The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences, 2025, **80(12)**, gbaf178
https://doi.org/10.1093/geronb/gbaf178
Advance access publication: 23 September 2025
Research Article

Mindfulness-based stress reduction and loneliness in older adults: two randomized controlled trials

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Decision Editor: Annie L. Nguyen, PhD, MPH (Psychological Sciences Section)

Abstract

Objectives: Loneliness is one of the most robust risk factors for morbidity and accelerated mortality among older adults, and effective interventions are needed. However, interventions to reduce loneliness have shown limited success, especially in this population. Indeed, research suggests that simply increasing social contact might not combat loneliness; instead, addressing the cognitive and emotional mechanisms of loneliness might be more effective. Here, in two randomized controlled trials (RCT), we explored whether mindfulness training could reduce loneliness.

Methods: This study tested an 8-week Mindfulness-Based Stress Reduction (MBSR) program on loneliness in older adults across two RCTs. Study 1 compared MBSR to a waitlist (WL) control, and Study 2 compared MBSR to the Health Enhancement Program (HEP).

Results: From baseline to follow-up, MBSR significantly reduced loneliness compared to WL in Study 1 ($b = -1.680$, $SE = 0.273$, 95% CI [−3.325, −0.034], $p = .045$, $\beta = -0.402$). In Study 2, MBSR and HEP both reduced loneliness (main effect of time: $b = -3.598$, $SE = 0.957$, 95% CI [−5.481, −0.1.716], $p < .001$, $\beta = -0.378$), with no significant difference between conditions. Baseline depressive symptoms, perceived stress, sex, age, or homework did not reliably moderate effects on reducing loneliness.

Discussion: These findings suggest that both MBSR and HEP may be promising approaches to addressing loneliness in older adults with effects lasting for months.

Keywords: Psychological interventions, Social isolation, Well-being

Loneliness, the distressing feeling that one's social needs are unmet, has profound implications for physical and mental health (Cacioppo et al., 2002). Loneliness is common, with estimates suggesting that more than one-third of adults older than 45 are lonely, including those who are married, and many older adults are socially isolated (Holt-Lunstad et al., 2017). Furthermore, loneliness is one of the strongest predictors of mortality risk, stronger than other risk factors, including smoking, lack of exercise, and high body mass index (Holt-Lunstad et al., 2010). The link between loneliness and poor health is especially pronounced in the older population, where studies have demonstrated associations with poorer health outcomes among older adults (Hawkley & Cacioppo, 2010). For example, loneliness is linked to a 50% increase in the risk of dementia, and increases in type 2 diabetes, hypertension, and suicide (Conwell et al., 2011; Lazzari & Rabottini, 2022; Strodl & Kenardy, 2006; Yang et al., 2016). Research has suggested a few pathways by which loneliness affects health, including poor health behaviors, increased stress reactivity, and long-term effects on relevant physiology (Cacioppo & Hawkley, 2003). Risk factors for high levels of loneliness include being more socially isolated, having health conditions that limit activities of daily living, and being retired (Holt-Lunstad, 2017). Loneliness increases the risk of premature death by as much as 26% (Holt-Lunstad et al., 2015), highlighting its public health relevance. In recognition of these risks, the U.S. Surgeon General identified loneliness as a public health epidemic in 2023 (U.S. Surgeon General, 2023).

Despite its widespread impact, loneliness remains challenging to treat. Many interventions have focused more on increasing social contact than addressing the cognitive and emotional mechanisms underlying loneliness. As a result, these

Received: April 22 2025; Accepted: September 16 2025

interventions often fail to reduce loneliness long-term: meta-analyses of loneliness interventions find small or mixed effects, and the quality of the evidence is often low (Hickin et al., 2021; Veronese et al., 2021). This is especially true of interventions to reduce loneliness in older adults (Hoang et al., 2022). The sociocognitive model of loneliness offers a framework for understanding why it is so challenging to address loneliness. This model posits that loneliness is sustained by a cycle of social threat vigilance, negative social biases, and maladaptive coping (Hawkley & Cacioppo, 2010). These processes exacerbate feelings of loneliness by leading individuals to perceive social interactions as less rewarding and more threatening. Importantly, loneliness is conceptually distinct from social isolation. While social isolation refers to the objective lack of social contacts, loneliness is the subjective feeling of social disconnection that can persist even in the presence of social relationships (Holt-Lunstad et al., 2015). Thus, simply being around others is unlikely to ameliorate feelings of loneliness because that experience may activate maladaptive social cognitions and increase negative emotions in lonely individuals. However, interventions that focus on building social skills beyond simply increasing social contact may be effective, as these skills may facilitate social interactions that lead to fewer negative emotions (Masi et al., 2011). Given this distinction, meta-analyses show that interventions that focus solely on increasing social contact—such as social networking or group-based interventions—do not consistently reduce loneliness (Hoang et al., 2022; Masi et al., 2011), reinforcing the need for interventions that target the underlying cognitive and emotional mechanisms of loneliness, consistent with loneliness theories. While there are likely a multitude of factors that contribute to loneliness, interventions could be a powerful way to offer skills training and agency to those at-risk or high in loneliness.

Mindfulness-based interventions, such as Mindfulness-Based Stress Reduction (MBSR), offer a promising approach to addressing loneliness by addressing cognitive patterns that reinforce loneliness. MBSR emphasizes present-moment awareness and nonjudgmental acceptance of thoughts and feelings (Kabat-Zinn, 2003); this increased awareness of and openness to one's habitual reactions may counteract the hypervigilance and negative cognitive biases that perpetuate loneliness (Lindsay et al., 2019). For example, a 14-day smartphone-based mindfulness program for community adults was shown to reduce daily feelings of loneliness in the days following the intervention (Lindsay et al., 2019). However, it is not clear whether an 8-week MBSR program can lead to sustained reductions in feelings of loneliness in older adults, and whether reductions differ from an active comparison condition. Few randomized controlled trials (RCTs) have tested mindfulness for reducing loneliness, and even fewer have focused on older adults or included MBSR programs and active comparison conditions (Teoh et al., 2021). Mindfulness may be particularly well-suited to addressing loneliness in older adults. It promotes acceptance of difficult emotions—such as grief, loss, or fear of declining health—which often accompany aging and contribute to feelings of loneliness (Creswell et al., 2012). Additionally, mindfulness is accessible for older adults, especially those with limited mobility (Morone & Greco, 2014).

