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Interventions Associated With Reduced Loneliness and Social Isolation in Older Adults

A Systematic Review and Meta-analysis

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Abstract

IMPORTANCE Loneliness and social isolation are public health concerns faced by older adults due to physical, cognitive, and psychosocial changes that develop with aging. Loneliness and social isolation are associated with increased morbidity and mortality.

OBJECTIVE To evaluate interventions, targeting older adults, associated with a reduction in loneliness and social isolation.

DATA SOURCES OVID, CINAHL, CENTRAL, Embase, PsychINFO, Web of Science, and Scopus were searched from inception to March 2020.

STUDY SELECTION Peer-reviewed randomized clinical trials measuring loneliness and social isolation or support in adults aged 65 years or older. Only English language articles were included.

DATA EXTRACTION AND SYNTHESIS Two independent reviewers screened studies, extracted data, and assessed risk of bias. Random-effects models were performed to pool the overall effect size by intervention. Statistical heterogeneity was evaluated with the I^2 statistic and by estimating prediction intervals. Data were analyzed from November 2021 to September 2022.

MAIN OUTCOMES AND MEASURES Quantitative measures of loneliness, social isolation, or social support based on an effect size of standardized mean differences.

RESULTS Seventy studies were included in the systematic review (8259 participants); 44 studies were included in the loneliness meta-analysis (33 in the community with 3535 participants; 11 in long-term care with 1057 participants), with participants' ages ranging from 55 to 100 years. Study sizes ranged from 8 to 741 participants. Interventions included animal therapy, psychotherapy or cognitive behavioral therapy, multicomponent, counseling, exercise, music therapy, occupational therapy, reminiscence therapy, social interventions, and technological interventions. Most interventions had a small effect size. Animal therapy in long-term care, when accounting for studies with no active controls, had the largest effect size on loneliness reduction (−1.86; 95% CI, −3.14 to −0.59; I^2 = 86%) followed by technological interventions (videoconferencing) in long-term care (−1.40; 95% CI, −2.37 to −0.44; I^2 = 70%).

CONCLUSIONS AND RELEVANCE In this study, animal therapy and technology in long-term care had large effect sizes, but also high heterogeneity, so the effect size's magnitude should be interpreted with caution. The small number of studies per intervention limits conclusions on sources of heterogeneity. Overall quality of evidence was very low. Future studies should consider measures

(continued)

Key Points

Question What interventions are associated with reduced loneliness and social isolation in older adults?

Findings In this systematic review of 70 studies with 8259 participants (with meta-analysis of 44 studies with loneliness outcomes; 33 in the community and 11 in long-term care), animal therapy, multicomponent interventions, exercise, technological interventions, and therapy (eg, cognitive behavioral therapy and psychotherapy) had small to large effect sizes associated with reductions in loneliness and social isolation. Studies in long-term care demonstrated a large effect size.

Meaning These findings suggest that several interventions are associated with a reduction in loneliness in older adults, but cautious interpretation is required given the high heterogeneity and a small number of studies per intervention.

+ Supplemental content

Author affiliations and article information are listed at the end of this article.

Abstract (continued)

of social isolation in long-term care and identify the contextual components that are associated with a reduction in loneliness.

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Introduction

Older adults (generally defined as those aged ≥65 years)[1-3] are more vulnerable than younger adults to loneliness and social isolation.[4-7] The COVID-19 pandemic has exacerbated this phenomenon.[8] Loneliness is described as the subjective perception of missing social contacts or a desired companion, while social isolation is the objective lack of social contact with other persons.[9] Loneliness and social isolation are associated with morbidity and mortality.[10-13] In the US, one-third of adults aged 45 years and older report loneliness and nearly one-quarter of adults aged 65 years and older are considered socially isolated.[9]

Loneliness in older adults can be mediated by supportive social networks,[14] physical mobility,[15] and living arrangements.[9] Previous systematic reviews (SRs) on interventions targeting loneliness showed that a multitude of interventions[16-19] can be associated with reduced loneliness in older adults, including physical exercise,[20-22] reminiscence therapy,[23] and technological interventions.[24,25] Several reviews[17,20,21] incorporated social support as an outcome, suggesting that multiple mechanisms may improve the social milieu of older adults. Although more recent studies have divided interventions by subtype, previous SRs were limited to a specific intervention (eg, exercise or technology),[17,20-25] the absence of meta-analyses, and an older search date.[16,18,26,27] The most recent meta-analysis[18] searched the literature to 2009 and included 20 randomized clinical trials of only loneliness outcomes. There has since been increasing awareness of loneliness and social isolation by clinicians, researchers, and policy makers, with calls to centralize evidence and best practices. The National Academies Press additionally highlights the importance of assessing both social isolation and loneliness.[9] The aim of this SR and meta-analysis was to update and broaden the knowledge base on the interventions associated with a reduction in loneliness and social isolation in older adults.

Methods

This SR and meta-analysis was registered with PROSPERO (CRD42020178836). We reported according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) reporting guideline.[39]

Eligibility Criteria

We included randomized clinical trials of adults aged 65 years and older that reported a validated quantitative outcome measurement of loneliness, social isolation, or social support or network in the English language. There was no exclusion based on prerequisite loneliness and/or social isolation. Theses and protocols were searched to identify subsequently published studies and were included if there was a peer-reviewed journal publication. Social support was defined as a multifaceted concept encompassing the type of support being received, and the perception of having accessible and quality social ties, with social needs being met.[28,29] Low social support and loneliness are interrelated constructs that are associated with poorer quality of life.[30,31]

Search Strategy and Selection Criteria

The search was conducted on March 2020. We searched OVID, CINAHL, CENTRAL, Embase, PsychINFO, Web of Science, and Scopus databases. Citations of included SRs were hand searched.

We included 5 concepts and their associated MeSH, EMTREE, or PsychINFO terms: older adult, social isolation or loneliness or social support, social intervention, technology, and music therapy or animal therapy. Details of the search strategy can be found in eTable 1 in the Supplement.

Study Selection

Titles, abstracts, and full-text articles were reviewed in duplicate for inclusion or exclusion. Full texts of intervention studies targeting loneliness or social isolation in older adults were included. Discrepancies were resolved by discussion, and if required, a third reviewer. The κ statistic was used to determine reviewer agreement (eTable 2 in the Supplement) for abstract selection.

