Original Article

Jenny Ploeg, RN, PhD, Professor, School of Nursing, Scientific Director, Aging, Community and Health Research Unit, Associate Member, Department of Health, Aging and Society, McMaster Institute for Research on Aging, McMaster University

Muhammad Usman Ali, MD, MSc, Department of Clinical Epidemiology and Biostatistics, Faculty of Health Sciences, McMaster University

Maureen Markle-Reid, RN, MScN, PhD, Associate Professor and Canada Research Chair Person-Centred Interventions for Older Adults with Multimorbidity and their Caregivers, School of Nursing, Scientific Director, Aging, Community and Health Research Unit, McMaster Institute for Research on Aging, McMaster University

Ruta Valaitis RN, PhD, Associate Professor, School of Nursing, Dorothy C. Hall Chair in Primary Health Care Nursing, Scientific Co-Director of the Aging Community and Health Research Unit, Deputy Director, WHO Collaborating Centre for Primary Care and Health Human Resources, Associate Member of the Department of Family Medicine, McMaster Institute for Research on Aging, McMaster University

Amy Bartholomew, RN, BScN, MScN, Research Coordinator, Aging, Community and Health Research Unit, McMaster University

Donna Fitzpatrick-Lewis, MSW, Department of Clinical Epidemiology and Biostatistics, Faculty of Health Sciences, McMaster University

Carrie McAiney, PhD, Department of Psychiatry & Behavioural Neurosciences, Program for Interprofessional Practice, Education and Research, McMaster University

Diana Sherifali RN, BScN, PhD, CDE; Associate Professor, School of Nursing, Faculty of Health Sciences, McMaster University, Hamilton, ON, Canada. Co-Director McMaster Evidence Review and Synthesis Team, McMaster University, Hamilton, ON, Canada; Diabetes Care and Research Program, Hamilton Health Sciences, Hamilton, ON, Canada

Corresponding Author:
Diana Sherifali, RN, BScN, PhD, CDE
School of Nursing

Abstract

Background:
Approaches to support the health and well-being of family caregivers of adults with chronic conditions are increasingly important given the key roles caregivers play in helping family members to live in the community. Internet-based interventions to support caregivers have the potential to lessen the negative health impacts associated with caregiving and result in improved health outcomes.

Objectives:
The primary objective of this systematic review and meta-analysis was to examine the effect of caregiver-focused internet-based interventions, compared to no or minimal internet-based interventions, on caregiver outcomes. The secondary objective was to assess the effect of different types of internet-based interventions (e.g., education, peer and professional psychosocial support, and electronic monitoring of the care recipient) compared to no or minimal internet-based interventions, on caregiver outcomes.

Methods:
Medline, EMBASE, CIHAHL, PsychInfo, Cochrane and Ageline were searched from January 1995 to April 2017 for relevant randomized controlled trials or controlled clinical trials that compared caregiver-focused internet-based intervention programs with no or minimal internet-based interventions for caregivers of adults with at least one chronic condition. Studies were included if they involved: (1) adult family or friend caregivers (18 years of age or older) of adults living in the community with a chronic condition; (2) a caregiver-focused internet-based intervention of education or psychosocial support or electronic monitoring of the care recipient; and (3) general caregiver outcomes (i.e., burden, life satisfaction, self-efficacy or mastery,
reaction to problem behavior, self-esteem, strain, and social support). 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 these caregiver outcomes were meta-analyzed.

**Results:**
The search yielded 7,927 unique citations of which 294 studies were screened at full-text. Of those, 14 studies met the inclusion criteria; 12 were randomized controlled trials and one study was a controlled clinical trial. One study used an RCT design in one country and a controlled clinical trial design in two other countries. Beneficial effects of any internet-based intervention program, compared to no or minimal internet-based intervention, resulted in a mean increase of 0.85 points (95% CI 0.12 to 1.57) for caregiver self esteem, a mean increase of 0.36 points (95% CI 0.11 to 0.62) for caregiver self-efficacy or mastery, and a mean decrease of 0.32 points (95% CI -0.54 to -0.09) for caregiver strain. However, the results are based on poor quality studies.

