

Assessment of sex analysis in studies of technology-based interventions to alleviate caregiver burden among caregivers of persons with dementia

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Abstract

Background: With an increase in the number of family caregivers for persons with dementia, caregiver burden is a major concern. Defined as computer-based devices and programs, technology has been identified as an intervention to address this issue. However, to date, there is little consideration of sex differences among caregivers in the design and planning of these interventions.

Objective: To systematically review the literature on technology-based interventions for caregivers of persons with dementia and report the frequency and approaches of sex-based analysis.

Methods: The literature was systematically searched for reviews of technology-based interventions for caregivers of persons with dementia. All titles and abstracts of publications included in the retrieved reviews were screened using pre-determined inclusion and exclusion criteria. Full text articles that met the inclusion criteria were included for analysis.

Results: Four reviews were identified and 19 articles representing 17 studies were retrieved. Among these studies, only four examined outcomes by sex. In the studies that examined outcomes by sex, three reported significant differences ($p < 0.05$) between male and female caregivers.

Conclusions: There is currently a lack of (1) sex-based analyses, (2) inclusion of males and (3) provision of sex-specific information in studies of technology-based interventions for caregivers of persons with dementia.

Keywords

Assistive technology, caregiving, independent living, rehabilitation, sex-based

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Introduction

Dementia has become a major concern in Canada with an annual total economic burden of \$33 billion.¹ An estimated 750,000 Canadians are living with dementia-related conditions and by 2038, that number will more than double to affect over one million Canadians.¹ Dementia results from several conditions, the most common being Alzheimer's disease, and is an overall term that describes a wide range of symptoms associated with a decline in mental ability.² In addition to symptoms associated with cognitive decline, persons with dementia (PWD) also experience behavioral and psychological disturbances such as depressive mood, anxiety, restlessness, agitation among others.^{3,4} Similar to other cognitive conditions, dementia is

progressive with symptoms appearing slowly before gradually getting worse.² As a result of the high prevalence of dementia coupled with an aging population, an increasing number of families are providing home care

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for PWDs. While the presence of kinship and a familiar home environment have been shown to delay unfavorable health outcomes such as death or institutionalization of the care recipient, caregiving for PWD remains a highly stressful experience for many family caregivers and may contribute to negative physical and psychological health outcomes.⁵⁻⁷

Given the high personal cost faced by caregivers of PWD, interventions have been developed with the goal of improving the health and psychosocial outcomes of PWD and their caregivers.⁸ Defined as computer-based devices and programs, technology has been proposed as a tool to improve independent living, safety, the quality of life of PWD and their family caregivers.⁹⁻¹⁰ Technology-based interventions can play a variety of roles such as providing task reminders, supporting behavioral management strategies and improving communication systems.¹¹ Examples of technology-based interventions include cognitive aids, smart home monitoring systems, interactive telecommunication devices and environment sensors.¹⁰ As a result, these interventions have been shown to have positive effects for caregivers of PWD including more free time and peace of mind, as well as increased compassion for the care recipients.¹² While these interventions may not provide immediate relief for caregivers, they may help to alleviate some of the caregiving stressors and hence, indirectly reduce caregiver burden and stress.

The stress and burden experienced by caregivers of PWD may be influenced by sex. Sex is a multidimensional biological construct that encompasses anatomy, physiology, genes, and hormones that distinguish males from females.¹³ It is important to note that the construct of sex is distinct from that of gender, which refers to the social and cultural processes by which individuals learn, adopt, negotiate, and express attitudinal or behavioral patterns assigned to them based on their sex.¹³ Previous analyses of sex differences among caregivers have shown strong associations with respect to well-being, psychosocial, and overall health status.¹⁴ Specifically, female caregivers have reported higher levels of depressive symptomatology and are at a higher risk for clinical depression compared to their male counterparts.¹⁵ Additionally, differences were also observed in relation to subjective measures of health and well-being, with female caregivers reporting a greater perception of ill health and lower levels of quality of life than male caregivers.¹⁶ Similarly, the forms of caregiver burden and stress experienced were also heavily influenced by sex distinctions. While male caregivers were found to experience a low morale and a greater need for social support, the burden experienced by female caregivers was often attributed to their relationships with other family members.¹⁷