Data Extraction

Data were extracted and entered into an Excel version 16.64 (Microsoft Corp) template by independent pairs of authors (J.M. and S.M., C.V.T. and P.H., K.R. and H.S., C.W. and P.H., and K.M. and P.H.). One author extracted and entered the data while the second author confirmed accuracy. The following data were extracted: author, year, country, setting, study design, number of participants, attrition, demographics (mean or median age and percentage female), inclusion and exclusion criteria, loneliness or social support scale used, study outcomes, and a description of the study groups. Authors were contacted to obtain missing study data. Long-term care (LTC) was defined as participants who required institutional living (eg, nursing home); this excluded assisted and retirement living.[1] For studies with multiple outcome measurement time points, the final measurement was extracted. Studies were grouped by intervention (eg, animal therapy, psychotherapy or cognitive behavioral therapy [CBT], exercise, social interventions, and information and communications technology), similar to recent SRs.[27,32] Combination or multicomponent interventions were defined as studies containing multiple different interventions (eg, exercise and CBT).[18,20,24,27] Intervention types were assessed independently by 1 author (P.H.) and reviewed by 2 other authors (J.M. and J.A.K.). Discrepancies were resolved by consensus.

Risk of Bias

Risk of bias was assessed independently by pairs of authors (J.M. and S.M., C.V.T. and P.H., K.R. and H.S., C.W. and P.H., and K.M. and P.H.) using the revised Cochrane risk of bias tool for randomized trials.[33] Discrepancies were resolved by consensus or a third reviewer.

Statistical Analysis

Articles with quantitative outcomes were included in meta-analysis when possible. Social support and social isolation were analyzed separately from loneliness. The standardized mean difference, Cohen *d*,[34] and associated 95% CIs were estimated for studies with available data. We used the compute.es package in R version 1.3.1056 (R Project for Statistical Computing) to estimate Cohen *d* when sufficient information was available.[35] Random-effects models using generic inverse variance methods were performed to pool the overall effect size (ES) by intervention. Statistical heterogeneity was evaluated with the I^2 statistic and estimating prediction intervals. Prediction intervals were estimated using an equation in Higgins et al[36] that uses a *t* distribution with $K-2$ degrees of freedom (where K represents number of studies). When heterogeneity was observed, we used the find.outliers function in R to identify which studies may be contributing the most influence to the heterogeneity, then removed these for a subsequent analysis.[37] Sensitivity analyses were performed excluding multicomponent interventions (eg, combined Tai Chi and CBT) from the main analysis, and studies without active controls. We separately analyzed community and LTC settings, as studies suggest benefit for interventions targeting loneliness in LTC, where loneliness is highly prevalent.[23,32] Mixed settings that included LTC were not included in the meta-analysis. Heterogeneity was qualitatively assessed given the heterogeneity in study design and methods, and the limited statistical power to perform meta-regression. Funnel plots were produced to assess for potential publication bias (eFigure 1 in the Supplement). Statistical analyses were completed using

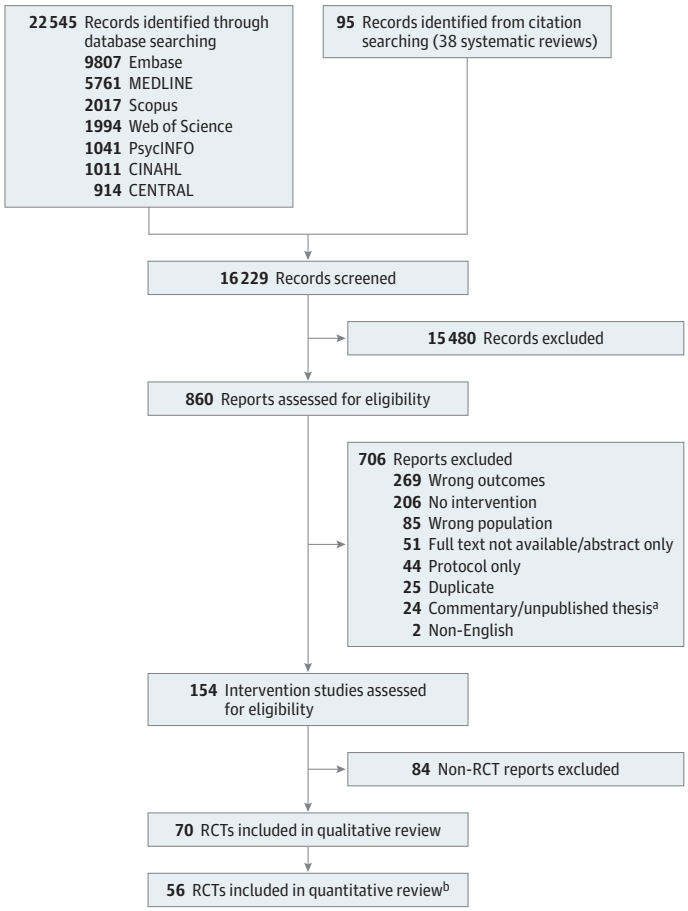
RStudio, version 1.3.1056 (R Project for Statistical Computing). Estimating methods for Cohen *d* can be found in eTable 3 in the Supplement. The BMJ Best Practice Grading of Recommendations Assessment, Development and Evaluation of Evidence Tool was applied to assess the quality of the evidence.[38] Two-sided $P < .05$ was considered significant. Data were analyzed from November 2021 to September 2022.

Results

The search resulted in 16 229 citations, with 15 460 excluded after title and abstract screening. Eight hundred sixty studies were included for full-text review, of which 790 were excluded. The PRISMA flow diagram of the search results is shown in **Figure 1**. Seventy studies with 8259 participants met the criteria for inclusion in the SR (**Table** and eTable 4 in the Supplement). Articles were published between 1985 and 2020. Most studies were conducted in the US (25 studies). Forty-three studies enrolled community-dwelling individuals, and 12 were conducted in LTC settings. Study sizes ranged from 8 to 741 in the SR, with participants being predominantly female (range, 0%-100%) and between the ages of 55 to 100 years. Loneliness was measured using the UCLA Loneliness scale (33 studies),[40] followed by the De Jong Gierveld Loneliness Scale (13 studies).[41] Social isolation was primarily measured using the Lubben Social Network Scale (3 studies).[42]

Fourteen studies were excluded from the meta-analysis for lack of reported outcomes or LTC combined with a community setting (eTable 5 in the Supplement).[43-56] Forty-four studies were included in the loneliness outcome meta-analysis (33 in community; 11 in LTC) (**Figure 2**, **Figure 3**, and **Figure 4**;

Figure 1. Flow Diagram of Studies Included in the Systematic Review and Meta-analysis



RCT indicates randomized clinical trial.