**Conclusions:**
The review found evidence for the positive effects of internet-based intervention programs on self-efficacy, self esteem, and strain of caregivers of adults living with a chronic condition.

Further high-quality research is needed to inform the effectiveness of specific types of internet-based interventions on caregiver outcomes.

Trial Registration: PROSPERO CRD42018091715

KEYWORDS: Internet, support, education, caregivers, burden, chronic conditions, meta-analysis

**Introduction**
The number of individuals living with chronic conditions is on the rise globally [1]. Family and friend caregivers provide up to 75% of the health and supportive care needs for older adults living in the community in Canada [2]. While caregiving can be very rewarding, it is also associated with adverse physical, mental and psychosocial health outcomes [3-5]. Examples of negative outcomes as a result of caregiving include burden, strain, being dissatisfied with life, feeling alone or isolated, and low self-efficacy [3-8]. Practical solutions to address the needs of caregivers are urgently needed.

Recently, there has been great interest in the use of internet-based interventions to support caregivers. It has been suggested that the delivery of healthcare interventions through the internet may result in improved accessibility of services as well as reduced healthcare costs [9]. There is accumulating evidence for the positive effect of caregiver-focused internet-based interventions in 11 recent systematic or narrative reviews [10-20]. All of these reviews provide some evidence of improvements in caregivers’ health or wellbeing (e.g., burden, depression, self-efficacy, confidence) as a result of internet-based programs. Most of the reviews included studies with both high and low quality of designs, and noted the limited methodological quality of included studies as a concern. In addition, most reviews did not examine the effect of different types of internet-based support on caregivers. Finally, none of the reviews included a meta-analysis to quantify the magnitude of effect across studies.

The primary objective of this study was to conduct a systematic review and meta-analysis to assess the effect of caregiver-focused internet-based interventions, compared to no or minimal internet-based interventions, on outcomes for caregivers of adults with at least one chronic condition living in the community. The caregiver outcomes examined in this paper include burden, life satisfaction, self-efficacy or mastery, reaction to problem behavior, self-esteem, strain, and social support. The secondary objective was to examine whether specific types of
internet-based interventions had a beneficial effect on these caregiver outcomes, in order to address previous review limitations. This review included only studies with the most rigorous designs, randomized controlled trials (RCTs) and controlled clinical trials (CCTs). This is a companion paper to a systematic review and meta-analysis that examines the effect of internet-based interventions on caregiver mental health outcomes [21].

Methods
This systematic review and meta-analysis was conducted following the preferred reporting items for systematic reviews and meta-analysis (PRISMA) guidelines [22].

Population
The population of interest included family and friend caregivers, aged 18 years and older, who were 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 caregiver-focused internet-based modality to deliver an intervention, which could include either a single component program or multi-modal program.

Outcomes
The outcomes assessed in this meta-analysis included the following caregiver outcomes: burden, life satisfaction, self-efficacy or mastery, reaction to problem behavior, self-esteem, strain, and social support. Mental health outcomes are addressed in a companion paper [21].

Study Design
Studies were included if they met the following inclusion criteria: (1) study designs were a RCT or CCT; (2) studies examined any internet-based intervention program for caregivers of older adults having at least one chronic condition and 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 caregiving outcome of interest (burden, life satisfaction, self-efficacy or mastery, reaction to problem behavior, self-esteem, strain or social support); (6) studies used any measurement tool to examine the outcomes of interest; and (7) studies in which the control group received no or minimal internet-based intervention. 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), grey or unpublished literature, conference abstracts, and letters or editorials. All published 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 a 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 [23], 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 [24]. Disagreements were resolved through consensus between the two reviewers.

Data analysis
A meta-analysis was used to combine the results across studies for each 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 burden, life satisfaction, self-efficacy or mastery, reaction to problem behavior, self-esteem, strain and social support. We used intention-to-treat (ITT) outcome data where possible, however, if no ITT data was 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) [25]. The SMD accounts for similar outcomes measured using different assessment tools (e.g., caregiver burden assessed using different outcome measures such as the Zarit Burden Interview and Caregiver Quality of Life Scale). 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 [26, 27]. 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) [28].