On the other hand, other interventions that focus on wellness (e.g., exercise interventions) could lead to reductions in loneliness, although effects are generally small (Hoang et al., 2022; Shvedko et al., 2018). Previous physical activity wellness interventions in older adults have sometimes focused on physical pain but found co-occurring psychological benefits (Tse et al., 2012, 2016), while others focused on how physical activity interventions might reduce stress and increase social support in ways that lead to changes in loneliness (Chan et al., 2017; Ehlers et al., 2017). Some work has found that physical activity interventions that are not in a group-based setting can also reduce loneliness (Baez et al., 2017). Interventions that encourage physical activity and healthy living may target different mechanisms of loneliness, but isolating psychological mechanisms is challenging due to the multidimensional nature of these health promotion interventions. Possible mechanisms include greater social and emotional support in group settings, improved quality of life, and changes in stress-related neurobiology (Shvedko et al., 2018). Furthermore, health education programs are popular active comparison conditions for mindfulness training programs. Based on the literature, a health education program is a stringent comparison condition in this case, as there may be benefits for well-being, but the mechanisms likely differ from mindfulness training.

Here, we examine the effects of MBSR on loneliness in older adults using data from two RCTs. Study 1 assessed MBSR against a WL control group, offering an initial test of MBSR on loneliness in older adults. Study 2 compared MBSR to an active control condition, the Health Enhancement Program (HEP), to explore MBSR's effects over a health education control. Furthermore, in Study 2, participants who were high in loneliness were recruited to participate. Both studies assessed loneliness at baseline, post-intervention, and at a follow-up timepoint months later (6-month follow-up for Study 1 and a 3-month follow-up for Study 2). Sensitivity analyses explored whether baseline stress, depressive symptoms, age, sex, and homework practice moderated MBSR's effects. Importantly, we aimed to evaluate MBSR's effects across two independent trials and explore the impact of different control conditions.

Method

Study 1

Participants

Healthy older adults over the age of 65 ($N = 219$) were randomized into an MBSR or a WL arm (see Figure 1 for CONSORT chart, Table 1 for baseline characteristics, Supplemental Information for eligibility criteria). Data were collected from December 2006 to April 2010 across six intervention cohorts (Barkan et al., 2016; Gallegos et al., 2018; Gallegos, Hoerger, Talbot, Krasner, et al., 2013; Gallegos, Hoerger, Talbot, Moynihan, et al., 2013; Moynihan et al., 2013). The planned sample size for the trial was determined for the study's primary aim (detecting a treatment difference in antibody response to four different doses of benign antigen); $N = 200$ participants were needed to achieve >80% power. These analyses are secondary to the primary aims of the parent trial.

Recruitment

Participants were recruited from the greater Rochester area through local newspapers and flyers in the University of Rochester primary care health offices. Potential participants were over the age of 65 (except for 3 participants, 63–64 years of age, who enrolled with their partners).

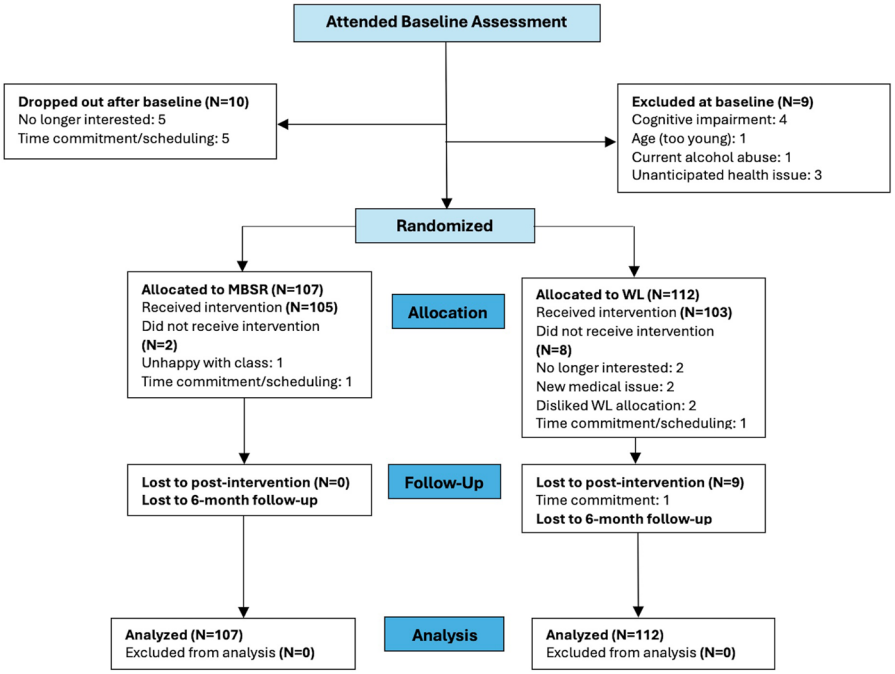

Figure 1. CONSORT flowchart for Study 1. MBSR = Mindfulness-Based Stress Reducion; WL = Waitlist.

Table 1. Baseline characteristics of participants in Study 1 and Study 2.