[a] Theses that were not published or do not have an associated publication in a peer-reviewed journal were excluded.

[b] A total of 56 studies were included in quantitative review, comprising 44 studies of loneliness outcomes, 5 studies of social isolation outcomes, and 8 studies of social support outcomes.

Table. Participants and Study Characteristics in Studies Included in the Systematic Review

Source (country)	Setting	Study design	Age, mean (SD), y	Sample, No. (percentage female)	Loneliness/social support scale[a]
Animal therapy					
Banks et al,[72] 2008 (US)	LTC	RCT	NR (NR)	38 (NR)	UCLA
Banks, and Banks,[71] 2005 (US)	LTC	RCT	80 (NR)	37 (57)	UCLA
Banks and Banks,[70] 2002 (US)	LTC	RCT	NR (NR)	45 (80)	UCLA
Jessen et al,[75] 1996 (US)	Rehabilitation unit	RCT	76 (NR)	40 (67.5)	Revised UCLA
Robinson et al,[74] 2013 (New Zealand)	Retirement home and hospital	RCT	NR (55-100)[b]	40 (67.5)	UCLA
Sollami et al,[73] 2017 (Italy)	Nursing home	RCT	Intervention: 85.07 (10.12); control: 84.91 (9.07)	28 (NR)	UCLA
Therapy					
Cox et al,[48] 2007 (US)	Variable	RCT: 3 groups	78.42 (9.78)	177 (76.8)	PGCMS Lonely Dissatisfaction
Jarvis et al,[110] 2019 (South Africa)	Residential care facility	RCT	74.93 (6.41)	32 (81.3)	De Jong Gierveld (6 item)
Li et al,[63] 2018 (China)	Community	RCT: Cluster	Intervention: 71.77 (5.49) Control: 71.88 (5.38)	201 (intervention: 44.3; control: 38.6)	Social Support Rating Scale
Nelson et al,[112] 2019 (US)	Community cancer center	RCT	76 (4)	59 (53)	UCLA Loneliness short form
Parry et al,[65] 2016 (United Kingdom)	Community	RCT	75.5 (8.55)	415 (70.1)	LSNS (6); De Jong Gierveld
Theeke et al,[111] 2016 (US)	Community	RCT	75 (7.5)	27 (89)	Revised UCLA
Combination or multicomponent					
Boen et al,[57] 2012 (Norway)	Community center	RCT	NR (NR)	138 (intervention: 59.5; control: 54.7)	Oslo-3 Social Support Scale
Huang et al,[59] 2011 (Taiwan)	Community	RCT	NR (NR)	186 (58.6)	Chinese version of the Inventory of Social Supportive Behaviors
Joubert et al,[49] 2013 (Australia)	Emergency department/community	RCT	71.25 (NR)	8 (75)	MOS: social support
Kapan et al,[58] 2017 (Austria)	Community	RCT	82.6 (8.1)	80 (84)	WHOQOL-BREF (social support)
Markle-Reid et al,[64] 2006 (Canada)	Nursing home	RCT	83.82 (5.37)	288 (76.9)	Personal Resource Questionnaire 85 (part 2)
Ollongvist et al,[52] 2008 (Finland)	Rehabilitation center	RCT	78 (NR)	741 (86)	Subjective 1-4 loneliness scale converted into binary outcome
Saito et al,[77] 2012 (Japan)	Community	RCT	Intervention: 72.6 (4.4) Control: 72.8 (4.8)	76 (intervention: 60; control: 70)	Ando-Osada-Kodama loneliness scale
Tse et al,[78] 2012 (Hong Kong)	Nursing home	Cluster RCT	85.17 (6.48)	535 (72.5)	Revised UCLA
Tse et al,[79] 2013 (China)	Nursing home	RCT: Cluster	≥ 80-89 (NR)[c]	90 (62.2)	Revised UCLA
Tse et al,[80] 2016 (China)	Nursing home	RCT: Cluster	NR (NR)	60 (82)	Geriatric Suicide Ideation Scale, Chinese version
Counseling					
Alaviani et al,[86] 2015 (Iran)	Community	RCT	NR (NR)	150 (100)	Revised UCLA
Chow et al,[81] 2019 (China)	Community	RCT: Cluster	74.3 (7.5)	125 (81.60)	De Jong Gierveld Loneliness Scale (7)
Cohen-Mansfield et al,[82] 2018 (Israel)	Community	RCT	Intervention: 76.6 (6.8)	89 (81.08)	Mean of 3 weight means: UCLA (8), frequency of loneliness (Mullins), and severity of loneliness
			Control: 79 (6.62)		
Estebsari et al,[43] 2018 (Iran)	Health house	RCT	65.9 (3.6)	464 (50)	De Jong Gierveld (7)
Kremers et al,[84] 2006 the (Netherlands)	Community	RCT	Intervention: 62.8. (6.4)	142 (100)	De Jong Gierveld
			Control: 65.2 (7.6)		
Mountain et al,[83] 2017 (United Kingdom)	Community	RCT	Intervention: 72.9 (65-92)	288 (intervention: 69.7; control: 66.4)	De Jong Gierveld
			Control: 71.3 (65-90)		
Routasalo et al,[85] 2009 (Finland)	Community	RCT	Intervention: 80 (75-92)[b,c]	235 (intervention: 74.4; control: 72.9)	UCLA
			Control: 80 (75-90)[b,c]		

(continued)

Table. Participants and Study Characteristics in Studies Included in the Systematic Review (continued)