Together, these sex differences in the types and levels of caregiver burden give rise to the adoption of different coping strategies among male and female caregivers. In particular, female caregivers tended to employ more emotion-focused coping, which involves addressing the feelings associated with a particular strain or stressor. On the other hand, male caregivers gravitate towards problem-focused strategies that involve pragmatically addressing the tangible consequences of the strain or stressor.¹⁸

With respect to technology, sex and gender play an important role in the attitudes and acceptance of new technologies. Several prior studies have found a greater interest and more positive attitude towards information technologies among males compared to females.¹⁹ Consequently, these different attitudes towards technology have also been shown to influence the decision to adopt new technologies. Specifically, males' decisions are mainly influenced by their positive attitudes towards technology while females are mainly influenced by subjective norm and behavioral control.²⁰

Despite the significant sex and gender differences with respect to caregiver burden and technology, previous research on technology-based interventions has often overlooked the importance of sex differences among caregivers of PWD. To address this research gap, this paper systematically reviewed the literature on technology-based interventions for caregivers of PWD to assess the extent to which sex differences were incorporated in the evaluation of technology-based interventions for caregivers of PWD. Specifically, this exploratory study assessed the presence and forms of sex-based analysis as well as differential outcomes between male and female caregivers within current studies on technology-based interventions for caregivers of PWD.

Methods

Search strategy

The following databases were systematically searched to identify reviews of technology-based interventions that aim to alleviate caregiver burden among caregivers of PWD: the Cochrane Database of Systematic Reviews (2005 to present), MEDLINE (1946 to present), MEDLINE In-Process (present), and Embase (1980 to present). Search terms that encompass the three main themes of this paper, caregivers, dementia, and technology were used. In addition, search strategies of previous reviews on technology-based interventions for caregivers of PWD were consulted to ensure a more comprehensive screen of the literature. These terms included but were not limited to, "technology", "tech-based", "caregiver", "caregiving", "dementia",

“Alzheimer’s”, and “review”. A full list of the search terms is provided in the supplementary material.

Study selection

A total of six reviews on technology-based interventions for caregivers of PWD were identified from the databases searched, of which two were excluded because they examined the unmet needs of PWD rather than those of the caregivers or focused exclusively on the use of robotic technology in the care of elderly PWD and therefore did not involve caregivers of PWD. Hence, four reviews were included in the analysis.

A total of 80 articles that the reviews included for analysis were retrieved. The titles and abstracts of all of these included articles were retrieved and reviewed based on a set inclusion and exclusion criteria. Articles that examined the use and effects of technology-based interventions for caregivers of PWD were included. Given that technology is a rapidly advancing field, papers that were published before the year 2000 were excluded as they may not represent the latest breakthroughs in this field. Additionally, articles that were conducted in settings other than the home and/or involved formal caregivers (e.g. personal support worker, nurses) or PWD exclusively were also excluded as it was beyond the focus of this paper (family caregivers of PWD within the home setting).

Of the 80 articles included within the retrieved reviews, 10 were duplicates and 51 articles were

eliminated from the study (Figure 1). Of the eliminated articles, 15 were excluded as they were published before the year 2000. Another 19 publications were excluded as they did not involve caregivers of PWD. Similarly, 15 were removed from the analysis because they were not conducted within home settings. Two articles were eliminated from the analysis as they were conference proceeding abstracts and full text versions were unavailable. A total of 19 articles from the four previously retrieved reviews were included in this analysis.

Data extraction from articles

In this analysis of sex differences in the studies of technology-based interventions to alleviate caregiver burden among caregivers of PWD, 19 included articles were retrieved. From these papers, the following information was extracted: authors and year of publication; purpose and type of technology examined in the study; study design; total number of participants; percentages of each sex; whether or not sex-based data analysis was performed; and observed sex-specific findings or trends (Table 1). As a number of the articles retrieved from the reviews were based on the same overall study and utilized the same data source, all of the publications related to a single study were reviewed and integrated as a single entry in the table of results whenever possible (Table 1). In most cases, the data from the original publication were used to determine the number and sex distribution of the participants. However, in the event