Variable	Study 1					Study 2				
	MBSR (n=107)		Wait List (n=112)		p_{diff}	MBSR (n=93)		HEP (n=97)		p_{diff}
	N	%	*N*	%		*N*	%	*N*	%	
Gender (female)	67	62.3	70	62.5	.99	75	80.7	74	76.3	.47
Age ($M \pm SD$)	72.08 ± 6.82		73.41 ± 6.60		.14	69.96 ± 4.31		69.59 ± 4.27		.55
Race					—					.69
White	104	97.2	111	99.1		78	83.9	83	85.6	
Black	2	1.9	1	0.9		11	11.8	11	11.3	
Asian	1	0.9	0	0.0		1	1.1	1	1.0	
Bi/multi-racial	0	0.0	0	0.0		3	3.2	2	2.1	
Ethnicity					—					
Hispanic/Latinx	2	1.9	0	0.0		1	1.1	5	5.2	.11
Not Hispanic/Latinx	105	98.1	112	100.0		92	98.9	92	94.9	
Marital Status					.47					.93
Married	72	67.3	64	57.1		39	42.0	43	44.3	
Single	7	6.5	7	6.3		15	16.1	18	18.6	
Separated	0	0.0	1	0.9		2	2.2	3	3.1	
Divorced	13	12.2	17	15.2		23	24.7	20	20.6	
Widowed	15	14.0	23	20.5		14	15.1	13	13.4	
Education ($M \pm SD$)	16.33 ± 2.78		16.50 ± 2.83		.73					.35
No high school diploma						1	1.08	2	2.06	
GED						0	0.0	2	2.06	
High school diploma						2	2.2	7	7.2	
Technical training						2	2.2	4	4.1	
Some college, no degree						11	11.8	12	12.4	
Associate degree						4	4.3	2	2.06	
Bachelor's degree						34	36.6	23	23.7	
Master's degree						33	35.5	38	39.2	
MD, PhD, JD, PharmD						6	6.5	7	7.2	

Note. HEP = Health Education Program; MBSR = Mindfulness-based Stress Reduction. The p_{diff} column shows significance levels based on t and χ^2 tests of condition differences. In Study 1, the p_{diff} cell is empty for the race and ethnicity variables, given the small number of non-White and Hispanic/Latinx participants in each condition.

Procedure

Participants were randomly assigned to an 8-week MBSR program or a WL control condition. Psychosocial and demographic data were collected at baseline (week 0), and loneliness was assessed at post-intervention (week 9) and 6-month follow-up (week 33). Participants were debriefed after completing all study assessments and compensated up to $100.

Materials

Intervention program

MBSR. The MBSR program was a group-based, 8-week standardized curriculum including weekly 2-hr sessions and one 7-hr retreat. MBSR included training of four primary practices: sitting meditation, body scan meditation, mindful movement, and walking meditation. MBSR classes were taught by one instructor who had completed the UMass Center for Mindfulness in Medicine, Health Care, and Society MBSR teacher trainings. Daily homework (45 min) was assigned at the end of each class. No additional resources were offered at the end of the intervention program, but participants were encouraged to continue practicing in their daily lives. Waitlist participants were offered the opportunity to participate in the MBSR program after they completed the study.

Randomization and masking

Participants were randomly assigned to MBSR or a WL in equal distribution with a randomly generated list. Intervention instructors were unaware of outcome measures, while outcome assessors were blinded to condition.

Measures

Loneliness

Loneliness was assessed at baseline, post-intervention, and follow-up using the 7-item UCLA Loneliness Scale, UCLA-7 (Oshagan & Allen, 1992). This scale measures the extent to which participants felt lonely over the past month on a 4-point Likert scale ranging from 1 (never) to 4 (always) (e.g., "How often do you feel alone?"). Relevant items were reverse-coded, and all items were summed to create a total loneliness score, with higher scores reflecting higher loneliness (sample Cronbach's $\alpha = 0.88$).

Baseline perceived stress

Perceived stress over the past month was assessed at baseline using the 10-item Perceived Stress Scale (PSS), with higher scores reflecting higher stress (sample Cronbach's $\alpha = 0.89$) (Cohen et al., 1983).

Baseline depressive symptoms

Depressive symptoms were assessed at baseline using the 20-item Center for Epidemiological Studies Depression Scale (CES-D), with higher scores indicating greater depressive symptoms (sample Cronbach's $\alpha = 0.89$) (Radloff, 1977).

Attendance and practice

Class attendance was recorded via a sign-in sheet, with adherence calculated as the total number of sessions out of nine (eight weekly sessions, one day-long retreat). Self-reported homework practice was assessed via weekly practice logs (See Supplemental Information). As WL had no training, these variables were only collected in MBSR.

Study 2

Participants

Lonely older adults ($N = 190$) were enrolled and randomized in this two-arm parallel trial (see Figure 2 for CONSORT flow chart and Table 1 for baseline characteristics). Participants were screened to be healthy, between the ages of 65 and 93, and moderately lonely (≥4 on the Short Form UCLA-R; Hughes et al., 2004); see Supplemental Information for details and eligibility criteria. Study data were collected between October 2016 and February 2020 across eight intervention cohorts (Lindsay et al., 2021, 2022). The planned sample size for the trial was determined by estimating a small-medium effect ($d = 0.3$) of MBSR compared to the HEP and a pre-post correlation of $r = 0.80$; $N = 188$ participants were needed to achieve >80% power.

Recruitment

Participants were recruited from the greater Pittsburgh area through local research registries, local learning centers, outreach events at local organizations and older adult housing, and newspaper, radio, bus, email, and mailed advertisements. The study was advertised for older adults interested in ways to reduce stress and increase social connections.

Procedure

At baseline (week 0), eligible participants completed questionnaire assessments and then were randomly assigned to either MBSR or HEP programs (1:1, see Supplemental Information). Questionnaire measures were assessed again post-intervention (week 9) and at follow-up (week 20). Participants were debriefed and given a chance to ask questions after completing all assessments and compensated up to $475, including bonus payments for high adherence to study procedures.

Materials

Intervention programs

Both the MBSR and HEP interventions were standardized curriculum-based group programs with 8 weekly 2-hr group sessions, a day-long retreat during the sixth week, and 45 min of homework assignments 6 days per week. Trained research staff attended intervention sessions to monitor intervention fidelity and address research questions. During the 3-month follow-up period, participants were encouraged to continue practices from their program. At the final class session, participants in both intervention programs were given a resource sheet (see details below) and received a weekly email from the research team with an intervention content-relevant quote for 12 weeks (i.e., until the follow-up assessment).