Source (country)	Setting	Study design	Age, mean (SD), y	Sample, No. (percentage female)	Loneliness/social support scale[a]
Exercise					
Baez et al,[88] 2017 (Italy)	Independent living	RCT	71 (5.7)	40 (72.5)	Revised UCLA (3 item)
Chan et al,[90] 2017 (China)	Community	RCT	77.3 (7.4)	48 (76)	De Jong Gierveld (6)
Ehlers et al,[87] 2017 (United States)	Community	RCT: 4 groups	65.39 (4.56)	247 (68.4)	UCLA
Jansons et al,[67] 2017 (Australia)	Community	RCT	Intervention: 68 (11)	105 (63.81)	Friendship Scale
			Control: 66 (13)		
Jones et al,[89] 2019 (Canada)	Community	RCT	74.5 (6.2)	66 (42.4)	De Jong Gierveld
McAuley, et al[50] 2000 (US)	Community	RCT	66.71 (5.35)	174 (71.8)	UCLA
Tse et al,[55] 2014 (China)	Long-term care	RCT	85.44 (6.29)	396 (80.1)	UCLA
Wang et al,[91] 2010 (US)	Community	RCT	74.9 (8.4)	18 (88.9)	UCLA (3 item)
Music therapy					
Giovagnoli et al,[66] 2018 (Italy and US)		RCT	73.2 (NR)	45 (68.89)	LSNS
Johnson et al,[92] 2020 (US)	Senior centers	RCT: Waitlist-control	71.3 (7.2)	390 (76)	National Institutes of Health Toolbox: loneliness
Yap et al,[69] 2017 (Singapore)	Community	RCT: Waitlist control	74.65 (6.4)	51 (94)	LSNS
Other or miscellaneous					
De Craen et al,[93] 2006 the (Netherlands)	Community	RCT	85 (NR)	402 (intervention: 64; control: 67)	De Jong Gierveld
Larsson et al,[94] 2016 (Sweden)	Community	RCT: 2-period crossover design	71.2 (NR)	30 (80)	UCLA
Pynnönen et al,[53] 2018 (Finland)	Community	RCT	77.0 (1.43)	257 (75)	Social provisions scale
Taube et al,[54] 2018 (Sweden)	Community	RCT	81.5 (6.4)	153 (67)	Single item question
Reminiscence therapy					
Chiang et al,[95] 2009 (Taiwan)	Nursing home	RCT: Waiting list control	77.24 (3.97)	130 (0)	Revised UCLA
Moieni et al,[97] 2020 (US)	Community	RCT	70.9 (6.5)	78 (100)	UCLA
Westerhof et al,[96] 2017 (the Netherlands)	Care facility	RCT	84.2 (8.5)	81 (82)	De Jong Gierveld
Social intervention					
Andersson et al,[100] 1985 (Sweden)	Community	RCT	77 (NR)	64 (100)	UCLA (4 item)
Charlesworth et al,[102] 2008 (United Kingdom)	Community	RCT	68 (11.4)	236 (64)	Stroebe 2 item scale; the Multidimensional Scale of Perceived Social Support
Hartke and King.,[101] 2003 (US)	Community	RCT	69.72 (6)	124 (76)	UCLA
Heller et al,[44] 1991 (US)	Community	RCT	74 (NR)[c]	291 (100)	Paloutzian/Ellison Loneliness scale
					Perceived social support scale
MacIntyre et al,[61] 1999 (Canada)	Community	RCT	79.4 (7.0)	22 (68)	Social integration scale
Mountain et al,[99] 2014 (United Kingdom)	Community	RCT	Intervention: 81.8 (5.8)	70 (58.57)	De Jong Gierveld
			Control: 80.1 (3.7)		
Rook et al,[98] 2003 (US)	Community	RCT	70.52 (6.89)	180 (65.6)	UCLA (10 item)
Walshe et al,[56] 2016 (United Kingdom)	Community	RCT	72 (37-92)[b]	196 (60)	De Jong Gierveld (6)
Technology					
Bickmore et al,[103] 2005 (US)	Community	RCT	74 (NR)	21 (86)	Revised UCLA
Bond et al,[62] 2010 (US)	Community	RCT	Intervention: 66 (5.7)	62 (45)	Diabetes support scale
			Control: 68 (6.2)		
Czaja et al,[104] 2018 (US)	Community	RCT	76.15 (7.4)	300 (78)	UCLA-V3
Dodge et al,[105] 2015 (US)	Retirement community and senior center	RCT	80.5 (6.8)	83 (75.9)	Hughs loneliness scale
Gustafson et al,[76] 2019 (US)		RCT	NR (NR)	31 (61.3)	UCLA Loneliness Scale

(continued)

Table. Participants and Study Characteristics in Studies Included in the Systematic Review (continued)

Source (country)	Setting	Study design	Age, mean (SD), y	Sample, No. (percentage female)	Loneliness/social support scale[a]
Morgenstern et al,[68] 2015 (US)	Community	RCT	Intervention: 76.95 (8.51)	265 (100)	Perceived Isolation Index in an elderly population
			Control: 75.05 (8.20)		
Morton et al,[46] 2018 (Australia)	Community and Care homes	RCT: 2x2	80.71 (8.77)	121 (65)	UCLA (8 item)
Nikitina et al,[51] 2018 (Russia)	Community	RCT	Pilot 1: Intervention 68.2 (7.8)	Pilot 1: 20 (95)	Revised UCLA (3 item)
			Control: 65.0 (6.1)	Pilot 2: 40 (100)	
			Pilot 2: Intervention 67.6 (6.2)		
			Control: 68.8 (7.2)		
Sidner et al,[106] 2018 (US)	Community	RCT: 3 groups	66 (7.89)	44 (NR)	Revised UCLA
Slegers et al,[107] 2008 (the Netherlands)	Community	RCT: multigroup control	NR (NR)	236 (NR)	De Jong Gierveld
Tsai et al,[108] 2011 (Taiwan)	Nursing home	RCT	Intervention: 73.82 (11.19)	90 (intervention: 55; control: 60)	UCLA Loneliness Scale
			Control: 79.26 (7.07)		
Tsai et al,[109] 2020 (China)	Long-term care	RCT: cluster	Intervention: 81.07 (8.46)	62 (intervention: 75; control: 56.7)	Revised UCLA
			Control: 68.95 (11.65)		
Wan et al,[60] 2017 (US)	Community	RCT	68.6 (8.3)	114 (1.8)	MOS: Social Support
White et al,[47] 2002 (US)	Congregate housing and nursing facility	RCT	Intervention: 71 (12)	100 (intervention: 71; control: 82)	UCLA
			Control: 72 (11)		
Woodward et al,[45] 2011 (US)	Community	RCT	71.85 (7.09)	83 (72)	Loneliness was measured using a 6 item scale

Abbreviations: De Jong Gierveld, De Jong Gierveld Loneliness Scale; LSNS, Lubben Social Network Scale; LTC, long-term care; MOS, Medical outcomes study social support survey; NR, not reported; PGCMS, Philadelphia Geriatric Center Morale Scale; RCT, randomized clinical trial; UCLA, University of California, Los Angeles Loneliness Scale.

