic review and meta-analysis was conducted following the preferred reporting items
for systematic reviews and meta-analysis (PRISMA) guidelines [25].
Population

The population of interest included informal caregivers, aged 18 years and older, who were currently providing caregiving support to adults (≥ 18 years) living in the community with at least one chronic condition (i.e., ‘care recipient’).

Interventions

Studies selected for this systematic review included those that examined any internet-based modality to deliver an intervention, which could include either a single component program or multi-modal program to informal caregivers. An internet-based program was defined as any web-based series of instructions, options, plans, lessons, modules or curriculum.

Outcomes

The primary outcome of interest for this systematic review was mental health, specifically including depressive symptoms, stress/distress, anxiety, coping, overall mental health, quality of life and overall health.

Study Design

Studies were included according to the following inclusion criteria (1) study designs were a randomized controlled trial (RCT) or a controlled clinical trial (CCT); (2) studies examined any internet-based intervention program for informal caregivers of older adults having at least one chronic condition living in the community; (3) studies were published between January 1, 1995 and April 19, 2017; (4) studies were published in English; (5) studies reported on at least one mental health outcome of interest; (6) studies used any measurement tool to examine the mental health outcomes of interest; (7) studies in which the comparator or control group received none or minimal internet-based intervention (e.g., links to a website for information). There were no restrictions on the nature of chronic conditions of care recipients. Exclusion criteria included all
other types of study designs (i.e., observational studies, case reports), studies that compared
different types of program- or module-specific internet-based interventions, grey or unpublished
literature, conference abstracts, and letters or editorials. All study protocols without preliminary
results for data extraction were also excluded.

**Search Strategy**

A peer-reviewed search strategy was developed by two research librarians at McMaster
University. EMBASE, Medline, PsychInfo, CINAHL, Cochrane and Ageline were searched for
studies published between January 1, 1995 and April 19, 2017. Reference lists of systematic
reviews were searched for relevant studies not captured by the initial search. Results were de-
duplicated and the citations were uploaded to a secure internet-based platform. More detailed
information about the search terms is available in Multimedia Appendix 1.

**Selection of Studies**

Two reviewers independently selected studies for possible inclusion based on title and abstract
review. Studies meeting inclusion criteria by either reviewer then underwent full-text review.
Any disagreements were discussed between reviewers, and a third party was involved to help
reach consensus, as necessary.

**Data Extraction and Quality Assessment**

Full data extraction, including characteristics of included studies, was completed by one reviewer
and verified by a second reviewer. Risk of bias found in individual studies was assessed by one
reviewer and verified by a second reviewer. Risk of bias was assessed using the Cochrane risk of
bias framework [26], which evaluates the level of bias for sequence generation, allocation
concealment, blinding, completeness of outcome assessment, selective reporting, and other
biases. The quality of the clinical evidence was critically appraised by one reviewer and verified
by a second reviewer using the Grading of Recommendations Assessment, Development, and Evaluation system (GRADE), which evaluates the risk for bias, inconsistency, indirectness, and imprecision for each outcome [27]. Disagreements were resolved through consensus between the two reviewers.

Data analysis

A meta-analysis was used to combine the results across studies by outcome using the published data from included studies. To perform the meta-analysis, we used immediate post-treatment data (mean, standard deviation) for continuous outcomes such as depression, stress or distress, anxiety, coping, overall mental health, quality of life and overall health. We utilized intention-to-treat (ITT) outcome data where possible, however, if no ITT data were reported we used study completer’s outcome data.

The DerSimonian and Laird random effects models with inverse variance (IV) method were used to generate the summary measures of effect in the form of standardized mean difference (SMD) [28]. The SMD accounts for similar outcomes measured using different assessment tools (e.g., depressive symptoms were assessed using different outcome measures such as Center for Epidemiologic Studies Depression Scale and Beck Depression Inventory) [29]. In this situation, it was necessary to standardize the results of the studies to a uniform scale before they could be combined in a quantitative synthesis. SMDs were calculated using change from baseline data for intervention and control groups for each study with relevant outcome data. For each outcome, data from the corresponding study was used to calculate the mean difference between pre-treatment (baseline) and post-treatment (final or end-point) values along with its standard deviation for both intervention and control groups. In studies where the standard deviation (SD) was not reported, we calculated the SD from the reported standard error (SE) of the mean, 95%
confidence intervals (CIs) and p-values or z-values using equations provided in Chapter 7 and Chapter 9 of the Cochrane Handbook for Systematic Reviews of Interventions [30, 31]. The SMD is interpreted based on its magnitude according to Cohen’s d recommended thresholds (~0.2 = small effect; ~0.5 = medium effect; ~0.8 = large effect) [32].