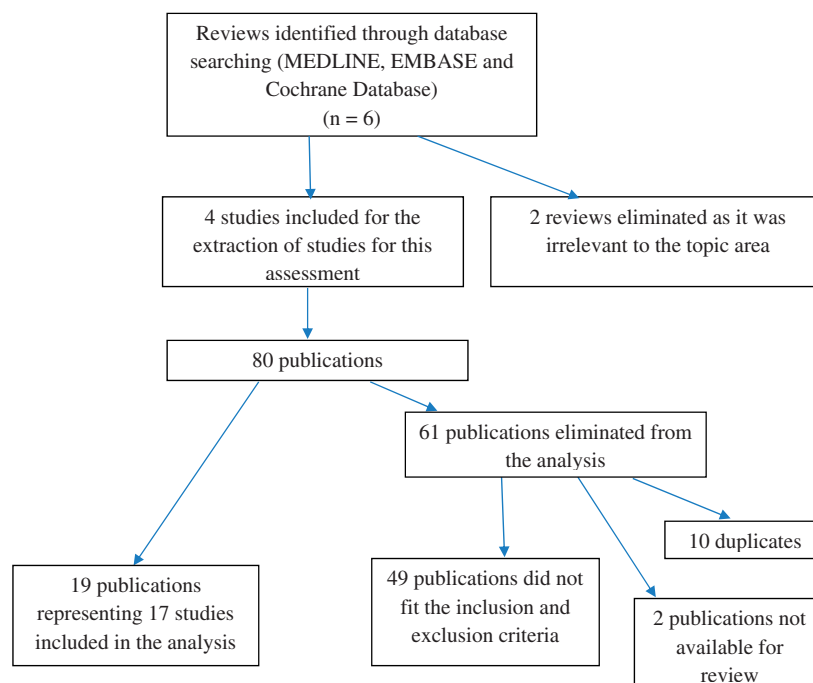


Figure 1. Flow chart of study inclusion and exclusion.

Table 1. Studies included in the assessment of sex-based analysis in studies of technology-based interventions to alleviate caregiver burden among caregivers of PWD.

Authors and Year	Purpose	Technology	Study design and participants	Sex distribution	Sex-based analysis	Sex-specific findings or trends
<i>Telephone-based interventions</i>						
Chang et al. (2004) ³⁵	To determine the perceived helpfulness of telephone calls to caregivers	Telephone calls to caregivers and videos	RCT; 83 community-based caregivers	90% female	No	No
Paul et al. (2000) ³⁶	To study the possibility of providing rural caregivers nutritional information and tool for interaction	Questionnaire evaluating a videoconference aimed to provide information on nutrition and dementia	Cross-sectional survey; 66 family and professional rural caregivers of PWD Did not provide the proportion of each caregiver type	No information provided	No	No
Winter and Gitlin (2007) ³⁷	To evaluate the feasibility and effectiveness of professionally led telephone-based support groups	Telephone-based support group	RCT; 103 family caregivers of PWD	100% female	No	No
<i>Internet-based interventions</i>						
Beauchamp et al. (2005) ³⁸	To evaluate the efficacy of a multimedia support program delivered over the internet to employed caregivers	Worksite-based internet multimedia program	RCT; 299 employed family caregivers	73% female	No	No
Lee et al. (2000) ³⁹	To examine the probability of a telemedicine system as a model of home- and community-based care system for elderly individuals with dementia	Dementia Telemedicine Center which provides telemedicine, tele-education and tele-counseling services for individuals with dementia, their family and formal caregivers	Pretest-Posttest; a total of 2955 system users, including 620 family caregivers	No information provided	No	No
Marziali et al. (2006) ⁴⁰	To study the possibility of duplicating online group interactions typical of face-to-face support groups	Internet-based support groups	Pretest-Posttest feasibility Study; 34 family caregivers of persons with Alzheimer's, Parkinson's or stroke. Did not provide the proportion of individuals with each of the condition	No information provided	No.	No.
Marziali and Donahue (2006) ⁴¹	To evaluate the effects of an innovative, Internet-based psychosocial intervention for family caregivers of older adults with neurodegenerative disease	Web site with links to information, e-mail, threaded discussion and video-conferencing link that allowed participation in a guided psychosocial support group	RCT; 66 family caregivers of individuals with neurodegenerative disease including Alzheimer's, stroke-related dementia, and Parkinson's (22 per disease group)	No information provided.	No	No

(continued)