[a] Short versions of the scale are identified by the number of items in parenthesis next to the scale name.

[b] Denotes a range.

[c] Denotes a median.

eFigure 2 in the Supplement). The social support outcome meta-analysis (8 studies), all set in the community, is found in eFigure 2 and eTable 6 in the Supplement.[57-64] Five studies set in the community measured social isolation (eFigure 2, eTable 6 in the Supplement).[65-69] The total number of participants eligible for loneliness quantitative analysis was 3535 in community and 1057 in LTC (706 participants for social isolation [community] and 932 participants for social support [community]). Meta-analyses are presented for loneliness outcomes unless otherwise specified. Forest plots with 2 or fewer studies can be found in eFigure 2 in the Supplement. Seven studies had a loneliness enrollment prerequisite. Overall study quality was very low (eTable 7 in the Supplement). The overall risk of bias of the included studies was high (eFigure 3 and eTable 8 in the Supplement), associated with the effect of adhering to the intervention (eg, participants' and researchers' awareness of the intervention), unreported adherence outcomes, and repeated outcome measurement.

Animal Therapy

Six studies[70-75] were included in the meta-analysis, 2 in the community (Figure 4) and 4 in LTC with an ES of −0.41 (95% CI, −1.75 to 0.92; I^2 = 87%; P = .005) and −1.05 (95% CI, −2.93 to 0.84; I^2 = 95%; P < .001), respectively. Upon excluding a study[71] comparing group to individual animal therapy, the effect size was −1.86 (95% CI, −3.14 to −0.59; I^2 = 86%; P < .001). Generally, participants interacted with living dogs or robotic animals (seal or dog). One study[75] provided a bird in the participant's room for the study duration.

Combination and Multicomponent Interventions

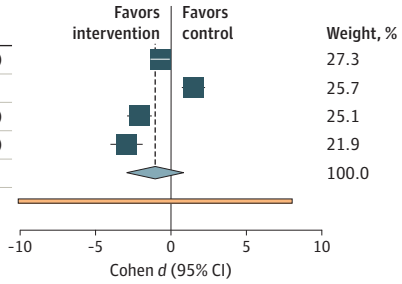
Five studies[76-80] were included in the meta-analysis, 2 in the community (Figure 4) and 3 in LTC. The ES was −0.67 (95% CI, −1.13 to −0.21; I^2 = 0%; P = .704) in community and −0.53 (95% CI, −0.86 to −0.20; I^2 = 57%; P = .099) in LTC. Interventions included exercise with arts and crafts, home care with nursing outreach and educational resources, Tai Chi and CBT, and pain management programs.

Figure 2. Meta-analysis Forest Plot Summary Divided by Intervention: Animal Therapy, Combined or Multicomponent, Counseling, and Cognitive Behavioral Therapy and Psychotherapy

A Animal therapy: LTC

Study	Intervention	Participants, No.	Cohen *d* (95% CI)
Banks et al,[70] 2002	Dog	45	-0.72 (-1.36 to -0.08)
Banks et al,[71] 2005	Group vs individual (dog)	33	1.49 (0.72 to 2.26)
Banks et al,[72] 2008	Dog/robotic dog	38	-2.09 (-2.91 to -1.27)
Banks et al,[73] 2017	Dog	28	-2.95 (-4.01 to -1.88)
Random effects model			-1.05 (-2.93 to 0.84)
Prediction interval			(-10.13 to 8.03)

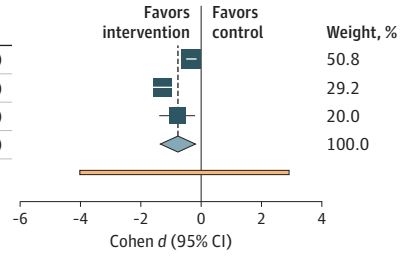
Heterogeneity: I^2 = 95% (90%-97%), P <.01



B Combined or multicomponent LTC

Study	Intervention	Participants, No.	Cohen *d* (95% CI)
Tse et al,[78] 2012	Exercise program and arts/crafts/music	535	-0.32 (-0.49 to -0.15)
Tse et al,[79] 2013	Nursing intervention, physiotherapy, and gardening	90	-0.72 (-1.15 to -0.29)
Tse et al,[80] 2016	Exercise program and pain management education	50	-0.79 (-1.39 to -0.20)
Random effects model			-0.53 (-0.86 to -0.20)
Prediction interval			(-4.02 to 2.95)

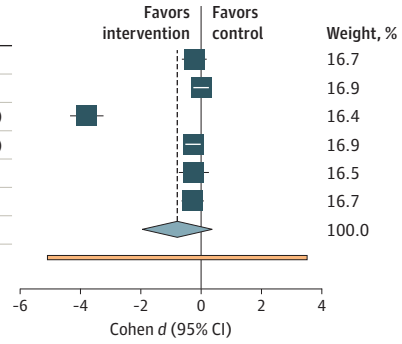
Heterogeneity: I^2 = 57% (0%-88%), P = .10



C Counseling: community

Study	Intervention	Participants, No.	Cohen *d* (95% CI)
Kremers et al,[84] 2006	Group sessions	98	-0.37 (-0.78 to 0.05)
Routasalo et al,[85] 2009	Group sessions	235	0.00 (-0.26 to 0.26)
Alaviani et al,[86] 2015	Multistrategy psychosocial support	140	-3.79 (-4.34 to -3.24)
Mountain et al,[83] 2017	Group and individual session	238	-0.29 (-0.54 to -0.03)
Cohen-Mansfield et al,[82] 2018	Group and individual session	63	-0.24 (-0.74 to 0.26)
Chow et al,[81] 2019	Bereavement counseling (group)	101	-0.18 (-0.60 to 0.24)
Random effects model			-0.80 (-1.96 to 0.36)
Prediction interval			(-5.10 to 3.49)