The primary meta-analysis was to examine any type of internet-based intervention program by mental health outcome. Subsequently, the secondary meta-analysis was to examine the effects of specific types of internet-based intervention programs on mental health outcomes. Based on our previous work [24], intervention types were categorized accordingly: (1) internet-based information or education only; (2) internet-based information or education plus peer psychosocial support (PPS); (c) internet-based information or education plus professional psychosocial support (PFPS); (d) internet-based information or education plus combined peer and professional psychosocial support; and (e) internet-based intervention with telephone monitoring along with combined peer and professional psychosocial support.

Statistical heterogeneity of combined studies was examined using standard methods. The $I^2$ statistic was used to quantify the magnitude of statistical heterogeneity between studies where $I^2$ of 30% to 60% represents moderate and $I^2$ of >60% represents substantial heterogeneity [33]. A p-value of < 0.1 was used as a guide to indicate where statistically significant heterogeneity may exist, upon which a closer examination of study differences was performed. All analyses were performed using Review Manager (RevMan Version 5.3) [34], STATA (version 14) [35] and GRADEpro Guideline Development Tool software packages [36].
Results

Study Selection

The search resulted in 7,923 unique citations which were screened independently by two project staff. At title and abstract screening, we excluded 7,633 studies, leaving 290 studies to be screened at full-text. Of those 290 studies, we identified 13 studies (14 papers) that met the inclusion criteria for this systematic review. References lists of the on-topic systematic reviews and included studies were searched but no additional studies were added (Figure 1).

Figure 1: Flow Diagram for Study Selection of Internet-based Interventions on Mental Health Outcomes for Caregivers
Description of Studies

The study design and caregiver and care recipient characteristics of the included studies are shown in Table 1 (See Multimedia Appendix 2 for Detailed Characteristics of Included Studies). From among the 13 included studies, there were 11 studies that were RCTs [37-48], one study that was a CCT [49], and one study that combined both RCT and CCT designs [50]. Five of the included RCTs were conducted in Europe [37-41] and five RCTs were conducted in the USA [44-46, 48], of which one RCT reported relevant outcomes across two papers [42, 43]. There was one RCT conducted in Canada [47]. The CCT was conducted across the USA, Puerto Rico and Mexico [49] and the combined CCT and RCT was conducted across three European countries [50].

In regard to the type of chronic conditions among care recipients, 9 studies included patients with some form of dementia [37-41, 44, 48-50]. Cardiovascular health disorders were represented in three studies, of which two studies included only stroke survivors [45, 46] and the other study included a mixed stroke population of stroke-related dementia combined with patients having Alzheimer’s disease and Parkinson’s disease [47]. One study was based on non-small cell lung cancer care recipients [42, 43]. All included studies were considered small in sample size (≤150 subjects per arm) and had a short length of study follow-up (< 6 months). One study included a slightly longer study follow-up time period of one-year [46]. A majority of studies included informal caregivers of 50+ years of age (Range: 53.8 to 67.8 years) [38-47, 50], except in one study that included family caregivers who were also partially working and therefore reported a slightly lower age [48]. Two studies did not provide information on the average age of caregivers [37, 49]. More than half of the caregivers were female in all of the included studies (Range: 56.3% to 100%).
<table>
<thead>
<tr>
<th>Author, Year, Country</th>
<th>Study Type</th>
<th>Sample Size</th>
<th>Length of Study Follow-Up</th>
<th>Caregiver &amp; Care Recipient Characteristics</th>
<th>Mean CG Age (years)</th>
<th>% CG Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hattink, 2016 [50] Germany, Belgium</td>
<td>RCT, CCT</td>
<td>17/15</td>
<td>NR</td>
<td>Caregiver: informal carers, with house specifications for the internet system. Care recipient: mild cognitive impairment or dementia.</td>
<td>66.0</td>
<td>56.3</td>
</tr>
<tr>
<td>Nunez-Naveira, 2016 [37] Denmark, Poland, Spain</td>
<td>RCT</td>
<td>36/41</td>
<td>3 mo.</td>
<td>Caregiver: informal carers, caring for a person with dementia for 6+ weeks, experiencing burden and at risk for depression, and without cognitive impairment, being illiterate, severe hearing, visual or motor limitations. Care recipient: dementia.</td>
<td>NR</td>
<td>63.9</td>
</tr>
<tr>
<td>Blom, 2015 [38] Netherlands</td>
<td>RCT</td>
<td>149/96</td>
<td>5-6 mo.</td>
<td>Caregivers: family carers, presence of symptoms of depression or anxiety or feelings of burden. Care recipient: dementia.</td>
<td>61.2</td>
<td>69.4</td>
</tr>
<tr>
<td>Cristancho-Lacroix, 2015 [39] France</td>
<td>RCT</td>
<td>25/24</td>
<td>3 mo.</td>
<td>Caregivers: informal carers, 18+ years of age, French speaking, score 12+ on the PSS-14, spend 4+ hours with the care recipient. Care recipient: AD.</td>
<td>61.6</td>
<td>65.5</td>
</tr>
<tr>
<td>Hattink, 2015 [40] Netherlands</td>
<td>RCT</td>
<td>27/32</td>
<td>2-4 mo.</td>
<td>Caregivers: informal, volunteer, or professional caregivers of persons with dementia. Care recipient: dementia.</td>
<td>53.8</td>
<td>71.5</td>
</tr>
<tr>
<td>Torkamani, 2014 [41] UK, Spain, Greece</td>
<td>RCT</td>
<td>30/30</td>
<td>6 mo.</td>
<td>Caregivers: full-time caregiver. Care recipients: dementia with or without PD, some independence and moderate to mild cognitive impairment.</td>
<td>60.7</td>
<td>NR</td>
</tr>
<tr>
<td>DuBenske, 2014 [42]; Namkoong, 2012 [43] USA</td>
<td>RCT</td>
<td>144/141</td>
<td>6 mo.</td>
<td>Caregivers: informal carers, adults (18+ years) who provides instrumental, emotional, financial support. Care recipient: English-speaking adult patients with non-small cell lung cancer of stage IIIA or higher; life expectancy of 4+ months.</td>
<td>55.6</td>
<td>68.3</td>
</tr>
<tr>
<td>Kajiyama, 2013 [44]</td>
<td>RCT</td>
<td>75/75</td>
<td>3 mo.</td>
<td>Caregivers: family carers, 21+ years of age, caring for persons with dementia,</td>
<td>56.1</td>
<td>84.5</td>
</tr>
</tbody>
</table>
USA without clinical depression, 8+ hours of caregiving.  
*Care recipients:* dementia.