The primary meta-analysis examined caregiver-focused internet-based interventions by caregiver outcome. Subsequently, the secondary meta-analysis examined the effects of specific types of caregiver-focused internet-based intervention programs on caregiver outcomes. Based on our previous work [18], intervention types were categorized accordingly: (1) internet-based information or education only; (2) internet-based information or education plus peer psychosocial support; (3) internet-based information or education plus professional psychosocial support; (4) internet-based information or education plus combined peer and professional psychosocial support; and (5) internet-based information or education plus professional psychosocial support plus electronic monitoring of the care recipient.

Statistical heterogeneity of combined studies was examined using standard methods. The I² statistic was used to quantify the magnitude of statistical heterogeneity between studies where I² of 30% to 60% represents moderate and I² of >60% represents substantial heterogeneity [26]. 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) [29], STATA (version 14) [30] and GRADEpro Guideline Development Tool software packages [31].
Results

Search

The search resulted in 7,927 unique citations which were screened independently by two project staff (See Figure 1). At title and abstract screening, we excluded 7,633 studies, leaving 294 studies to be screened at full-text. Of those we identified 14 studies (16 papers) that met the inclusion criteria for this review. References lists of the on-topic systematic reviews and included studies were searched but no additional studies were added.

Figure 1: Flow Diagram for Study Selection of Internet-Based Interventions on Caregiving Outcomes
Summary of included studies
The purpose, methods, participants and intervention of the included studies are shown in Multimedia Appendix 2.

Study Design
Among the 14 included studies, 12 studies were RCTs [32-43], one study was a CCT [44] and one study used an RCT design in one country and a CCT design in two other countries [45]. Companion papers were included for the studies by DuBenske [46] and Smith [47]. Four of the 12 RCTs were conducted in Europe [33-36] seven RCTs were conducted in the USA [32, 37, 38, 40-43] and one was conducted in South Korea [39]. The one CCT was conducted across the USA, Puerto Rico and Mexico [44] and the study that used both CCT and RCT designs was conducted across three European countries [45]. All included studies had relatively small sample sizes (≤150 subjects per arm) and most had a length of follow-up of 6 months or less. One study included a slightly longer study follow-up time period of one-year [42]. Seven of the 14 studies included reference to a theoretical or conceptual framework for the intervention including: stress and coping [43, 34, 37, 35, 41] framework of systemic organization [42], and the concept of ambient assisted living [33].
**Study Population**

Most studies included caregivers 50 years of age or older (Mean age ranged from 53.8 to 66.0) ([32, 34-39, 41, 42, 45] except one study that included caregivers who were working and reported a slightly lower mean age of 46.9 years [43]. Two studies did not provide information on the average age of caregivers [33, 44] and one study reported that 40% were over 50 years [40]. Eleven of 14 studies reported caregiver gender; in 10 studies more than half of the caregivers were female (56.3% to 100%). In relation to the type of chronic conditions among care recipients, nine studies included persons with some form of dementia [32-36, 38, 43-45]. In three studies, care recipients were stroke survivors [39, 41, 42]. Care recipients in one study had non-small cell lung cancer [37] and in another study care recipients had brain injury [40].

**Type of Internet-based Intervention**

Among the 14 included studies, three studies used an internet-based information or education only intervention [38, 40, 43] three studies used an internet-based information or education plus peer psychosocial support intervention [33-35], one study used an internet-based information or education plus professional psychosocial support intervention [39], six studies used an internet-based information or education plus combined peer and professional psychosocial support intervention [32, 36, 37, 41, 42, 44] and one study used an internet-based information or education plus professional psychosocial support intervention plus electronic monitoring [45].

**Comparator Groups**

The comparator groups received usual care or were part of a wait-list control where they had access to the internet program at the end of the study [32-36, 39, 42, 43, 45], had access to printed materials [44] or had access to a website with general information related to the condition or resources [37, 38, 40, 41].

**Outcomes**
Among the 14 included studies, outcomes examined included: burden (n=5); life satisfaction (n=3); self-efficacy or mastery (n=9); reaction to problem behaviour (n=2); self-esteem (n=1); strain (n=1); and social support (n=2). Measurement tools to assess caregiver outcomes varied across included studies (See Multimedia Appendix 3).