Mindfulness-based stress reduction

The MBSR program followed the MBSR Curriculum Guidelines (see Supplemental Information). Classes were taught by one of two experienced MBSR instructors who had completed the UMass Center for Mindfulness in Medicine, Health Care, and Society MBSR teacher trainings. Week 1 offered an overview with 45 min of body scan and introduction of mindfulness concepts; Week 2 body scan meditation and the seven attitudes of

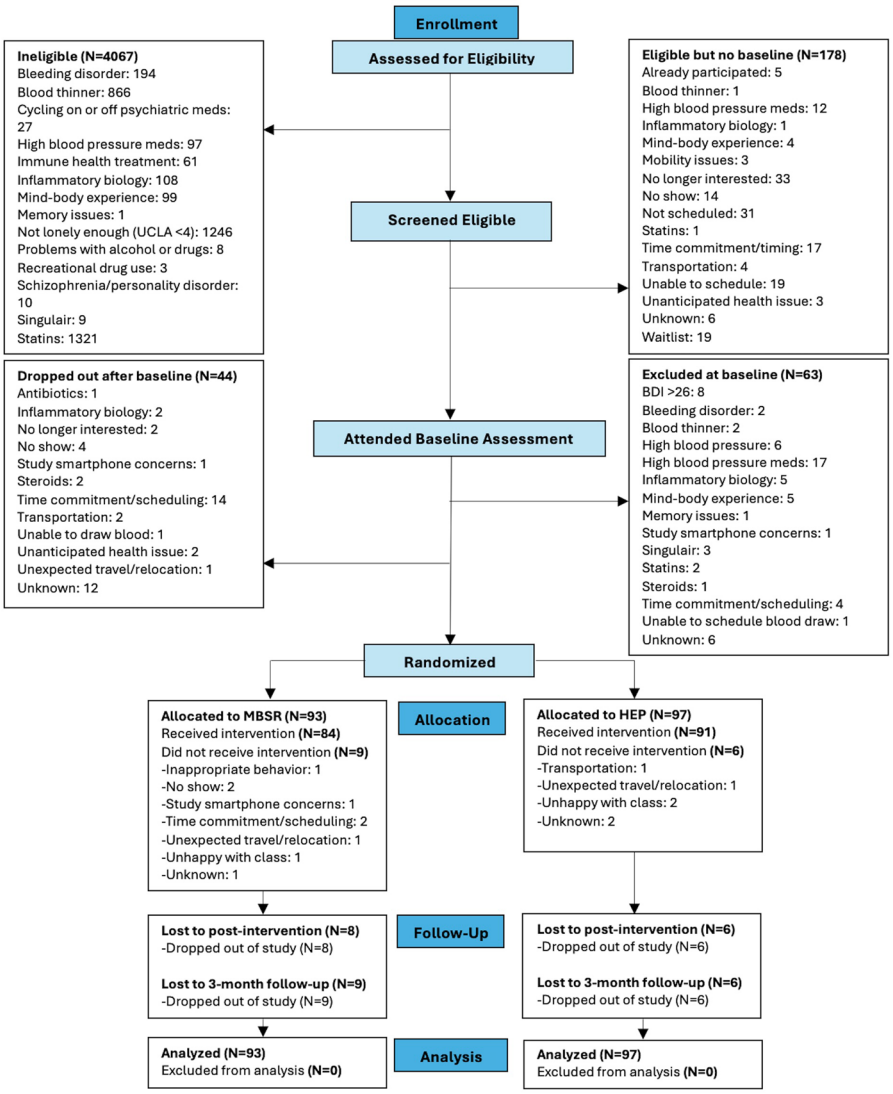

Figure 2. CONSORT Flowchart for Study 2. HEP = Health Enhancement Program; MBSR = Mindfulness-Based Stress Reduction.

mindfulness practice, as well as a discussion of responding and being aware of thoughts; Week 3 included mindful stretching and sitting meditation; Week 4 included mindful stretching and responding mindfully to stress; Week 5 included sitting meditation and stretching and approaching and coping with emotions; Week 6 included sitting meditation and styles of communication; the day-long retreat was silent and focused on mindfulness stretching, sitting meditation, body scans, walking meditation and awareness exercises; Week 7 included sitting meditation and mindful eating and diet; and Week 8 focused on sitting meditation and a review of the course materials before a closing ceremony. The resource sheet offered for participants at this final class had information regarding local classes and centers that support mindfulness, as well as books, podcasts, videos, and apps that could facilitate continued practice.

Health enhancement program

The HEP program followed guidelines outlined in previous research (MacCoon et al., 2012), including group discussions and activities to promote experiential learning of strength, aerobic, flexibility, and balance exercises, nutrition, and stress management through creative expression, particularly music. Week 1 offered an overview with 45 min of stretching and distribution of homework; Week 2 included stretching and strengthening exercises and a discussion of barriers to exercise; Week 3 included stretching and functional movement exercises alongside a discussion of a healthy diet; Week 4 completed functional movement training and diet education; Week 5 included stretching and education on inflammation; Week 6 included stretching with music and a drawing exercise focused on stress expression; the day-long retreat focused on health education about healthy activities and meal preparation, music and creative expression activities; Week 7 did rhythmic exercise with music and stretching and relaxation; and Week 8 focused on functional movement and a review of the course materials before a closing ceremony. The resource sheet offered for participants at this final class included relevant music and playlists, as well as websites with information about a healthy diet and eating practices. HEP classes were taught by one of two Registered and Licensed Dietitians.

Randomization and masking

Participants were randomized (1:1) to MBSR or HEP with a randomly generated list held by one author not involved in the intervention or analysis. Intervention instructors were unaware

of outcome measures, and outcome assessors were unaware of the condition.

Measures

Intervention and homework adherence

Class attendance was recorded via a sign-in sheet, with adherence calculated as the total number of sessions out of nine. Self-reported homework practice was assessed via daily survey links; daily practice duration was averaged across the intervention.