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Design</th>
<th>Sample</th>
<th>Duration</th>
<th>Caregivers:</th>
<th>Care recipients:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smith, 2012</td>
<td>USA</td>
<td>RCT</td>
<td>19/19</td>
<td>11 wk</td>
<td>Family carers, provided care to husband, with at least mild depression, cognitively and medically able to participate.</td>
<td>Male stroke survivors.</td>
</tr>
<tr>
<td>Pierce, 2009</td>
<td>USA</td>
<td>RCT</td>
<td>51/52</td>
<td>12 mo.</td>
<td>Primary day-to-day caregiver, English proficiency, novice web users.</td>
<td>Male stroke survivors.</td>
</tr>
<tr>
<td>Marziali, 2006</td>
<td>Canada</td>
<td>RCT</td>
<td>33/33e</td>
<td>6 mo.</td>
<td>Family carers.</td>
<td>Neurodegenerative disease (AD, stroke-related dementia, PD)</td>
</tr>
<tr>
<td>Beuchamp, 2005</td>
<td>USA</td>
<td>RCT</td>
<td>150/149</td>
<td>30 d</td>
<td>Family carers, part-time employment with 4+ contacts/month with care recipient.</td>
<td>Dementia.</td>
</tr>
</tbody>
</table>

a Sample size at baseline, intervention / control.  
b Mean age of caregivers was calculated across reported means of intervention and control groups in studies, where needed.  
c RCT in Germany. Length of study follow-up not specified.  
d Ages ranged from 42 to 78 years.  
e As reported in study of 22 caregivers per disease-specific cohort.

A brief description of each internet-based intervention is shown in Table 2. From among the 13 included studies, there were two studies (15.4%) that were categorized as having used an internet-based information or education only intervention [44, 48], three studies (23.1%) having used an internet-based information or education plus peer psychosocial support (PPS) intervention [37, 39, 40], one study (7.7%) having used an internet-based information or education plus professional psychosocial support (PFPS) intervention [38], six studies (46.2%) having used an internet-based information or education plus combined peer and professional psychosocial support intervention [41-43, 45-47, 49], and one study (7.7%) having used an internet-based intervention with telephone monitoring along with combined peer and professional psychosocial support [50].
Studies had a comparison group defined as receiving no internet-based intervention which could have included minimal guidance on information resources or website use [37, 40, 41, 44, 45, 47], usual care with or without additional information [39, 42, 43, 46, 48, 50], printed information [49], or electronic communications (e.g. e-bulletins) [38].