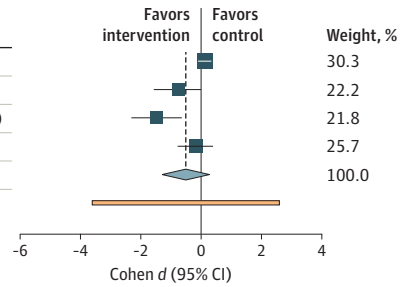
Heterogeneity: I^2 = 97% (95%-98%), P <.01



D Therapy (eg, CBT, psychotherapy): community

Study	Intervention	Participants, No.	Cohen *d* (95% CI)
Parry et al,[62] 2016	CBT	313	0.10 (-0.12 to 0.32)
Theeke et al,[111] 2016	CBT	27	-0.79 (-1.58 to 0)
Jarvis et al,[110] 2019	CBT	30	-1.50 (-2.32 to -0.69)
Nelson et al,[112] 2019	Psychotherapy	48	-0.18 (-0.75 to 0.39)
Random effects model			-0.52 (-1.21 to 0.17)
Prediction interval			(-3.62 to 2.58)

Heterogeneity: I^2 = 83% (56%-93%), P <.01



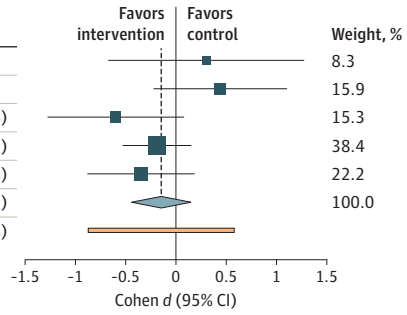
CBT indicates cognitive behavioral therapy; LTC, long-term care.

Figure 3. Meta-analysis Forest Plot Summary Divided by Intervention: Exercise, Social Interventions, and Technological Interventions

A Exercise: community

Study	Intervention	Participants, No.	Cohen *d* (95% CI)
Wang et al,[91] 2010	Yoga (group)	17	0.30 (-0.68 to 1.28)
Baez et al,[88] 2017	Exercise program	36	0.44 (-0.23 to 1.10)
Chan et al,[90] 2017	Tai Chi Qigong (group)	35	-0.60 (-1.28 to 0.08)
Ehlers et al,[87] 2017	Dance, strength, walk/walk plus	169	-0.19 (-0.53 to 0.15)
Jones et al,[89] 2019	Exercise program	55	-0.35 (-0.88 to 0.18)
Random effects model			-0.15 (-0.44 to 0.15)
Prediction interval			(-0.87 to 0.58)

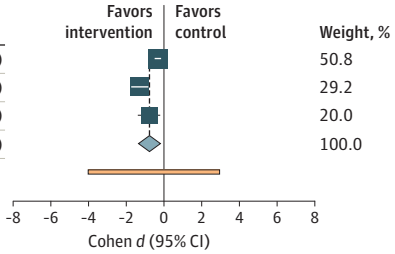
Heterogeneity: I^2 = 35% (0%-75%), P = .19



B Exercise: LTC

Study	Intervention	Participants, No.	Cohen *d* (95% CI)
Tse et al,[78] 2012	Exercise program and arts/crafts/music	535	-0.32 (-0.49 to -0.15)
Tse et al,[79] 2013	Nursing intervention, physiotherapy, and gardening	90	-0.72 (-1.15 to -0.29)
Tse et al,[80] 2016	Exercise program and pain management education	50	-0.79 (-1.39 to -0.20)
Random effects model			-0.53 (-0.86 to -0.20)
Prediction interval			(-4.02 to 2.95)

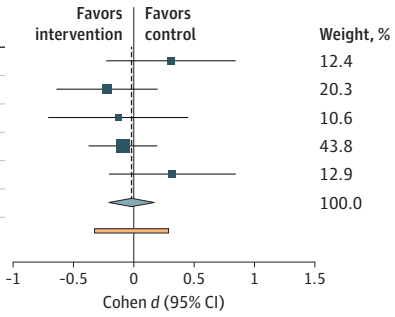
Heterogeneity: I^2 = 57% (0%-88%), P = .10



C Social interventions: community

Study	Intervention	Participants, No.	Cohen *d* (95% CI)
Anderson et al,[100] 1984	Group meetings	57	0.31 (-0.23 to 0.84)
Hartke and King,[101] 2003	Telephone support	88	-0.22 (-0.64 to 0.20)
Rook and Sorkin,[98] 2003	Foster grandparent	47	-0.13 (-0.71 to 0.45)
Charlesworth et al,[102] 2008	Befriending	190	-0.09 (-0.38 to 0.20)
Mountain et al,[99] 2014	Friendly visitor (call)	56	0.32 (-0.21 to 0.84)
Random effects model			-0.02 (-0.21 to 0.17)
Prediction interval			(-0.33 to 0.29)

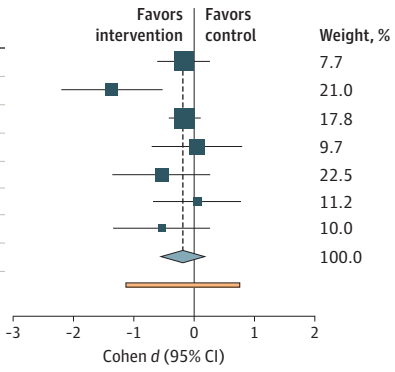
Heterogeneity: I^2 = 7% (0%-81%), P = .37



D Technological interventions: community

Study	Intervention	Participants, No.	Cohen *d* (95% CI)
Bickmore et al,[103] 2005	Computerized animated artifacts	17	0.79 (-0.19 to 1.77)
Slegers ,[107] 2008	Computer training	190	0.03 (-0.28 to 0.34)
Dodge,[105] 2015	Video chat	83	-0.18 (-0.61 to 0.25)
Larsson et al,[94] 2016	Occupational therapy	28	-1.37 (-2.19 to 0.55)
Czaja et al,[104] 2018	Computer/technology program	255	-0.17 (-0.42 to 0.08)
Sidner et al,[106] 2018	Virtual robot/agent	36	0.05 (-0.68 to 0.78)
Gustafson et al,[76] 2019	Website and tracker	25	-0.54 (-1.34 to 0.26)
Random effects model			-0.19 (-0.51 to 0.14)
Prediction interval			(-1.12 to 0.75)

Heterogeneity: I^2 = 59% (4%-82%), P = .02



LTC indicates long-term care.