Loneliness

Loneliness was assessed at baseline, post-intervention, and follow-up using the 20-item UCLA Loneliness Scale (UCLA-20) (Russell, 1996). This widely used scale measures the extent to which participants felt lonely over the past month on a 4-point Likert scale ranging from 1 (never) to 4 (always) (e.g., "How often do you feel alone?"). Relevant items were reverse-coded, and all items were summed to create a total loneliness score, with higher scores reflecting higher loneliness (sample Cronbach's α = 0.87). Items matching the 7-item version of the scale were also used to compute UCLA-7 to match Study 1.

Baseline perceived stress

Perceived stress was assessed at baseline using the PSS, with higher scores reflecting greater stress (sample Cronbach's α = 0.88) (Cohen et al., 1983).

Baseline depressive symptoms

Depressive symptoms were assessed at baseline using the 21-item Beck Depression Inventory, with higher scores reflecting more severe symptoms (sample Cronbach's α = 0.88) (Beck et al., 1961).

Self-reported mindfulness skills

A participant's self-reported tendency to use mindfulness skills in daily life was assessed at baseline, post-intervention, and follow-up using the Five Facet Mindfulness Questionnaire (FFMQ) (Baer et al., 2008). The FFMQ mean score was calculated across 24 items with higher scores reflecting greater use of mindfulness skills (sample Cronbach's α = 0.86).

Analyses

To assess the effect of MBSR versus WL (Study 1) and MBSR versus HEP (Study 2) on self-reported loneliness, mixed effects modeling with restricted maximum likelihood was used to estimate two-level random-coefficients models (Raudenbush & Bryk, 2002). In these models, primary interest was in the 2 (intervention condition) × 3 (time) interaction. This allowed analysis of the full, intent-to-treat (ITT) sample—using all available data from all randomized subjects as allocated with no imputation. R Studio (v. 2024.12.1) was used to estimate all models. Planned comparisons testing for MBSR versus control condition differences from baseline to post-intervention and baseline to follow-up were calculated within these MLMs. The optimal error covariance structure for each of the models was determined through chi-square tests comparing the -2 restricted log likelihood model fit indices for each outcome. Study 1 models used an unstructured type, while Study 2 models used an autoregressive structure (the difference in covariance structures was such that in Study 2), the autocorrelation between outcome scores decreased exponentially with the time between samples. In Study 1, the correlation between outcome scores remained stable over time between samples. Cohen's *d* was used to estimate effect sizes using means and standard deviations from each study for within-group analyses, while standardized β were included as a proxy for effect size for time by condition interaction analyses. All continuous variables were normally distributed except for CES-D scores in Study 1, which were square-root transformed to correct for non-normality.

As an exploratory analysis in Study 2, we examined whether changes in self-reported mindfulness differed by intervention condition, and whether those changes in mindfulness corresponded to changes in loneliness. These data were also analyzed in R with MLM using the ITT sample. Planned comparisons were calculated within these MLMs using the same method as the primary analyses, and the optimal error covariance structure was the unstructured type.

Results

Preliminary analyses

Study 1

Table 1 shows demographic characteristics by condition; intervention conditions did not differ on these characteristics. MBSR participants were highly adherent (classes attended $M = 8.29$ out of 9). Preliminary *t*-tests revealed that at baseline, UCLA-7 scores did not differ by condition ($t(216) = -0.82$, $p = .41$); however, MBSR participants had higher baseline PSS scores ($t(216) = -2.64$, $p = .009$) and higher CES-D scores ($t(216) = -2.08$, $p = .039$), so these baseline scores were covaried in Study 1 analyses. Overall, participant dropout rate was low (MBSR = 2, WL = 9); however, the difference between conditions was significant ($\chi^2(1) = 4.36$, $p = .037$). Dropouts had higher baseline CES-D depressive symptoms than study completers ($t(216) = -2.06$, $p = .041$) but did not differ from completers on any other baseline characteristics. No study-related adverse events were reported. See Supplementary Table 1 for descriptive statistics and intercorrelations among baseline psychological variables.

Study 2

Table 1 shows demographic characteristics by condition; intervention conditions did not differ on these characteristics. Baseline UCLA-20 and UCLA-7 scores did not differ by condition (UCLA-20 $t(186) = 0.98$, $p = .331$; UCLA-7 $t(186) = 1.26$, $p = .211$), neither did PSS scores ($t(186) = 1.36$, $p = 0.176$) nor BDI scores ($t(175) = 0.11$, $p = .909$). Participants were highly adherent in both conditions ($M = 8$ of 9 classes attended). HEP participants completed more daily homework than MBSR participants ($M = 39.90$, $SD = 19.08$, and $M = 31.31$, $SD = 15.40$, respectively, $t(188) = -3.40$, $p = .001$), likely because homework from the HEP condition included tracking physical activity, exercise, and other health behaviors. Fifteen participants dropped out, and there was no difference in attrition between MBSR ($n = 9$) and HEP ($n = 6$) conditions ($\chi^2(1) = 0.796$, $p = .372$). Dropouts did not differ from completers in any baseline characteristics. No study-related adverse events were reported. See Supplementary Table 2 for descriptive statistics and intercorrelations among baseline psychological variables.

Intervention effects on loneliness

Study 1

We predicted a decrease in loneliness scores over time for MBSR participants but no change for WL participants. First, we

examined the change in loneliness scores from baseline to post-intervention. There was no main effect of time on UCLA-7 scores ($b = 0.757$, $SE = 0.519$, 95% CI [−0.264, 1.777], $p = .146$, $\beta = 0.181$), nor a significant time by condition interaction ($b = -0.073$, $SE = 0.829$, 95% CI [−1.703, −1.556], $p = .930$, $\beta = -0.018$). We then explored whether these changes were sustained across time to the 6-month follow-up. There was a main effect of time on UCLA-7 scores ($b = 1.623$, $SE = 0.212$, 95% CI [0.602, 2.643], $p = .002$, $\beta = 0.389$), and a significant time by condition interaction. MBSR participants showed a significant decrease in loneliness over time relative to WL ($b = -1.680$, $SE = 0.273$, 95% CI [−3.325, −0.034], $p = .045$, $\beta = -0.402$). See Table 2 for descriptive statistics and effect sizes.