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 Figure 2. Overall, the Cochrane Risk of Bias (RoB) showed mixed quality of study methodology; 1 study with low RoB [35], 4 studies with high RoB [34, 37, 44, 45] and 9 studies with unclear RoB due to lack of relevant details in the published papers [32, 33, 36, 38-43].

Figure 2: Risk of Bias of Included Studies

<table>
<thead>
<tr>
<th>Author, year</th>
<th>Sequence Generation</th>
<th>Allocation Concealment</th>
<th>Blinding of Participants/Providers</th>
<th>Blinding of Outcome Assessment</th>
<th>Incomplete Outcome Data</th>
<th>Selective Reporting</th>
<th>Other Bias</th>
<th>Overall ROB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beauchamp, 2005 [43]</td>
<td>U</td>
<td>U</td>
<td>U</td>
<td>U</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Cristancho-Lacroix, 2015 [34]</td>
<td>L</td>
<td>U</td>
<td>H</td>
<td>H</td>
<td>L</td>
<td>L</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>DuBenske, 2014 [37]</td>
<td>U</td>
<td>U</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>L</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>Companion Paper: Gustafson, 2013 [46]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hattink, 2015 [35]</td>
<td>L</td>
<td>U</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Hattink, 2016 [45]</td>
<td>H</td>
<td>H</td>
<td>U</td>
<td>U</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Kajiyama, 2013 [38]</td>
<td>U</td>
<td>U</td>
<td>U</td>
<td>U</td>
<td>H</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>
Effectiveness of Internet-Based Interventions

The meta-analysis included an examination of any type of internet-based intervention as well as an examination of each type of internet-based intervention by caregiver outcome. All forest plots are shown in Multimedia Appendix 4.

Any Internet-Based Intervention

A summary of the results of the meta-analysis of any caregiver-focused internet-based intervention on caregiver outcomes is shown in Table 1. Compared to no or minimal internet-based intervention, any type of internet-based intervention resulted in a statistically significant mean increase of 0.85 points (95% CI 0.12 to 1.57) for caregiver self esteem, a statistically significant mean increase of 0.36 points (95% CI 0.11 to 0.62) for caregiver self-efficacy or
mastery, and a statistically significant mean decrease of 0.32 points (95% CI -0.54 to -0.09) for caregiver strain. There were no statistically significant differences between groups for the caregiver outcomes of caregiver burden, life satisfaction, reaction to problem behavior, and social support. Heterogeneity for the combined effect estimate was observed for the outcomes of caregiver burden, self-efficacy or mastery, reaction to problem behavior and social support. The overall GRADE quality of evidence for each outcome ranged from moderate to very low. See Multimedia Appendix 5 for the full GRADE assessment details.

**Table 1. Summary of Effectiveness of Any Internet-Based Intervention**

<table>
<thead>
<tr>
<th>Caregiver Outcomes</th>
<th>No. Of Studies</th>
<th>Intervention / Control</th>
<th>Estimate Standardized Mean Difference (95% CI)</th>
<th>I²</th>
<th>GRADE Quality Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caregiver Burden</td>
<td>5</td>
<td>132 / 147</td>
<td>0.03 (-0.31 to 0.36)</td>
<td>48%</td>
<td>Very Low</td>
</tr>
<tr>
<td>Life Satisfaction</td>
<td>3</td>
<td>170 / 165</td>
<td>-0.17 (-0.39 to 0.04)</td>
<td>0%</td>
<td>Very Low</td>
</tr>
<tr>
<td>Self-efficacy or Mastery</td>
<td>9</td>
<td>306 / 309</td>
<td><strong>0.36</strong> <em>(0.11 to 0.62)</em></td>
<td>46%</td>
<td>Low</td>
</tr>
<tr>
<td>Reaction to Problem Behavior</td>
<td>2</td>
<td>71 / 81</td>
<td>-0.10 (-0.66 to 0.45)</td>
<td>63%</td>
<td>Very Low</td>
</tr>
<tr>
<td>Self Esteem</td>
<td>1</td>
<td>15 / 17</td>
<td><strong>0.85</strong> <em>(0.12 to 1.57)</em></td>
<td>-</td>
<td>Very Low</td>
</tr>
<tr>
<td>Caregiver Strain</td>
<td>1</td>
<td>150 / 149</td>
<td>-0.32 <em>(0.54 to -0.09)</em></td>
<td>-</td>
<td>Moderate</td>
</tr>
<tr>
<td>Social Support</td>
<td>2</td>
<td>30 / 34</td>
<td>-0.38 *(1.12 to 0.35)</td>
<td>53%</td>
<td>Very Low</td>
</tr>
</tbody>
</table>

