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## Regular Research Article

# The Leveraging Exercise to Age in Place (LEAP) Study: Engaging Older Adults in Community-Based Exercise Classes to Impact Loneliness and Social Isolation

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## ABSTRACT

**Objective:** Social isolation and loneliness are associated with morbidity and mortality in older adults. Limited evidence exists regarding which interventions improve connectedness in this population. **Design/Setting/Participants:** In this pre-post study we assessed community-based group health class participants' (age  $\geq 50$ ) loneliness and social isolation. Participants ( $n = 382$ ) were referred by a Cedars-Sinai Medical Network (Los Angeles, California) healthcare provider or self-referred from the community (July 2017–March 2020). **Intervention:** Participants met with a program coordinator and selected Arthritis Exercise, Tai Chi for Arthritis, EnbanceFitness, or the Healthier Living Workshop. **Measurements:** We measured social isolation using the Duke Social Support Index (DSSI) and loneliness using the UCLA 3-item Loneliness Scale at baseline, class completion, and 6 months. **Results:** Mean age was 76.8 years (standard deviation,  $SD = 9.1$ ); 315 (83.1%) were female; 173 (45.9%) were Non-Hispanic white; 143 (37.9%) were Non-Hispanic Black; 173 (46.1%) lived alone; mean baseline DSSI score was 26.9 ( $SD = 4.0$ ) and mean baseline UCLA score was 4.8 ( $SD = 1.8$ ). On multivariable analysis adjusted for gender, race/ethnicity, income, self-rated health, and household size, DSSI improved by 2.4% at 6-week compared to baseline (estimated ratio,  $ER: 1.024$ ; 95% confidence interval [CI]: 1.010–1.038;  $p$ -value = 0.001), and 3.3% at 6-month ( $ER: 1.033$ ; 95% CI: 1.016–1.050;  $p$ -value < 0.001). UCLA score after adjusting for age, gender, race/ethnicity, live alone, number of chronic conditions, income, and self-rated health, did not change at 6-week ( $ER: 0.994$ ;

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95% CI: 0.962–1.027;  $p$ -value = 0.713), but decreased by 6.9% at 6-months (ER: 0.931; 95% CI: 0.895–0.968;  $p$ -value <0.001). **Conclusion:** Community-based group health class participants reported decreased loneliness and social isolation at 6-month follow-up. (Am J Geriatr Psychiatry 2020; ■■■:■■■–■■■)

## INTRODUCTION/OBJECTIVE

Social isolation and loneliness are associated with significant morbidity and mortality in older adults. Holt-Lundstadt et al.<sup>1</sup> have equated the mortality risk of social isolation to smoking 15 cigarettes daily. Studies report lonely individuals have greater risk of functional decline<sup>2</sup> and death.<sup>3,4</sup> Demographics changes in the United States have led to a 10% increase in those living alone<sup>5</sup> and one-third of adults over the age of 45 reported feeling lonely.<sup>6</sup> Among community-dwelling older adults ( $\geq 65$  years) in the United States, 24% self-reported social isolation, with 4% reporting severe social isolation.<sup>7</sup> Socially isolated Medicare enrollees drive an additional 6.7 billion annually in Medicare spending due to increased length of hospital stay and need for skilled postacute care.<sup>8</sup> Both loneliness and social isolation are potentially modifiable risk factors. Despite the high physical, emotional, and economic burdens associated with loneliness and social isolation, limited evidence exists regarding which interventions improve connectedness.<sup>9,10</sup>

We aimed to evaluate the impact of group health classes on loneliness and social isolation in community-dwelling older adults. We utilized a community health coach embedded in our geriatrics practice, as a program coordinator. Our community health coach received referrals from health care providers and community-based organizations to connect participants with one of four evidence-based programs (EBPs) or a different community-based program if they were not eligible for or did not desire to participate in a research study. This model was based on the senior reach gatekeeper model where referrals by physicians and community members successfully recruited older adults into programming.<sup>11</sup>

Our intervention aimed to incorporate approaches from the growing conceptual framework in medical literature regarding successful methods to reducing social isolation in older adults. An integrative review of interventions for reducing loneliness and social

isolation in older adults identified adaptability, a community development approach, and productive engagement as the factors associated with the most effective interventions.<sup>12</sup> Another review found that participatory and group-based interventions were more effective.<sup>13</sup> We hypothesized that participation in an EBP would positively impact social connectedness and loneliness in older adults, through a purpose-driven activity designed to promote physical activity and social interaction with peers.

Area Agencies on Aging have encouraged the use of EBPs as federally funded community offerings for older adults. We aimed to evaluate if these programs could positively impact loneliness and social isolation as a new outcome for this intervention. EBPs implemented at community centers and using local partners provide a community-centered option to facilitate peer interaction. We chose to use EBPs recommended for falls prevention<sup>14</sup> as older adults who have a fear of falling are also more likely to be socially isolated.<sup>15</sup> Participants would then have a dual-benefit of falls reduction and potentially decreasing social isolation. Additionally lonely individuals report less physical activity than their less lonely counterparts<sup>16</sup> and those with more functional impairments are at increased risk for loneliness.<sup>17</sup> We aimed to demonstrate the impact of exercise based EBPs on loneliness and social isolation as these programs would offer a scalable intervention with multifaceted benefits for older adults. Our initial primary hypothesis was that the DSSI would improve by 4 points following EBP participation and be maintained at 6-month. Our secondary hypotheses were that EBP participation would decrease falls risk and health care utilization and these analyses will be conducted in the future.