Study 2

We predicted MBSR training would lead to greater decreases in loneliness over time than HEP. First, we examined the change in loneliness scores from baseline to post-intervention. There was a significant main effect of time, such that both MBSR and HEP condition participants showed a significant decrease in UCLA-7 scores from baseline to post-intervention ($b = -1.993$, $SE = 0.371$, 95% CI [−2.723, −1.264], $p < .001$, $\beta = -0.470$). However, there was no significant time by condition interaction; the two intervention conditions did not differ in loneliness from baseline to post-intervention ($b = 0.975$, $SE = 0.517$, 95% CI [−0.041, 1.991], $p = .060$, $\beta = 0.230$). The effects were comparable using UCLA-20 scale. There was a significant main effect of time on loneliness from baseline to post-intervention ($b = -4.114$, $SE = 0.787$, 95% CI [−5.661, −2.566], $p < .001$, $\beta = -0.432$), but no time by condition interaction ($b = 1.949$, $SE = 1.096$, 95% CI [−0.207, 4.105], $p = .076$, $\beta = 0.205$).

We then explored whether these changes were sustained at the 3-month follow-up. There was a significant main effect of time, such that both MBSR and HEP condition participants showed a significant decrease in UCLA-7 scores over time ($b = -1.898$, $SE = 0.436$, 95% CI [−2.756, −1.040], $p < .001$, $\beta = -0.448$). However, there was no significant time by condition interaction ($b = 0.454$, $SE = 0.602$, 95% CI [−0.731, 1.639], $p = .452$, $\beta = 0.107$). The effects were comparable using the UCLA-20 scale. There was a significant main effect of time on loneliness ($b = -3.598$, $SE = 0.957$, 95% CI [−5.481, −0.1.716], $p < .001$, $\beta = -0.378$), but no time by condition interaction ($b = 0.460$, $SE = 1.320$, 95% CI [−2.137, 3.056], $p = .728$, $\beta = 0.048$). See Table 2 for descriptive statistics and effect sizes.

Sensitivity analyses

Baseline psychological and demographic characteristics (stress, depressive symptoms, homework practice, and demographics) were evaluated as moderators of the relationship between condition and loneliness across all three timepoints.

Study 1

Baseline stress scores did not moderate the time by condition interaction (baseline to post-intervention: $b = 0.017$, $SE = 0.062$, 95% CI [−0.105, 0.138], $p = .789$, $\beta = 0.004$; baseline to follow-up: $b = 0.122$, $SE = 0.062$, 95% CI [−0.001, 0.244], $p = .052$, $\beta = 0.030$). Depressive symptoms scores also did not moderate the time by condition interaction (baseline to post-intervention: $b = 0.225$, $SE = 0.289$, 95% CI [−0.343, 0.793], $p = .436$, $\beta = 0.054$; baseline to follow-up: $b = 0.490$, $SE = 0.289$, 95% CI [−0.078, 1.058], $p = .090$, $\beta = 0.118$).

In a separate model, sex did not moderate the time by condition interaction (baseline to post-intervention: $b = -0.780$, $SE = 0.836$, 95% CI [−2.422, .863], $p = .351$, $\beta = -0.187$; baseline to follow-up: $b = 0.233$, $SE = 0.836$, 95% CI [−1.410, 1.875], $p = .781$, $\beta = 0.056$). However, age served as a moderator in the time by condition interaction (baseline to post-intervention: $b = 0.004$, $SE = 0.060$, 95% CI [−0.114, 0.122], $p = .948$, $\beta = 0.001$; baseline to follow-up: $b = -0.167$, $SE = 0.060$, 95% CI [−0.285, −0.050], $p = .005$, $\beta = -0.040$). As shown in Supplementary Figure 1, MBSR participants, relative to WL participants, showed greater declines in loneliness between post-intervention and follow-up, especially MBSR participants of a younger age. Homework practice in the MBSR condition was not associated with a change in loneliness scores ($b = 0.001$, $SE = 0.004$, 95% CI [−0.007, 0.008], $p = .881$, $\beta = 0.058$).

Study 2

As in Study 1, baseline stress scores did not significantly moderate the time by condition interaction on UCLA-7 scores (baseline to post-intervention: $b = 0.103$, $SE = 0.085$, 95% CI [−0.064, 0.269], $p = .226$, $\beta = 0.024$; baseline to follow-up: $b = 0.099$, $SE = 0.097$, 95% CI [−0.092, 0.290], $p = .309$, $\beta = 0.023$) nor on UCLA-20 scores (baseline to post-intervention: $b = 0.191$, $SE = 0.178$, 95% CI [−0.160, 0.542], $p = .284$, $\beta = 0.020$; baseline to follow-up: $b = 0.183$, $SE = 0.211$, 95% CI [−0.231, 0.598], $p = .385$, $\beta = 0.019$).

Table 2. Mean (and *SD*) values in MBSR and control conditions at baseline, post-intervention, and follow-up time points for Study 1 and Study 2 intent-to-treat samples.