Table 2. Summary of intervention details (N=13 studies)

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Intervention Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Information or Education Only (n=2 studies)</strong></td>
<td></td>
</tr>
<tr>
<td>Kajiyama, 2013 [44]</td>
<td>iCare (ICC), 3 mo. six module web-based training program focused on reducing stress, relaxation techniques, behavioral activities, communication skills, management, nutrition and activity topics; video, role-modeling, workbook, exercises, practice opportunities, action plan.</td>
</tr>
<tr>
<td>Beauchamp, 2005 [48]</td>
<td>Caregiver’s Friend: Dealing with Dementia, 30-day, three modules comprised of topics including knowledge, cognitive and behavioural skills, and affective learning; web-based multimedia of text and video focused on positive caregiving strategies; tailored links; focus on coping strategies.</td>
</tr>
<tr>
<td><strong>Information or Education plus Peer Psychological Support (n=3 studies)</strong></td>
<td></td>
</tr>
<tr>
<td>Nunez-Naveira, 2016 [37]</td>
<td>UnderstAID, 3 mo. five module web-based learning platform covering 15 different topics, 4 levels of complexity of topic information; text, videos, images, resources, calendar/reminders for appointments and medication intake; social network section to interact with other caregivers.</td>
</tr>
<tr>
<td>Cristancho-Lacroix, 2015 [39]</td>
<td>Diapason program, 3 mo. web-based psychoeducational program, weekly thematic sessions completed and user satisfaction surveys, theoretical and practical information, practice guide, application to real life; baseline training on website use; peer forum.</td>
</tr>
<tr>
<td>Hattink, 2015 [40]</td>
<td>STAR platform/personalized training portal; 2 to 4 mo. of web-based course of text, videos, interactive exercises, knowledge tests, additional resources; learning advisor; Facebook community.</td>
</tr>
<tr>
<td><strong>Information or Education plus Professional Psychological Support (n=1 study)</strong></td>
<td></td>
</tr>
<tr>
<td>Blom, 2015 [38]</td>
<td>Mastery over Dementia (MoD), 5-6 mo. eight lesson web-based course (plus booster session) with coaching from a psychologist, plus monitoring and evaluation from the coach; focused on reducing caregiver symptoms of depression and anxiety; exercises and homework; text and video information.</td>
</tr>
<tr>
<td><strong>Information or Education plus Peer &amp; Professional Psychological Support (n=6 studies)</strong></td>
<td></td>
</tr>
</tbody>
</table>
| Pagan-Ortiz, 2014 [49] | Cuidate Cuidador (Caregiver, take care of yourself), 1 mo. website use to increase knowledge, self-efficacy, perceived social support, decrease caregiver }
burden, emotional distress; included 4 group sessions (1-1.5 hrs in length) with instruction on its use; culturally focused (Hispanic caregivers), ‘how-to’ instructions and information, stories, resources, videos, ability to post and interact with other caregivers, ask an expert resource section; option of being audio-based.

<table>
<thead>
<tr>
<th>Torkamani, 2014 [41]</th>
<th>ALLADDIN, 6 mo. web-based platform of support, information, management, and communication; includes distant monitoring to clinicians and forum for carers; music, relaxation and exercise techniques.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DuBenske, 2014 [42] &amp; Namkoong, 2012 [43]</td>
<td>CHESS (Comprehensive Health Enhancement Support System), Coping with Lung Cancer: A Network of Support website, up to 2 years of use, provided information, communication/support from peers, experts, clinicians, coaching tools; clinical reporting.</td>
</tr>
<tr>
<td>Smith, 2012 [45]</td>
<td>11 wk, five component web-based program of professional guide, educational videos, online chat sessions, email and message board, resource room; supported by experienced CVD nurse manager.</td>
</tr>
<tr>
<td>Pierce, 2009 [46]</td>
<td>Caring ~ Web, 12 mo. four component web-based program of linked websites, educational information, email forum with clinician specialists (i.e., nurse, rehab team), facilitated email discussion among all participants.</td>
</tr>
<tr>
<td>Marziali, 2006 [47]</td>
<td>Caring for Others, 22 wk supported web-based psychosocial intervention, with information, email access, Q&amp;A forum; 10 weekly sessions of support-group video conferencing (i.e., group therapist); 12 weekly online sessions facilitated by a group member.</td>
</tr>
<tr>
<td><strong>Information or Education plus Telephone Monitoring and Peer &amp; Professional Psychological Support (n=1 study)</strong></td>
<td><strong>Information or Education plus Telephone Monitoring and Peer &amp; Professional Psychological Support (n=1 study)</strong></td>
</tr>
<tr>
<td>Pierce, 2009 [48]</td>
<td>Caring ~ Web, 12 mo. four component web-based program of linked websites, educational information, email forum with clinician specialists (i.e., nurse, rehab team), facilitated email discussion among all participants.</td>
</tr>
<tr>
<td>Marziali, 2006 [49]</td>
<td>Caring for Others, 22 wk supported web-based psychosocial intervention, with information, email access, Q&amp;A forum; 10 weekly sessions of support-group video conferencing (i.e., group therapist); 12 weekly online sessions facilitated by a group member.</td>
</tr>
</tbody>
</table>

Outcome assessment tools used for relevant mental health outcomes are summarized in Table 3.