Table 1. Continued

Authors and Year	Purpose	Technology	Study design and participants	Sex distribution	Sex-based analysis	Sex-specific findings or trends
<i>Integrated interventions</i>						
Bank et al. (2006) ⁴²	To demonstrate the usefulness of technology in conducting support group	Computer-telephone mediated integrated system for calls, messages and conferences with other caregivers	Pretest–Posttest; 41 family caregivers of PWD	76% female	Yes; examined the relationship between frequency of group participation and sex	No
Czaja and Rubert (2002) ⁴³	To describe how technology can be used to support caregivers and improve PWD and their quality of life	Computer integrated telephone system for communication and information access	Pretest–Posttest; 44 family caregivers	77% female	No	No
Eisdorfer et al. (2004) ⁴⁴	To study efficacy of a family therapy and technology-based intervention in reducing depressive symptoms	Computer–telephone integrated system for communication and access for supportive resources	RCT; 225 family caregivers	75% female	No	No
Finkel et al. (2007) ⁴⁵	To evaluate the effectiveness of a technology-based caregiver psychosocial intervention	Computer–telephone integration system that enable users to place and receive calls, send and retrieve messages, access information and services and conferences with other individuals simultaneously	RCT; 36 family caregivers of persons with Alzheimer disease or related dementia	68% female	No	No
Gitlin et al. (2003) ⁴⁶	To determine the pooled treatment effect of 15 different Resources for Enhancing Alzheimer's Caregiver Health (REACH) interventions on caregiver burden and depression	15 interventions that included skills-training, telephone-linked computer, environmental skill building programs, computer-telephone integration system, coping with caregiving classes and enhanced support groups	Pretest–posttest; 1222 family caregivers of PWD	81% female	Yes; examined if basic caregiver characteristics (i.e. sex) was associated with pooled treatment effects of all of the interventions	Yes; interventions were found to be superior in reducing caregiver burden than control for females but not males.
Glueckauf et al. (2004) ⁴⁷	Describes the development and implementation of Alzheimer's Caregiver Support Online for caregiver of individuals with progressive dementia	Internet- and telephone-based education and support network that consist of audiovisual presentations, message boards, chat rooms, electronic library and help resources	Pretest–Posttest; 21 family caregivers	86% female	No	No

(continued)

Table 1. Continued

Authors and Year	Purpose	Technology	Study design and participants	Sex distribution	Sex-based analysis	Sex-specific findings or trends
Mahoney et al. (2001) ⁴⁹	Examine the usefulness of a telephone-based intervention to help family caregivers manage disruptive behaviors in people with Alzheimer's disease	Computer-mediated interactive voice response system integrated with voicemail	RCT; 100 family caregivers	Intervention group (n = 49): 82% female Control group (n = 51): 75% female	Yes; examined sex differences of adopters (caregivers who went on to use the system for two or more consecutive months) and non-adopters as well as relationship between caregivers' sex and duration of use of the intervention system	Yes; the proportion of males who were adopters was much greater than non-adopters.
Mahoney et al. (2003) ⁵⁰						
Smyth et al. (2007) ⁵¹	To analyze importance of dimensions of social support and expectations of technology-mediated support groups	Questionnaire with items used to determine the importance of each dimension of social support (emotional, social and informational) as perceived by caregivers of PWD	Cross-sectional survey; 118 family caregivers of PWD	67% female	Yes; explored relationships between caregivers' sex and their responses	Yes; females considered informational and companionship support more important than males.
<i>Home monitoring interventions</i>						
Atlus et al. (2000) ⁵²	To study the use and usefulness of a monitoring system for caregivers peace of mind	Passive electronic monitoring system	Cross-sectional survey; 352 respondents, of which 48 are family home caregivers	Majority females; did not provide any detailed sex distribution	No	No
Kinney et al. (2004) ⁵³	To evaluate the use of usefulness of a monitoring system for caregivers	Passive internet-based monitoring system	Pretest-posttest; 19 family caregivers	58% female	No	No

RCT: randomized control trials; PWD: persons with dementia.

that the information within the publications was inconsistent with what was stated in the review, the statistics and data from the original publication were used in the analysis and calculations. Upon the completion of the data extraction process, the studies and their corresponding publications were categorized based on the types of technology examined, namely telephone-based, internet-based, integrated, and home monitoring interventions.

Within this analysis, telephone-based interventions were defined as interventions that involve the use of the telephone exclusively; internet-based interventions were systems that are web-based and require an internet connection; and integrated interventions were defined as interventions that incorporated multiple technological devices including computers and telephones. Finally, home monitoring interventions were defined as systems that help caregivers of PWD monitor the care recipient when they are alone in the home.