Variable	MBSR				Control				
	Time 1	Time 2	Time 3	d_{av}	Time 1	Time 2	Time 3	d_{av}	p_{inter}
Study 1									
UCLA-7	12.44 ± 4.32	12.15 ± 4.22	11.91 ± 4.14	0.07, 0.13	11.96 ± 4.21	11.84 ± 4.04	11.91 ± 4.15	0.03, 0.01	.038
Study 2									
UCLA-20	43.09 ± 9.86	39.12 ± 9.15	39.82 ± 9.86	0.42, 0.33	41.72 ± 9.39	39.34 ± 9.09	38.62 ± 9.27	0.26, 0.33	.73
UCLA-7	15.92 ± 4.22	13.95 ± 4.45	14.10 ± 4.29	0.45, 0.43	15.18 ± 3.93	14.09 ± 4.32	13.79 ± 3.93	0.26, 0.35	.43
FFMQ	3.58 ± 0.45	3.72 ± 0.44	3.69 ± 0.40	0.31, 0.26	3.53 ± 0.49	3.71 ± 0.48	3.70 ± 0.50	0.37, 0.34	.37

Note. Control = Wait List (Study 1), Health Education Program (Study 2); d_{av} = Cohen's *d* (within-subjects); the first value in the dav columns represents the pre- to post-intervention effect size; the second value represents the effect size pre-intervention to follow-up; FFMQ = Five Facet Mindfulness Questionnaire mean score; MBSR = Mindfulness-based Stress Reduction; pinter = *p*-value of condition by time (pre-intervention to follow-up) interaction; Time 1 = Baseline; Time 2 = Post-intervention; Time 3 = Follow-up at 6 months (Study 1) or 3 months (Study 2); UCLA-7 = 7-item UCLA Loneliness Scale; UCLA-20 = full UCLA Loneliness Scale.

Baseline depressive symptoms scores did not moderate the time by condition interactions on UCLA-7 scores (baseline to post-intervention: $b = 0.133$, $SE = 0.080$, 95% CI [−0.024, 0.290], $p = .096$, $\beta = 0.031$; baseline to follow-up: $b = 0.121$, $SE = 0.093$, 95% CI [−0.063, 0.304], $p = .197$, $\beta = 0.029$). Results were similar with UCLA-20 scores (baseline to post-intervention: $b = 0.220$, $SE = 0.160$, 95% CI [−0.095, 0.535], $p = .170$, $\beta = 0.023$; baseline to follow-up: $b = 0.183$, $SE = 0.92$, 95% CI [−0.195, 0.551], $p = .342$, $\beta = 0.019$). Homework practice was not associated with change in loneliness scores from baseline to post-intervention in the MBSR condition (UCLA-7 $b = -0.006$, $SE = 0.032$, 95% CI [−0.069, 0.058], $p = .860$, $\beta = -0.023$; UCLA-20 $b = 0.007$, $SE = 0.065$, 95% CI [−0.122, 0.135], $p = .920$, $\beta = 0.013$). Inconsistent results were found in the HEP condition depending on the loneliness scale used as the outcome (UCLA-7 $b = -0.043$, $SE = 0.021$, 95% CI [−0.085, −0.002], $p = .039$, $\beta = -0.178$; UCLA-20 $b = -0.067$, $SE = 0.041$, 95% CI [−0.149, 0.016], $p = .111$, $\beta = -0.131$).

Exploratory analyses

Based on our findings in Study 2 that suggest both interventions successfully reduced loneliness in older adults, we performed additional exploratory analyses (which were not preregistered but offer some context for future studies). These exploratory analyses aimed to clarify the role that self-reported mindfulness played in both interventions' effects. We examined the time by condition effect on self-reported mindfulness (FFMQ). There was a significant main effect for time, such that both MBSR and HEP condition participants showed a significant increase in FFMQ scores over time (baseline to post-intervention: $b = 0.160$, $SE = 0.040$, 95% CI [0.081, 0.239], $p = .001$; baseline to follow-up: $b = 0.129$, $SE = 0.041$, 95% CI [0.049, 0.209], $p = .002$). Interestingly, the two intervention conditions did not differ in mindfulness changes over time (baseline to post-intervention: $b = 0.020$, $SE = 0.056$, 95% CI [−0.090, 0.130], $p = .722$; baseline to follow-up: $b = 0.050$, $SE = 0.056$, 95% CI [−0.060, 0.161], $p = .371$).

We then explored whether changes in mindfulness skills (FFMQ scores) following the intervention were associated with changes in loneliness. There was a main effect for mindfulness skills, such that higher mindfulness was associated with lower loneliness across time points (UCLA-7: $b = -3.347$, $SE = 0.732$, 95% CI [−4.788, −1.906], $p = 0.001$, $\beta = -0.369$; UCLA-20: $b = -8.999$, $SE = 1.550$, 95% CI [−12.047, −5.951], $p = .001$, $\beta = -0.441$). However, changes in mindfulness skills were not associated with changes in loneliness ($ps > .264$).

Discussion

Loneliness is a major risk factor for cognitive decline, depression, and morbidity and mortality in older adults, but effective interventions are limited (Hoang et al., 2022; Holt-Lunstad et al., 2015). Addressing loneliness through targeted interventions may not only improve emotional well-being but also mitigate the broader health risks associated with chronic loneliness. This report provides promising evidence that MBSR can reduce loneliness in older adults, addressing a scientific gap with two RCTs using some of the largest sample sizes to date. Study 2 further shows that a Health Education Program, which includes health education and exercise, had similar loneliness reduction benefits. Results show enduring effects of these interventions on loneliness, with significant reductions in loneliness even three and six months after the intervention, following a relatively brief, 8-week intervention.

High adherence suggests both programs are well-suited for aging adults, although additional effectiveness trials are needed. Neither study identified robust moderators of intervention effectiveness, including baseline stress, depressive symptoms, age, sex, and homework practice. The lack of moderation by homework practice may be due to high adherence, leading to restricted variability. Notably, Study 2 recruited participants with elevated loneliness at baseline, and both interventions reduced loneliness in this at-risk sample, further underscoring the relevance of structured, group-based behavioral interventions for vulnerable populations.