**Effect of Different Types of Internet-Based Interventions**

Caregiver outcomes of interest were examined for each type of internet-based intervention, as shown in Table 2. For *information or education only* interventions, results showed a significant
reduction with small effect sizes in caregiver strain (1 study; SMD= -0.32, 95% CI -0.54 to -0.09; P=0.007) and self-efficacy or mastery (1 study; SMD= 0.31, 95% CI 0.08 to 0.53; P=0.009). These results were based on moderate quality of evidence. The remaining outcomes of life satisfaction and reaction to problem behavior, assessed in only one study each, did not show statistically significant differences between groups.

For studies that examined information or education plus peer psychosocial support, there were no differences between intervention and control groups for any of the outcomes including burden, life satisfaction, self-efficacy or mastery, and reaction to problem behavior. The quality of this evidence was very low. For studies that examined information or education plus professional psychosocial support, results showed a mean increase of 1.2 points (95% CI 0.48 to 1.92) for self-efficacy or mastery compared to no or minimal internet-based intervention. The quality of this evidence was very low.

For studies that examined information or education plus combined peer and professional psychosocial support, results showed a mean increase of 0.85 points (95% CI 0.12 to 1.57) for self-esteem and a mean increase of 0.52 points (95% CI 0.10 to 0.94) for self-efficacy or mastery, compared to no or minimal internet-based intervention. The quality of this evidence was very low. For the outcomes of burden, life satisfaction and social support, there were no statistically significant differences between groups. Finally, the single study that examined information or education plus professional psychosocial support plus electronic monitoring, found no statistically significant difference between groups for the outcome of self-efficacy or mastery. The quality of this evidence was very low.
### Table 2. Summary of Effectiveness of Types of Internet-Based Interventions