Among the 13 included studies, outcomes examined included: depression (n=8); stress or distress (n=6); anxiety (n=2); coping (n=2); overall mental health (n=1); quality of life (n=4); and overall health (n=2). Measurement tools to assess mental health outcomes of interest varied across included studies. The most consistently used tool was the Centre for Epidemiological Studies Depression Scale (CES-D) for measuring depression.
Table 3. Mental health outcomes and measurement tools

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Measurement Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression</td>
<td>Beck Depression Inventory (BDI-II) [39]</td>
</tr>
<tr>
<td></td>
<td>Centre for Epidemiological Studies Depression Scale (CES-D) [37, 38, 44, 45, 46, 48, 49]</td>
</tr>
<tr>
<td>Stress or Distress</td>
<td>Perceived Stress Scale (PSS) [39, 44]</td>
</tr>
<tr>
<td></td>
<td>Neuropsychiatric Inventory (NPI) [41]</td>
</tr>
<tr>
<td></td>
<td>Customized two question approach [48]</td>
</tr>
<tr>
<td></td>
<td>Interpersonal Reactivity Index (IRI) [40]</td>
</tr>
<tr>
<td>Anxiety</td>
<td>Hospital Anxiety and Depression Scale (HADS) [38]</td>
</tr>
<tr>
<td></td>
<td>State-Trait Anxiety Inventory (STAI) [48]</td>
</tr>
<tr>
<td>Coping</td>
<td>Brief Cope Scale (BCS) [43]</td>
</tr>
<tr>
<td></td>
<td>Revised Ways of Coping (R-WoC) [48]</td>
</tr>
<tr>
<td>Mental Health</td>
<td>Short Version Profile of Mood States (SV-POMS) [42]</td>
</tr>
<tr>
<td>Quality of Life</td>
<td>Quality of Life in Alzheimer’s Disease Scale (QoLAD)* [50]</td>
</tr>
<tr>
<td></td>
<td>Non-specific tool (2 questions) [40]</td>
</tr>
<tr>
<td></td>
<td>Quality of Life Scale (QoLS) [41]</td>
</tr>
<tr>
<td></td>
<td>Perceived Quality of Life (PQoL) [44]</td>
</tr>
<tr>
<td>Overall Health</td>
<td>Nottingham Health Profile (NHP) [39]</td>
</tr>
<tr>
<td></td>
<td>EuroQoL (EQ5D) [41]</td>
</tr>
</tbody>
</table>

*a Plus, the Minimum Dataset of the Dutch National Programme for Elderly Care (MDS-NPO).

Risk of bias

The results of the critical appraisal of individual studies for level of bias for sequence generation, allocation concealment, blinding, completeness of outcome assessment, selective reporting, and other biases are shown in Table 4. Overall, the Cochrane Risk of Bias (RoB) showed mixed quality of study methodology; 2 studies with low RoB [38, 40], 3 studies with High RoB [39, 43, 50] and 8 studies with unclear RoB [37, 41, 44-49].

Figure 1. Risk of bias of included studies (N=13 studies)

Effectiveness of Internet-Based Interventions

The meta-analysis included an examination of any type of internet-based intervention as well as each type of internet-based intervention by mental health outcome. All forest plots are shown in Multimedia Appendix 3.
Any Internet-Based Intervention

A summary of the results of the meta-analysis of any internet-based intervention on mental health outcomes is shown in Table 5. Compared to no or minimal internet-based intervention, any type of internet-based intervention resulted in a mean decrease of 0.48 points (95% CI: -0.75 to -0.22) for stress or distress among caregivers and a mean decrease of 0.40 points (95% CI: -0.58 to -0.22) for anxiety among caregivers. There were no statistically significant differences between groups for the mental health outcomes of depression, coping, overall mental health, quality of life and overall health. Heterogeneity for the combined effect estimate was observed for the mental health outcomes of depression, stress or distress, quality of life and overall health (\(P < 0.1\)), but not for anxiety and coping. The overall GRADE quality of evidence for each outcome ranged from very low to low.