Six studies[57-60,63,64] were included in social support meta-analysis (all community-dwelling), with an ES of 0.29 (95% CI, 0.15 to 0.43) and low heterogeneity (I^2 = 0%; P = .66).

Counseling

Six group-based studies[81-86] in community-dwelling participants were included in the meta-analysis. Interventions included bereavement counseling and instructor-led group support programs. The ES was −0.80 (95% CI, −1.96 to 0.36); heterogeneity was substantial (I^2 = 97%; P < .001). When excluding Alaviani et al,[86] the ES was less pronounced (−0.19; 95% CI, −0.35 to −0.03), with no heterogeneity (I^2 = 0%; P = .48).

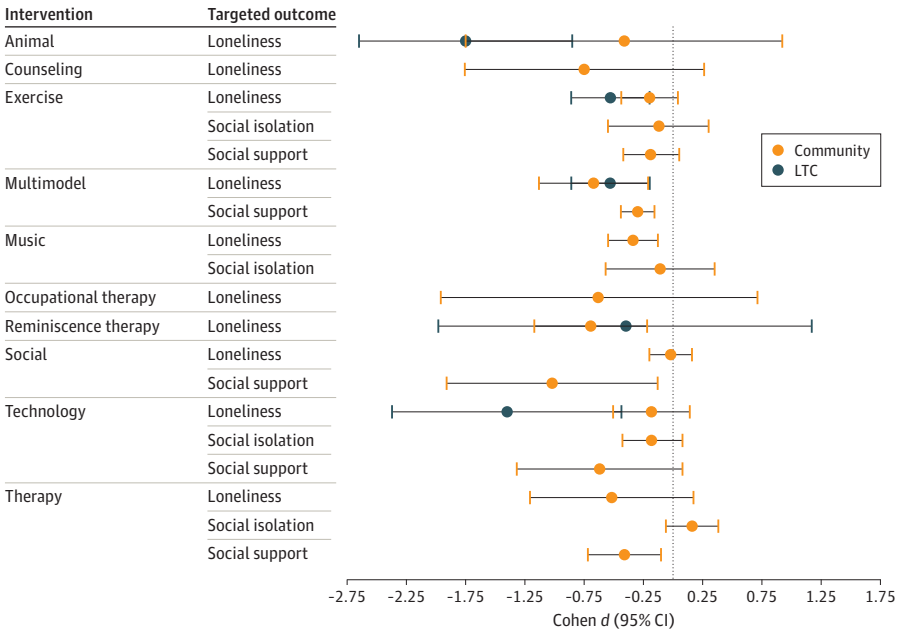
Exercise

Eight studies[78-80,87-91] were included in the meta-analysis, 5 in the community and 3 in LTC. All but 1 study was performed in a group setting (dance, yoga, Tai Chi, and strength and balance training).[67] The ES was −0.15 (95% CI, −0.44 to 0.15) and heterogeneity was low (I^2 = 35%; P = .19) in community and −0.53 (95% CI, −0.86 to −0.20; I^2 = 57%; P = .10) in LTC. The ES was similar when excluding studies without active controls (−0.45 in community; −0.32 in LTC). Three studies[57-59] were included in social support meta-analysis; ES was 0.17 (95% CI, −0.07 to 0.41) with low heterogeneity (I^2 = 0%; P = .48). There was a potential for small study publication bias on the community funnel plot (eFigure 1 in the Supplement). One study[67] set in the community assessed social isolation, with an ES of −0.12 (95% CI, −0.55 to 0.31).

Music

One community study[92] measured loneliness with an ES of −0.34 (95% CI, −0.55 to −0.13). Two community studies[66,69] were included in the meta-analysis for social isolation. The ES was −0.11 (95% CI, −0.57 to 0.35) and heterogeneity was low (I^2 = 0.0%; P = .37). Interventions included group rhythm instruments and a choir program.

Figure 4. Summary of Meta-analysis Data Including Loneliness, Social Isolation, and Social Support, Stratified by Setting (Community and Long-Term Care [LTC])



Social support outcome has been inverted such that benefit is toward the left of the figure.

Occupational Therapist-Guided Interventions

Two community-based studies[93,94] were included in the meta-analysis (Figure 4). Interventions included occupational therapist-guided technology or assistive devices training. The ES was −0.63 (95% CI, −1.96 to 0.71) with substantial heterogeneity (I^2 = 90%; P = .002). Larsson et al,[94] which enrolled persons who were lonely at baseline, was the only study that had a significant outcome in reducing loneliness.

Reminiscence Therapy

Two studies[95,96] set in LTC were included in the meta-analysis (Figure 4). Interventions included volunteer-led individual reminiscence sessions to group sessions that included sharing memories and identifying goals. The ES was −0.40 (95% CI, −1.98 to 1.17); heterogeneity was substantial (I^2 = 95%; P < .001). The study by Moieni et al,[97] which was set in the community, showed similar findings (ES −0.70; 95% CI, −1.17 to −0.22).

Social Intervention

Five studies[98-102] set in the community were included in the meta-analysis. Interventions included befriending a volunteer, formation of social groups with discussion topics, and intergenerational programming. The ES was −0.02 (95% CI, −0.21 to 0.17) with low heterogeneity (I^2 = 7%; P = .37). Excluding studies without active controls (ES = 0.10; 95% CI, −0.27 to 0.48) did not alter the conclusions. One study set in the community showed significant improvement in social support (ES = 1.02; 95% CI, 0.13 to 1.91).[61]

Technology

Nine studies[76,94,103-109] were included in the meta-analysis, 7 in the community and 2 in LTC (Figure 4). Interventions included computer training (in-person or online), videoconferencing (either with family or a trained interviewer), and pedometers to track and provide fitness goals. The ES was −0.19 (95% CI, −0.51 to 0.14; I^2 = 59%; P = .03) in community and −1.40 (95% CI, −2.37 to −0.44; I^2 = 70%; P = .07) in LTC. Attrition was highest in studies in LTC (up to 44%).[108,109] Exclusion of multicomponent interventions (community) did not change the ES (−0.15; 95% CI, −0.53 to 0.24). Social support meta-analysis (2 studies), set in the community-dwelling, had an ES of 0.62 (95% CI, −0.07 to 1.31; I^2 = 78%; P = .03).[60,62] One community-based study[68] measured social isolation (ES, −0.18; 95% CI, −0.43 to 0.08).