<table>
<thead>
<tr>
<th>Caregiver Outcomes</th>
<th>No. of Studies</th>
<th>Intervention / Control</th>
<th>Estimate Standard Mean Difference (95% CI)</th>
<th>( I^2 )</th>
<th>GRADE Quality Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Information or Education</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life Satisfaction</td>
<td>1</td>
<td>104 / 97</td>
<td>-0.22 (-0.50 to 0.06)</td>
<td>-</td>
<td>Very Low</td>
</tr>
<tr>
<td>Self-efficacy or Mastery</td>
<td>1</td>
<td>150 / 149</td>
<td>0.31 (0.08 to 0.53)</td>
<td>-</td>
<td>Moderate</td>
</tr>
<tr>
<td>Reaction to Problem Behavior</td>
<td>1</td>
<td>46/57</td>
<td>-0.35 (-0.75, 0.04)</td>
<td>-</td>
<td>Very Low</td>
</tr>
<tr>
<td>Strain</td>
<td>1</td>
<td>150/149</td>
<td>-0.32 (-0.54, -0.09)</td>
<td>-</td>
<td>Moderate</td>
</tr>
<tr>
<td><strong>Information or Education plus Peer Psychosocial Support</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burden</td>
<td>2</td>
<td>46 / 49</td>
<td>0.17 (-0.24 to 0.57)</td>
<td>0%</td>
<td>Very Low</td>
</tr>
<tr>
<td>Life Satisfaction</td>
<td>1</td>
<td>30/31</td>
<td>0.08 (-0.43 to 0.58)</td>
<td>-</td>
<td>Very Low</td>
</tr>
<tr>
<td>Self-efficacy or Mastery</td>
<td>3</td>
<td>76/80</td>
<td>0.14 (-0.41, 0.69)</td>
<td>66%</td>
<td>Very Low</td>
</tr>
<tr>
<td>Reaction to Problem Behavior</td>
<td>1</td>
<td>25/24</td>
<td>0.22 (-0.34, 0.78)</td>
<td>-</td>
<td>Very Low</td>
</tr>
<tr>
<td><strong>Information or Education plus Professional Psychosocial Support</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-efficacy or Mastery</td>
<td>1</td>
<td>18/18</td>
<td>1.20 (0.48, 1.92)</td>
<td>-</td>
<td>Very Low</td>
</tr>
<tr>
<td><strong>Information or Education plus Peer and Professional Psychosocial Support</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burden</td>
<td>3</td>
<td>86/98</td>
<td>-0.03 (-0.57, 0.50)</td>
<td>67%</td>
<td>Very Low</td>
</tr>
<tr>
<td>Life Satisfaction</td>
<td>1</td>
<td>36/37</td>
<td>-0.24 (-0.70, 0.22)</td>
<td>-</td>
<td>Very Low</td>
</tr>
<tr>
<td>Self-efficacy or Mastery</td>
<td>3</td>
<td>45/47</td>
<td>0.52 (0.10, 0.94)</td>
<td>0%</td>
<td>Very Low</td>
</tr>
<tr>
<td>Self-esteem</td>
<td>1</td>
<td>15/17</td>
<td>0.85 (0.12, 1.57)</td>
<td>-</td>
<td>Very Low</td>
</tr>
<tr>
<td>Social Support</td>
<td>2</td>
<td>30/34</td>
<td>-0.38 (-1.12, 0.35)</td>
<td>53%</td>
<td>Very Low</td>
</tr>
<tr>
<td><strong>Information or Education plus Professional Psychosocial Support plus Monitoring</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-efficacy or Mastery</td>
<td>1</td>
<td>17/15</td>
<td>0.17 (-0.52, 0.87)</td>
<td>-</td>
<td>Very Low</td>
</tr>
</tbody>
</table>
Discussion

To our knowledge, this paper and its companion paper, focused on caregiver mental health outcomes [21], are the first meta-analyses examining the effect of caregiver-focused internet-based interventions on outcomes of caregivers of adults with chronic conditions living in the community. This systematic review and meta-analysis showed small to medium beneficial effects of internet-based interventions on caregiver outcomes of self-esteem, self-efficacy or mastery and strain, but no effect on burden, life satisfaction, reaction to problem behaviour, and social support. For internet-based information or education interventions, there was a small effect size on self-efficacy or mastery and strain, with a moderate quality of evidence. For internet-based information or education plus professional psychosocial support (n=1 study), there was a large effect size for self-efficacy or mastery but the quality of evidence was very low. For internet-based information or education plus combined peer and professional psychosocial support, there was a large effect size for self-esteem and a moderate effect size for self-efficacy or mastery, but the quality of the evidence was also very low. Finally, for internet-based information or education plus professional psychosocial support plus electronic monitoring, there was no effect on self-efficacy or mastery.

There are a number of possible reasons why consistent findings across caregiver outcomes were not shown. According to the GRADE scores, the quality of evidence was low or very low for most of the outcomes examined, and none of the outcomes were rated as having high quality evidence. Further, some outcomes were assessed in only a single study, there was variability in the assessment tools used to assess outcomes, caregiver characteristics varied across studies, and too few studies examined different types of internet-based interventions, reflecting that this is an emerging area of research.
In relation to risk of bias, four studies had high risk of bias in the area of blinding participants or providers, three studies had high risk of bias in the area of incomplete outcome data, and two studies had high risk of bias for allocation concealment, blinding of outcome assessment, and sequence generation. There were also many areas where risk of bias could not be determined due to lack of information in the published papers. For example, risk of bias was unclear in 12 of 13 studies related to allocation concealment; in 10 of 14 studies related to blinding of outcome assessment; and in 9 of 14 studies related to blinding of participants and providers. It is vital that authors of such trials provide more detailed information about trial procedures using the CONSORT guidelines for non-pharmacological interventions [48] as this would enable more accurate assessment of studies for bias and may help to improve the quality of evidence in this area.