Criteria of sex-based analysis

The criteria for sex-based analysis within the studies were adapted from a previous study assessing the presence of sex-based analysis in Cochrane reviews.²¹ Using these criteria, a study was determined to have a

sex-based analysis if the analysis of the results for a given study was broken down by sex. These analyses could include textual comparisons of the results between males and females as well as tables or charts with sex distributed statistics. With respect to studies that incorporated a sex-based analysis, discordant results between male and female caregivers were examined and recorded. For the purposes of the analysis, a discordant outcome was recorded when: (1) the results were significantly different ($p < 0.05$) between males and females; or (2) the study found significant outcomes for only one sex. In the event that no discordant outcomes were reported, the analysis was marked as completed and any observed sex-specific trends were recorded.

Results

Sex distribution and sex-based analysis

As shown in Table 2, of the included studies three examined telephone-based interventions and another four examined internet-based interventions. Two studies investigated home monitoring interventions while eight focused on integrated interventions. With respect to research design (Table 3), seven studies were considered randomized control trials (RCTs); seven used a pretest-posttest design and the remaining three

Table 2. Sex-specific representation in studies of technology-based interventions to alleviate caregiver burden among caregivers of PWD based on intervention type.

Intervention type	Number of studies	Total participants ^a	% of females	Studies with both sexes	With sex-based analysis	With discordant outcomes
Telephone-based	3	252	96 ^b	2	0	0
Internet-based	4	975	73 ^b	4	0	0
Integrated	8	1807	79	8	4	3
Home monitoring	2	67	58 ^b	2	0	0

^aOnly family caregivers of PWD are included.

^bStudies that did not include the sex distribution of the participants are not included in this calculation.

Table 3. Sex-specific representation in studies of technology-based interventions to alleviate caregiver burden among caregivers of PWD based on study design.

Study design	Number of studies	Total participants ^a	% of females	Studies with both sexes	With sex-based analysis	With discordant outcomes
RCT	7	868	79 ^b	6	1	1
Pretest–Posttest	7	2001	80 ^b	7	2	1
Cross-sectional survey	3	232	67 ^b	3	1	1

^aOnly family caregivers of PWD are included.

^bStudies that did not include the sex distribution of the participants are not included in this calculation.

RCT: randomized control trials.

being cross sectional surveys. A breakdown of each of the 17 studies included in this analysis can be found in Table 1.

There was an over representation of females in studies that reported the sex distribution of participants across all study designs and technology types (Tables 2 and 3). In particular, one RCT examining a telephone-based intervention only included female participants. As a result, 96% of participants in the included studies that examine telephone-based interventions were female. Similarly, females made up 73% and 79% of participants in studies on internet-based and integrated interventions respectively. Among studies that examine home monitoring interventions, females represented 58% of the study population. Across the different study designs, 79% of participants in RCTs were female. Among pretest-posttest designs, 80% of participants were female. Finally, 67% of participants in cross-sectional studies were female. However, it is important to note that not all of the included studies reported on the sex distribution of the participants (Table 1).

Within the 16 studies that included males and females, four (25%) conducted a sex-based analysis of the outcome measures. Interestingly, all of the studies that incorporated a sex-based analysis examined integrated technological interventions (Table 2). In relation to the research design, sex-based analysis was present in each of the three study designs types: RCTs; pretest–posttest; and cross-sectional surveys (Table 3). Specifically, 14% of RCTs, 33% of cross-sectional surveys and 29% of pretest–posttest designs included sex-based analyses.

Discordant outcomes

Of the four studies in which a sex-based analysis was conducted, three discussed results in which there was a statistically significant ($p < 0.05$) discordance between outcome measures in females and males. Following is a review of the discordant findings from the included studies as described in Table 1.

In a study conducted by Gitlin et al.²² examining a variety of interventions (including integrated interventions), females were found to better benefit from the interventions compared to males, as demonstrated by the pooled parameter estimate of their Revised Memory and Behavior Problems Checklist Burden scores after undergoing the interventions for six months. On the other hand, no statistically significant difference in the pooled parameter estimate of the Centre for Epidemiological Studies-Depression Scale score (another outcome measure) was found between males and females after six months of undergoing the interventions.²²

Another study by Glueckauf et al.²³ on the usefulness and adoption of an integrated voice response system found discordance among males and females

with regards to the rate of technology adoption. Defined as individuals who used the intervention for two or more consecutive months throughout the duration of the study, a significantly higher proportion of adopters were men compared to nonadopters.²³ A similar trend was not observed among female participants within the study. Conversely, no statistically significant difference between males and females was found among the other outcomes measures of the study such as the intervention's duration of use.