Rising rates of loneliness have been called a looming public health crisis by researchers, clinicians, and policymakers. However, few interventions have been identified to combat loneliness, particularly in older adults at increased risk of the negative health effects of isolation (Hickin et al., 2021; Masi et al., 2011). Traditional approaches focusing on increasing social contact have shown limited effectiveness, as loneliness is a cognitive and emotional experience rather than a lack of social interaction. The sociocognitive model of loneliness suggests that loneliness is maintained by negative cognitive biases, hypervigilance to social threats, and maladaptive coping behaviors. Thus, interventions targeting cognitive distortions may be more effective than increasing social contact alone (Hawkley & Cacioppo, 2010; Hickin et al., 2021). The two interventions described in these findings both included group-based lessons, preventing the ability to separate the potential social interaction benefits from the skills-based training in emotion and attention regulation (MBSR) and health promotion (HEP). It is possible that these social settings improved the quality of social interaction for participants in a way that reduced feelings of loneliness. It is also possible that learning these skills in a social setting enhances the ability of cognitive and emotional skills training to facilitate reductions in loneliness. However, other work on smartphone-based mindfulness training has found significant reductions in loneliness (Lindsay et al., 2019) in the absence of group-based training settings, suggesting that there is another mechanism by which mindfulness training can reduce loneliness. Future work should explore whether the group-based setting is an important factor in the success of MBSR or HEP in reducing loneliness. Indeed, it is likely a combination of factors, both social and psychological, that contribute to reduced feelings of loneliness following interventions, and future work can focus on testing these mechanisms in concert.

MBSR may reduce the negative cognitive biases of loneliness by fostering acceptance of distressing emotions and reducing social reactivity (Lindsay et al., 2019). Mindfulness practices teach nonjudgmental awareness of thoughts and emotions, which may help individuals reframe social interactions as more positive, disrupting the negative cognitive cycle underlying loneliness. While HEP does not explicitly train participants in these skills, we found that participants in this condition showed increases in mindfulness over time. Meta-analyses have identified increases in mindfulness in other active control conditions as well (Tran et al., 2022). Exploratory analyses found no direct link between changes in mindfulness and changes in loneliness. Thus, the exact mechanism by which these interventions led to reductions in loneliness is not clear. Instead, it is possible that changes in trait mindfulness led to changes in relevant behaviors (coping, greater

acceptance, changes in maladaptive social cognitions) that affected how lonely participants felt (Patrichi et al., 2025). Future work can disentangle the mechanisms for reducing loneliness.

This study addresses a critical gap in loneliness research by providing robust RCT evidence in older adults—a population disproportionately affected by the health risks of loneliness. The findings highlight the potential for scalable, evidence-based interventions for healthcare and community programs and demonstrate that they have long-term effects on loneliness. Given the broad health implications of loneliness—including its links to cardiovascular disease, depression, and mortality—these interventions may offset healthcare burdens associated with chronic loneliness (Conwell et al., 2011; Hawkley & Cacioppo, 2010; Strodl & Kenardy, 2006; Yang et al., 2016). Future research should continue to explore cost-effective implementations of these interventions, including government-supported programs or community-based initiatives that provide accessible versions of MBSR and HEP. Future work should consider the structural and systemic factors that might contribute to loneliness risk, including economic inequalities and cultural factors, to better understand the individuals who might benefit most from interventions like MBSR and HEP.

These studies had some limitations. First, neither was designed to investigate the social effects of group-based training, limiting the ability to make conclusions regarding the role of social support in reducing loneliness. Second, the samples consisted of relatively healthy older adults, limiting generalizability. Third, while MBSR is a well-validated program, its instructor-led and in-person format could lead to issues in scalability due to cost and barriers to participation. There is growing interest in mobile app-based deliveries for treatments (Lindsay et al., 2019), and further research is needed to determine whether older adults can maintain engagement with technology-based programs. Additionally, Study 1 and Study 2 had some methodological differences—most notably the comparison condition (WL vs HEP), recruitment strategy (older adults vs lonely older adults), and follow-up time period (6 months vs 3 months). Although direct comparisons are not possible (nor the goal of this work), this heterogeneity also presents value in interpretation: despite the differences between the two studies, consistent findings across both studies suggest robust intervention effects.

Loneliness has profound mental and physical health consequences and accelerated mortality risk, yet effective interventions remain scarce. This study demonstrates that both MBSR and HEP can significantly and enduringly reduce loneliness in older adults, highlighting scalable solutions for this critical public health issue. By reducing loneliness, these interventions could improve emotional well-being and mitigate mortality risk, supporting efforts to promote healthy aging and resilience.

Supplementary material

Supplementary data are available at *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences* online.

Funding

Study 1 research was supported by grants from the National Institute on Aging of the National Institutes of Health (R01AG025474; P30AG064103). Study 2 research and manuscript preparation were supported by grants from the National Center for Complementary & Integrative Health at the National Institutes of Health (R01AT008685; K01AT011759). Recruitment was supported by the National Institutes of Health Clinical and Translational Science Award (CTSA) program (grant UL1TR001857). These funding sources were not involved in study design; data collection, analysis, or interpretation; writing of this report; or the decision to submit this article for publication. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Conflict of interest

J.D. Creswell is the Chief Science Officer at Equa Health. All authors report no conflicts of interest.

Data availability

Data, materials, code, and online resources: Code for analyses and available data will be available with OSF (https://osf.io/9dm5e). Supplemental Information regarding recruitment and intervention design is available. A data dictionary will be available with the publication. Data sharing may require an institutional data sharing agreement.

Preregistration: The parent trial for Study 1 (Moynihan et al., 2013) was registered with clinicaltrials.gov (NCT01027780), and the secondary analyses presented in this manuscript were preregistered with OSF prior to analysis (https://osf.io/9dm5e). Study 2 was preregistered with clinicaltrials.gov (NCT02888600) at the initiation of the study, and the analyses presented in this manuscript were part of the primary registered analyses. Exploratory analyses were not preregistered but were conducted as they could be beneficial for future work in this area.

Reporting: We report how we determined our sample size, all data exclusions, and all manipulations. Study 1 involved an analysis of existing data, and cited articles describe all measures in the study. All measures for Study 2 are available at the preregistration page.

Ethical Approval: In Study 1, written informed consent was obtained from all participants, and study procedures were approved by the University of Rochester IRB. In Study 2, written informed consent was obtained from all participants, and study procedures were approved by the Carnegie Mellon University and University of Pittsburgh IRBs.

Acknowledgments

We would like to thank Hayley Rahl, Jeffrey DeBoer, Megan Lipsett, Sarah Lipitz, and Adrian Williams for help with study management, as well as the many research assistants who collected and processed specimens and data.

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