<table>
<thead>
<tr>
<th>Table 4. Summary of Effectiveness of Any Internet-Based Interventions on Mental Health Outcomes</th>
<th>No. of Studies</th>
<th>Intervention / Control</th>
<th>Estimate Standard Mean Difference (95% CI)</th>
<th>I²</th>
<th>GRADE Quality Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression</td>
<td>8</td>
<td>407 / 422</td>
<td>-0.19 (-0.43 to 0.05)</td>
<td>59%^</td>
<td>Very Low</td>
</tr>
<tr>
<td>Stress or Distress</td>
<td>6</td>
<td>288 / 297</td>
<td>-0.48 (-0.75 to -0.22)</td>
<td>49%^</td>
<td>Low</td>
</tr>
<tr>
<td>Anxiety</td>
<td>2</td>
<td>240 / 239</td>
<td>-0.40 (-0.58 to -0.22)</td>
<td>0%</td>
<td>Low</td>
</tr>
<tr>
<td>Coping</td>
<td>2</td>
<td>199 / 204</td>
<td>-0.01 (-0.20 to 0.19)</td>
<td>0%</td>
<td>Very Low</td>
</tr>
<tr>
<td>Overall Mental Health</td>
<td>1</td>
<td>45 / 52</td>
<td>-0.29 (-0.69 to 0.11)</td>
<td>-</td>
<td>Very Low</td>
</tr>
<tr>
<td>Quality of Life</td>
<td>4</td>
<td>102 / 117</td>
<td>0.01 (-0.49 to 0.51)</td>
<td>68%^</td>
<td>Very Low</td>
</tr>
<tr>
<td>Overall Health</td>
<td>2</td>
<td>34 / 34</td>
<td>0.35 (-1.30 to 2.00)</td>
<td>88%^</td>
<td>Very Low</td>
</tr>
</tbody>
</table>

^ Statistically significant heterogeneity (\(P < 0.1\)).
Types of Internet-Based Interventions

Mental health outcomes of interest were examined by the different types of internet-based interventions, as shown in Table 6. For information or education only interventions, results showed a mean decrease of 0.31 points (95% CI: -0.50 to -0.11) for depression, a mean decrease of 0.57 points (95% CI: -0.77 to -0.37) for stress or distress, and a mean decrease of 0.42 points (95% CI: -0.65 to -0.19) for anxiety among caregivers, compared to minimal or no internet-based intervention. These results were based on moderate quality of evidence. The remaining mental health outcomes of coping, quality of life and overall health did not show statistically significant differences between groups. Four of the six mental health outcomes of interest included only one study. No heterogeneity was detected for the mental health outcomes.

For studies that examined information or education plus peer psychological support, there were no differences between intervention and control groups for any of the mental health outcomes in which there were data including depression, stress or distress, quality of life, and overall health. For studies that examined information or education plus professional psychological support, results showed a mean decrease of 0.34 points (95% CI: -0.63 to -0.05) for depression and a mean decrease of 0.36 points (95% CI: -0.66 to -0.07) for anxiety among caregivers, compared to minimal or no internet-based intervention. The quality of evidence for each of these outcomes was moderate.

For studies that examined information or education plus combined peer and professional psychological support, results showed a 1.25 point mean increase for overall health (95% CI: 0.24 to 2.25) among caregivers, compared to no or minimal internet-based intervention, however this result was based on one study with an overall sample size of less than 20 caregivers and
consequently very low quality of evidence. The remaining outcomes showed no differences between groups. There were no differences between groups for the intervention of information or education with telephone monitoring plus combined peer and professional psychological support for the outcome of quality of life. No other mental health outcomes were reported for this type of intervention. See Multimedia Appendix 4 for the full GRADE assessment details.

Table 5. Summary of effectiveness of types of internet-based interventions

<table>
<thead>
<tr>
<th>Mental Health Outcomes</th>
<th>No. of Studies</th>
<th>Intervention / Control</th>
<th>Estimate Standard Mean Difference (95% CI)</th>
<th>I²</th>
<th>GRADE Quality Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information or Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depression</td>
<td>2</td>
<td>196 / 206</td>
<td>-0.31 (-0.50 to -0.11)</td>
<td>0%</td>
<td>Moderate</td>
</tr>
<tr>
<td>Stress/Distress</td>
<td>2</td>
<td>196 / 206</td>
<td>-0.57 (-0.77 to -0.37)</td>
<td>0%</td>
<td>Moderate</td>
</tr>
<tr>
<td>Anxiety</td>
<td>1</td>
<td>150 / 149</td>
<td>-0.42 (-0.65 to -0.19)</td>
<td>-</td>
<td>Moderate</td>
</tr>
<tr>
<td>Coping</td>
<td>1</td>
<td>150 / 149</td>
<td>0.00 (-0.23 to 0.23)</td>
<td>-</td>
<td>Low</td>
</tr>
<tr>
<td>Overall Mental Health</td>
<td>1</td>
<td>45 / 52</td>
<td>-0.29 (-0.69 to 0.11)</td>
<td>-</td>
<td>Very Low</td>
</tr>
<tr>
<td>Quality of Life</td>
<td>1</td>
<td>46 / 57</td>
<td>0.33 (-0.06 to 0.72)</td>
<td>-</td>
<td>Very Low</td>
</tr>
<tr>
<td>Overall Health</td>
<td>1</td>
<td>25 / 24</td>
<td>-0.44 (-1.01 to 0.13)</td>
<td>-</td>
<td>Very Low</td>
</tr>
<tr>
<td>Information or Education + PPS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depression</td>
<td>2</td>
<td>55 / 55</td>
<td>-0.11 (-0.48 to 0.27)</td>
<td>0%</td>
<td>Very Low</td>
</tr>
<tr>
<td>Stress/Distress</td>
<td>2</td>
<td>52 / 56</td>
<td>-0.46 (-1.41 to 0.50)</td>
<td>83%</td>
<td>Very Low</td>
</tr>
<tr>
<td>Quality of Life</td>
<td>1</td>
<td>21 / 25</td>
<td>-0.36 (-0.95 to 0.22)</td>
<td>-</td>
<td>Very Low</td>
</tr>
<tr>
<td>Overall Health</td>
<td>1</td>
<td>25 / 24</td>
<td>-0.44 (-1.01 to 0.13)</td>
<td>-</td>
<td>Very Low</td>
</tr>
<tr>
<td>Information or Education + PFPS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depression</td>
<td>1</td>
<td>90 / 90</td>
<td>-0.34 (-0.63 to -0.05)</td>
<td>-</td>
<td>Moderate</td>
</tr>
<tr>
<td>Anxiety</td>
<td>1</td>
<td>90 / 90</td>
<td>-0.36 (-0.63 to -0.05)</td>
<td>-</td>
<td>Moderate</td>
</tr>
</tbody>
</table>
# Information or Education + Combined PPS + PFPS