Finally, the study by Smyth et al.²⁴ examined the importance of different forms of social support within technology-mediated support groups for caregivers of PWD. A statistical significant difference ($p < 0.05$) was found in the perceived importance of companionship support with females viewing it as more important than males. In addition, there was also a difference in the perception of the importance of information support, with females considering it as more important compared to males. However, this difference was not statistically significant ($p > 0.05$).

Discussion

This is the first study, to the best of our knowledge that assessed the presence and results of sex analysis in studies of technology-based interventions to alleviate caregiver burden among caregivers of PWD. The results of the assessment revealed a lack of quality sex-based analysis applicable to this subject area. Among studies that included both sexes, only four of them performed a sex-based analysis. All but one of the studies that performed a sex-based analysis found significant discordant outcomes between males and females. If more studies included an element of sex-based analysis, discordant outcomes might be uncovered more frequently. Indeed, frameworks for sex-based analysis such as a recent approach developed by Johnson et al.¹³ are increasingly used in scientific research. Within this approach, Johnson et al.¹³ presented several methodologies to incorporate sex and gender-based analysis at various stages of the research process. These methodologies include: reanalyzing or performing a secondary analysis on existing collected data; enhancing a current study by making modifications to the research design; and incorporating sex and gender-based analysis from the onset of a study. Systematic and consistent incorporation of these frameworks will go a long way in helping to elucidate discordance as well as examining the mechanisms behind these differences. Equipped with this knowledge, researchers may be able to determine the likelihood of a discordant outcome between male and female caregivers for a particular intervention.

Among the different types of interventions examined, integrated interventions received the greatest

sex-based analytic focus, with half of the studies investigating the sex effects of this particular form of intervention on caregivers of PWD. This finding reflects the recent trend of research on the role of integrated interventions in reducing caregiver burden. Earlier studies largely focused on single component interventions such as support groups, workshops, and education and training programs.^{6,17} However, these single intervention approaches have only shown modest effects in alleviating caregiver burden.²⁵ Subsequently, more recent studies have adopted an integrated intervention approach. For example, these novel multiple interventions include combinations of family counseling, case management, environmental modifications, behavioral management, and skills training programs.^{26–29} Results from this new generation of studies have proven to be more effective in reducing the stress and burden among caregivers of PWD. Hence, a similar shift from single component interventions to integrated technologies involving multiple components may also be taking place within the field of technology-based interventions for caregivers of PWD.

Across the three different research designs of the included studies, a smaller proportion of RCTs included a sex-based analysis compared to the other two study designs. This might be attributed to the increased logistical demands and challenges associated with conducting RCTs. While there may be limited resources to conduct a sex-based analysis in addition to the existing study plan, integrating a sex-based analysis from the outset may increase the significance of the findings, thereby elevating the study's relevance and overall impact.

While most of the studies included participants of both sexes, there were a disproportionately higher number of female study participants. While this may be interpreted as inattention to male caregivers of PWD, it is important to recognize the predominance of females within the entire caregiving population. Past research has found that females are more likely to be caregivers and represent up to 80% of the total caregiver population.³⁰ This presents a challenge for studies on interventions to alleviate PWD caregiver burden to include equal proportions of caregivers of both sexes as it may be more difficult to recruit male caregivers. Previous research on technology has found that males are more accepting of new technologies and with a growing population of both female and male PWD caregivers, sex differences in intervention adoption are increasingly salient.¹⁹ As such, greater efforts should be made to actively recruit male caregivers of PWD and gather their perspectives on these technology-based interventions.

Moreover, several of the included studies in the analysis did not describe the sex distribution of the participants. As a result, it was not possible to ascertain from these studies how many, if any, males were included.

This represents a complete neglect of any potential influence of sex differences on the outcomes measures and further reinforces the notion that sex differences are often ignored within health research. At the same time, the absence of such important information would also impede any further re-analysis of the data from a sex-based perspective.