The improvements in caregiver self-efficacy or mastery as a result of internet-based interventions in this study are promising. These improvements were seen in internet-based interventions that included information or education in combination with either professional psychosocial support, or both peer and professional psychosocial support. Caregiver self-efficacy, or a person’s perception of their ability to perform tasks related to caregiving competently, is a modifiable factor that is important in understanding the effect of internet-based caregiver interventions. Previous research has shown that higher self-efficacy is associated with fewer depressive symptoms among dementia family caregivers [49, 50]. Research also suggests that self-efficacy for managing dementia may protect caregivers against burden and depression [51] and that it plays a mediating role between social support and depressive symptoms [52].

For the outcome of self-efficacy or mastery, the addition of professional psychosocial support to information or education only resulted in an increase in the SMD from 0.31 to 1.20; while the addition of both peer and professional psychosocial support resulted in an increase in the SMD
from 0.31 to 0.52. This suggests that human support (either professional or peer or a combination of these), as previously shown in the review by Guay et al [13], plays an important role in improving caregiver outcomes.

The companion paper [21], a meta-analysis of the effect of internet-based interventions on caregiver mental health, showed that such interventions also result in a reduction in depressive symptoms, stress or distress, and anxiety. The companion paper included many of the same studies in this meta-analysis, so also had similar limitations in relation to quality of the evidence.

A theoretical basis for internet-based interventions has been shown to be effective [13, 53]. Half of the included studies reported using theory to develop their interventions, such as cognitive theories of stress [34, 41, 43]. Interventions that included behavior change techniques such as stress management may have contributed to significant findings. It is recommended that internet-based interventions for caregivers include a strong theoretical base [54] and include strategies to support improved self-efficacy, stress management and coping.

**Strengths and Limitations**

This review uses meta-analysis to summarize the most relevant trial evidence available on the effects of internet-based interventions on caregiving outcomes. Another strength of this review is the *a priori* selection of rigorous methodological designs, including only RCTs and CCTs. The review was conducted using a comprehensive search strategy and methodologically rigorous processes for systematic reviews and meta-analyses. The included papers were published between 2005 and 2016, with 12 of 14 published since 2012, which reflects the growing interest in internet technology to support caregivers. One of the limitations of the review involved the overall low quality of the studies included, despite being RCTs and CCTs. There was considerable heterogeneity of the interventions across studies, so results were examined
according to types of internet-based interventions. However, there were too few studies having used each type of internet-based intervention across the outcomes of interest.

**Conclusions**

This paper and its companion paper [21] are the first meta-analyses of the effect of internet-based interventions for caregivers of community-living adults with chronic conditions on caregiver outcomes. The findings indicate that there is accumulating evidence for the positive effect of caregiver-focused internet-based interventions to support family and friend caregivers. However, future high-quality research with stronger study designs, larger sample sizes, and the use of standardized tools to facilitate meta-analysis and assessment of clinical relevance are needed to understand the effect of such interventions, particularly multi-component interventions using peer or professional support.
Acknowledgements
This work is part of a program of research (Aging, Community and Health Research Unit) supported by the Canadian Institutes of Health Research Signature Initiative in Community-Based Primary Healthcare [55] (Funding Reference Number TTF 128261). This work was also supported by the McMaster Evidence Review and Synthesis team. MM-R was supported through a Canada Research Chair in Person-Centred Interventions for Older Adults with Multimorbidity and their Caregivers. RV was supported through the Dorothy C. Hall Chair in Primary Health Care Nursing, School of Nursing, McMaster University.

Conflicts of Interest
None declared

Abbreviations
CCT: controlled clinical trial
CI: confidence interval
IV: inverse variation
RCT: randomized controlled trial
RoB: risk of bias
SD: standard deviation
SE: standard error
SMD: standardized mean difference

Multimedia Appendix 1
Search Terms
Multimedia Appendix 2
Detailed Characteristics of Included Studies
Multimedia Appendix 3
References


31. GRADEpro [Computer program]. McMaster University; 2015.