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Mean value</th>
<th>95% CI</th>
<th>Heterogeneity</th>
<th>Quality of Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression</td>
<td>3</td>
<td>66 / 71</td>
<td>-0.11 (-1.01 to 0.78)</td>
<td>83%&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Very Low</td>
</tr>
<tr>
<td>Stress/Distress</td>
<td>2</td>
<td>40 / 35</td>
<td>-0.30 (-1.05 to 0.44)</td>
<td>61%</td>
<td>Very Low</td>
</tr>
<tr>
<td>Coping</td>
<td>1</td>
<td>49 / 55</td>
<td>-0.03 (-0.41 to 0.36)</td>
<td>-</td>
<td>Very Low</td>
</tr>
<tr>
<td>Overall Mental Health</td>
<td>1</td>
<td>45 / 52</td>
<td>-0.29 (-0.69 to 0.11)</td>
<td>-</td>
<td>Very Low</td>
</tr>
<tr>
<td>Quality of Life</td>
<td>1</td>
<td>18 / 20</td>
<td>0.55 (-0.10 to 1.20)</td>
<td>-</td>
<td>Very Low</td>
</tr>
<tr>
<td>Overall Health</td>
<td>1</td>
<td>9 / 10</td>
<td><strong>1.25 (0.24 to 2.25)</strong></td>
<td>-</td>
<td>Very Low</td>
</tr>
</tbody>
</table>

<sup>a</sup> Statistically significant heterogeneity (P < 0.1).

## Discussion

Our systematic review and meta-analysis showed small to moderate beneficial effects of internet-based interventions on caregiver mental health including a reduction in symptoms of depression, stress or distress and anxiety. The types of internet-based interventions that appeared to have a beneficial effect on mental health included information or education only on decreasing depression, stress or distress, and anxiety, as well as information or education plus professional psychological support on reducing depression and anxiety. Critical appraisal determined a wide range of the quality of evidence but included a moderate quality of evidence for a modest effect size for a beneficial effect among the two specific types of internet-based interventions of information or education only and information or education plus professional psychological support. Additional benefits were shown for the internet-based intervention of information or education plus combined peer and psychological support when it comes to overall health among...
caregivers, however this was based on a small sample size (<20) and a very low quality of evidence.

Accounting for the type of internet-based intervention revealed additional trends not shown when all types of internet-based interventions were combined. The results showed an approximate 20% increase in the magnitude of effect for stress or distress and an information or education only internet-based intervention among 2 studies, compared to when all 6 studies on stress or distress were combined. Symptoms of depression were improved for an information or education only internet-based intervention as well as for an information or education plus professional psychological support internet-based intervention, not shown when all 8 studies on depression were combined.