Significantly, none of the four review articles that referenced the 17 studies addressed the possible role of sex differences. Although it is recognized that literature and systematic reviews do not generally conduct sex-based analyses, a Sex and Gender in Systematic Reviews Planning Tool developed in recent years has demonstrated that such an analysis is possible.³¹ As health care professionals are expected to make decisions in accordance with these reviews, it is essential that the information provided is applicable to the target population. A health care professional responsible for prescribing technology-based interventions for both male and female caregivers of PWD should be aware of any data that supports different interventions for these caregiving groups. The inclusion of sex-based analysis in future reviews will benefit both health care professionals and caregivers of PWD who will receive interventions that better address their needs.

Recommendations

Given the potential sex differences in technology-based interventions among caregivers of PWD, studies on these interventions should include information on the sex distribution of the participants as it represents a pivotal first step in the incorporation of sex-based analysis within the research process. Additionally, based on the findings of this assessment of current studies, a three pronged approach to better integrate sex-based analyses in future studies of technology-based interventions for caregivers of PWD is recommended. First, more males need to be enrolled as participants in studies to ensure that the perspectives and needs of males are captured and addressed. One way this can be achieved is through the establishment of male caregiver of PWD support groups and databases.

In line with previous published literature and guidelines, researchers need to analyze outcomes of studies by sex and publish such information regardless of the results.^{32–34} While there is an increased focus on integrated technology-based interventions, sex-based analysis needs to be an integral part of the research process. This can be realized through using existing sex and gender-based analysis frameworks such as those presented by Johnson and colleagues.¹³ By including a sex-based analysis as part of research on technology-based interventions, future study findings can better inform the development,

implementation and evaluation of all technology-based interventions for caregivers of PWD.

Finally, systematic and literature reviews of studies that examine technology-based interventions for caregivers of PWD should include information on sex differences within their analyses. Existing frameworks designed to integrate these sex-based analyses within systematic and literature reviews can be utilized. Altogether, these approaches will lead to a stronger foundation of sex-based evidence that ultimately translates into sex-specific technology-based interventions that will reduce caregiver burden among caregivers of PWD. Additionally, these recommendations for an increased focus on sex-based analysis may also be relevant to the development and research process of other novel technologies within the field of rehabilitation.

Strengths and limitations

This study represents a first step in the exploration of sex-based analysis within the literature of technology-based interventions to alleviate caregiver burden among caregivers of PWD. With an inclusive search strategy across the databases, this paper was able to retrieve the majority of the major systematic and literature reviews within this topic area. It therefore allowed for a comprehensive assessment of sex-based analysis in current studies. In addition, the paper utilized published reviews as a source for studies on technology-based interventions, thereby ensuring that studies included for this assessment are methodologically sound and are of high quality.

On the other hand, limitations associated with the use of reviews as a source of studies to be included in the assessment need to be considered. Firstly, as technology is always changing rapidly and many of the reviews were published in the last five years, it may not represent the forefront of research within the field of technology-based interventions for caregivers of PWD.

As a result, very recent studies that are conducted and published may not be captured in this review and thereby not included in our assessment. In addition, it is recognized that relevant studies included in the grey literature and non-peer-reviewed reports not included in academic reviews may also be missed in this assessment. Given that the review focuses on technology interventions, publications in technology journals that have not been indexed by the databases searched may not have been captured. As such, future reviews should incorporate searches of additional technology-oriented databases to generate a more comprehensive overview of the available literature. Finally, it is acknowledged that the outcomes of studies that examined potential sex differences between male and female caregivers are diverse. As such, comparisons between the outcomes were and should not be made. Nonetheless,

these studies served as a glimpse into the potential sex differences among caregivers and calls out to the importance of incorporating sex analysis in future studies relating to caregivers of PWD and technology.

Conclusion

This paper provides a pioneering overview of the extent to which sex-based analyses are integrated in studies on technology-based interventions to alleviate caregiver burden among caregivers of PWD. As the number of caregivers of PWD continues to rise with the increasing prevalence of dementia, a greater demand for these technology-based interventions will be anticipated in the near future. It is important to be aware of and consider potential sex differences when developing and testing these interventions so as to be able to tailor the interventions as well as marketing strategies based on the different needs and preferences of male and female caregivers. Continued research and a greater level of integration of sex-based analysis within future studies is warranted and can inform the design, implementation and evaluation of sex-specific technology-based interventions for caregivers of PWD.

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Contributorship

All authors contributed to the conception and design of the review. CX developed the search strategy, performed the searches and drafted the manuscript. EM and AC read and provided feedback on the manuscript.

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