CBT and Psychotherapy

Four studies[65,110-112] set in the community were included in the meta-analysis with an ES of −0.52 (95% CI, −1.21 to 0.17), provided by trained personnel (eg, psychotherapist, doctoral students) in individual and group sessions. There was considerable heterogeneity (I^2 = 83%; P < .001). Upon excluding studies without active controls, the ES remained similar at −0.46 (95% CI, −1.39 to 0.46). One study[63] measured social support in the community (ES, 0.41; 95% CI, 0.10 to 0.72). Parry et al[65] also measured social isolation, with an ES of 0.16 (95% CI, −0.06 to 0.38).

Discussion

This SR and meta-analysis aimed to determine which interventions are associated with a reduction in loneliness and social isolation in older adults and, to our knowledge, is the largest and most comprehensive such study to date. We additionally separately analyzed outcomes of loneliness, social isolation, and social support. Overall, we found that animal therapy (accounting for one study of group compared to individual animal therapy) and technological interventions in LTC had a large ES. However, given the small number of studies in each intervention and high heterogeneity, cautious interpretation of the ES's magnitude is required.

Many interventions are associated with a reduction in loneliness, and all encouraged socialization in some form. Expectations and perceptions of an intervention may influence its effectiveness.[113] For example, studies with a specific goal, particularly in a group setting, may build social relationships that are associated with less loneliness (eg, exercise, multicomponent interventions, animal therapy, technology, psychotherapy, and CBT).[27] However, group interventions are not necessarily beneficial.[27,114] Interventions that target coping strategies (eg, psychotherapy, counseling, CBT, or reminiscence) may modify individual and environmental factors that can influence social behavior and self-efficacy, thereby reducing loneliness and improving socialization.[115-117]

Perhaps surprisingly, social interventions were not significant. Although social prescribing is thought to be a potentially effective intervention, in some it may cause social anxiety.[118-120] Additionally, meaningful friendships may not always result from prescribed interventions. Studies of longer duration, required to develop strong friendships, or high value relationships (eg, family and close friends) should be considered and prioritized.[121] Although this may explain why online interactions (eg, videoconferencing) with family had a large ES, only 2 studies were included. Accordingly, it is important that socially prescribed interventions are tailored to an individual's unique needs. Interventions in LTC may have shown greater ESs for several reasons, including a higher prevalence of loneliness, and being accustomed to group living with shared programs and activities.[32,122-124] A number of interventions among community-dwelling participants were not associated with reduced loneliness, potentially related to a highly heterogeneous population.[125,126] Interventions with social support meta-analysis generally had a smaller ES. This may reflect the subjective nature of these experiences and that an intervention may not change an individual's social network despite reducing their loneliness.[29,31]

Our SR found similar findings to previous studies. Animal therapy has generally shown positive outcomes for loneliness, potentially mediated by previous pet ownership (particularly dogs).[17,127,128] Multicomponent interventions generally found success, which is not unexpected given the advantage of incorporating multiple interventions.[19] Due to the multicomponent design of the LTC studies of exercise, the outcomes of exercise could not be isolated, despite the consistent negative effect size. Moreover, only 3 studies were identified. Similarly, reviews of exercise have found conflicting evidence on social support and loneliness.[20-22] Reviews that included reminiscence therapy found benefit, but few studies were identified.[18,19,23] Reviews of technological interventions generally found mixed ESs on loneliness.[18,19,114,129,130] Although a review from Chipps et al[24] identified benefit for videoconferencing, we have shown that this is potentially associated with studies in LTC. We similarly found no benefit for technological training programs (community). Similar to other reviews, there was moderate to substantial heterogeneity across most studies, which may be due to the complex and individual nature of loneliness.[119,131]

Interventions targeting negative self-thought were not consistently associated with reduced loneliness, though evidence suggests such interventions may be beneficial.[132] Future RCTs should aim for more equitable representation of sex/gender and culture, and incorporate measures of loneliness and social isolation.[133] Social isolation and social support require further study in LTC. Future studies should consider identifying important contextual components in LTC associated with a reduction in loneliness. Methodological quality can be improved by adherence outcomes and its analyses, reporting adverse events, and implementing active controls.

Limitations

This study has limitations. Sample sizes were small, and few studies used active controls, the latter potentially confounding the intervention effect. The majority of studies enrolled community-dwelling older adults and may affect generalizability. A number of studies of specific interventions shared study authors and participant recruitment geographical locations, which may increase the risk of bias: all studies of exercise and multicomponent in LTC (Tse et al),[78-80] 3 of 4 studies of animal therapy in LTC (Banks et al),[70-72] and all studies of technology in LTC (Tsai et al).[108,109] The latter 2

authors reported no overlap in study samples in our correspondence. Although Tse et al reported separately collected cohorts, the possibility of participant overlap remains. The small number of studies per meta-analysis limited conclusions on sources of heterogeneity and the ES's magnitude. The sustainability of the effect of the interventions cannot be concluded on the basis of our results. Only English language studies were included. Several studies required estimating Cohen *d* for pooling based on data provided in the original study (eg, *P* values and 95% CIs).

Conclusions

In this SR and meta-analysis, exercise and technological interventions in the community had the highest precision with small ESs, whereas animal therapy in LTC had the largest ES when accounting for one study comparing group to individual therapy. When exercise is combined with other interventions (eg, CBT), the benefit may be strengthened. These results require cautious interpretation due to high heterogeneity and a small number of studies, particularly with respect to the ES's magnitude.

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Acquisition, analysis, or interpretation of data: All authors.

Drafting of the manuscript: Hoang.

Critical revision of the manuscript for important intellectual content: Hoang, King, S. Moore, K. Moore, Reich, Tan, Whaley, McMillan.

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SUPPLEMENT.