Based on the detailed critical appraisal and quality assessment of included studies, there are a number of possible reasons that consistent findings across the mental health outcomes were not shown. According to the GRADE scores, the quality of evidence was poor for a number of the outcomes examined, and none of the outcomes were rated as having high quality evidence. This may reflect, in part, this new and evolving area of focus and the resulting lack of consistency across studies, for example, not all studies examined the mental health outcomes of interest, there was variability in the measurement tools used to assess the different mental health outcomes, the care recipients across studies differed, and too few studies examined the different types of internet-based interventions resulting in small numbers of studies for some outcomes. No differences were noted for multi-component internet-based interventions on coping and overall mental health since these outcomes were only examined in a few studies. No differences were noted for quality of life perhaps due to small sample sizes and differences in types of interventions. Studies included in the subgroup analyses by type of internet-based intervention
were judged to be predominately of low to very low quality of evidence suggesting a number of methodological limitations. There were also many areas where risk of bias could not be assessed due to lack of information. For example, risk of bias related to allocation concealment was rated as unclear in 11 of the 13 interventions assessed. Risk of bias related to blinding of participants and providers was rated as unclear in 9 of the 13 interventions examined. Risk of bias related to blinding of outcome assessors was rated as unclear in 7 of the interventions examined. The provision of more detailed information about trial procedures using the CONSORT guidelines for non-pharmacological interventions [51] would enable more accurate assessments of studies for bias and may, over time, help to elevate the quality of evidence in this area.

Despite significant findings across a range of evidence quality, the intervention mechanism by which improvements in mental health were achieved is still not clear. The interactivity of the information or education only internet-based interventions may have contributed to our significant findings, and as previously shown by Guay et al. [20]. The previously shown important role of human support [20] was variable in our findings, with a beneficial effect shown for the addition of professional psychological support only. It may be that the needs and experiences of the caregivers targeted in these multi-component interventions are so diverse that the potential impacts of internet-based interventions are not realized. A theoretical basis for internet-based interventions [20, 52] has shown to be impactful and a number of our included studies reported using theory to develop their interventions (e.g., [39, 45, 50]). Many interventions included behavior change techniques such as stress management (e.g., [37, 44]), problem solving (e.g., [38]), and graded tasks (e.g., [40]), which may have contributed to significant findings. The most efficacious interventions included caregivers and care recipients that were homogeneous, with caregivers characterized as being mostly older female adults and
the care recipients being those living with some form of dementia [38-41, 44, 47, 48]. Internet-based interventions, when designed with the target populations in mind, may be more likely to demonstrate a beneficial effect on the mental health of caregivers. Internet-based interventions being developed for caregivers should have a strong theoretical basis [53] and incorporate behavior change techniques, particularly those aimed to help manage stress and enhance coping.

**Strengths and Limitations**

This review summarizes the most relevant trial evidence available to assess the benefits of internet-based interventions on caregiver mental health outcomes. All of the available evidence was published between 2005 to 2017, with more literature published recently from (2013-2017), emphasizing the growing interest in internet technology to support caregivers. However, the review identified that the overall quality of evidence ranged from very low to moderate quality evidence. To our knowledge, this is the first systematic review and meta-analysis examining the impact of internet-based interventions on mental health outcomes of caregivers of adults with chronic conditions living in the community. Although this is an emerging field in the literature, our review set out an *a priori* selection of rigorous methodological designs, including RCTs and CCTs. This systematic review and meta-analysis was completed with a comprehensive search strategy developed to identify relevant and on-topic literature pertaining to internet-based interventions on informal caregiver mental health outcomes. The review was conducted using methodologically rigorous processes for systematic reviews and meta-analyzed the data using appropriate methods for combining studies that used different outcome assessment tools.

The limitations of the review include the methodological weakness of the studies included, despite being RCTs and CCTs. There was considerable heterogeneity in the interventions across studies. Therefore, we analyzed the impact of the internet-based interventions according to the
components of the interventions to understand the impact of these components, however there were too few studies having used each type of internet-based interventions across all of the mental health outcomes of interest. The dosing or amount of exposure to internet-based interventions is yet to be established due to the limited information pertaining to the intervention (e.g. intensity and description of components), as well as the generally short-term follow-up observed in the included studies.

Conclusions
This is the first meta-analysis of the impact of internet-based interventions for informal caregivers of adults with chronic conditions on caregiver mental health outcomes. The findings suggest there is an emergence of literature pertaining to internet-based interventions for informal caregivers examining the impact on mental health outcomes. However, future large, high-quality research with clear methodology and consistently reported outcomes of mental health using standardized assessment tools to facilitate meta-analysis and an assessment of clinical relevance are needed to further inform the effectiveness of such interventions, particularly multi-component internet-based interventions that use peer or professional health care provider support.

Acknowledgements
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Conflicts of Interest

None declared

Abbreviations

CCT: controlled clinical trial

CI: confidence interval

IV: inverse variation

RCT: randomized controlled trial

RoB: risk of bias

SE: standard error

SD: standard deviation

SMD: standardized mean difference

Multimedia Appendix 1

Search Terms

Multimedia Appendix 2

Detailed Characteristics of Included Studies

Multimedia Appendix 3

Meta-Analysis and Forest Plots

Multimedia Appendix 4

GRADE Assessment Details
References


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