## METHODS

### Study Design

This pre-post study included 382 community-dwelling participants age 50 years or older who

presented to a Cedars-Sinai Medical Network provider in Los Angeles, California or self-referred from the surrounding community. Recruitment started in July 2018 and ended in March 2020 due to the COVID-19 pandemic. Participants met with the program coordinator and selected from one of four EBPs: Tai Chi for Arthritis, EnhanceFitness, the Arthritis Foundation Exercise Program, and the Healthier Living Workshop. The study was registered with ClinicalTrials.gov (NCT03624049) and the protocol was approved by the Cedars-Sinai Institutional Review Board (IRB Pro00051676). All participants provided written informed consent prior to the start of the study. Initial enrollment goal was 2600 participants, which was the maximum number of class slots over 3 years based on the initial number of classes planned.

**Participants and Setting**

Participants were offered enrollment based on the following inclusion criteria: aged 50 years or older, community dwelling, able to complete questionnaires, able to consent to participate in the study, and ability to communicate in English. Participants were

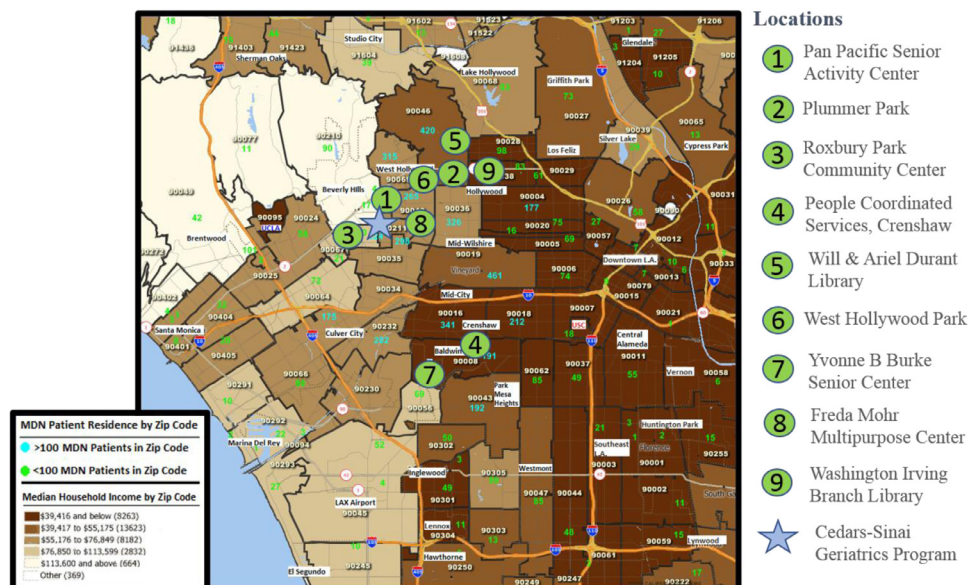
excluded if they had a known diagnosis of dementia, were permanent residents of a nursing facility, or were unable to attend a community-based program.

Nine different community host sites were selected based on accessibility to those with mobility limitations, access to parking and public transit, and location within a community with a known concentration of low-income older adults based on mapping of Cedars-Sinai Medical Network patients (Fig. 1). Community sites included senior centers, recreation centers, and libraries.

**Recruitment**

Participants were recruited during outpatient visits with Cedars-Sinai Medical Network providers and self-referred from flyers distributed in physician offices, posted at the community host sites, and embedded in host site newsletters. Primary care physicians, subspecialist physicians, nurse practitioners, pharmacists, social workers, and case managers placed electronic referrals in the medical record. The program health coach then called potential participants and facilitated consent and enrollment. Our program

**FIGURE 1. Program classes took place at nine different community sites surrounding the Cedars-Sinai Geriatrics Program with efforts made to locate classes in zip codes with high concentrations of low-income older adults.**



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health coach had a Masters in Gerontology and assisted participants in selecting a group health class that met their needs and preferences, either within one of the study classes, or in the community. She helped identify classes that were geographically accessible to participants and were adaptable to any physical limitations which the participants disclosed. Participants were mailed summaries of the class offerings to review. The Geriatric Program housed the program health coach and she met with some participants in clinic.

### Intervention

All four EBPs (Table 1) were taught by instructors from two community-based nonprofits – Jewish Family Service and Partners in Care with experience in running EBPs. Study classes and the program community health coach were funded through the AARP Foundation. All instructors were certified to teach and follow the guidelines for each class as outlined in the prior clinical trials during which the classes were developed. Classes were open for enrollment for the first 1–3 weeks and then closed to new participants afterward. After completion of the participants' initial session, if there was space in a subsequent class, participants could repeat the class or switch to a different class.

### Arthritis Foundation Exercise Program

The Arthritis Foundation Exercise Program is an EBP that aims to alleviate pain, decrease inactivity, decrease depression and decrease social isolation.<sup>18</sup> In prior trials, participants who completed 8 weeks of the program had statistically significant improvements in self-reported function, measured function, pain, fatigue, and arthritis self-management efficacy compared to nonparticipants.<sup>19,20</sup>

### Chronic Disease Self-Management

The Chronic Disease Self-Management program is a nonexercise based EBP designed to offer mutual support and build confidence in participants' ability to manage their health. In a multisite pre-post longitudinal study, participants experienced statistically significant improvements in pain, fatigue, activity limitations, communication with their physician, and medication adherence after completion of the program.<sup>21</sup>

### EnhanceFitness

The EnhanceFitness program is an EBP designed to increase strength, increase physical activity, and improve mood. In the original randomized controlled trial participants experienced a 13% improvement in social function, 52% improvement in depression, and 35% improvement in physical function<sup>22</sup> compared to nonparticipants. Subsequent studies found a decreased mortality rate for participants (1.4%) versus controls (2.9%)<sup>23</sup> and a decreased risk of falls.<sup>24</sup>

### Tai Chi for Arthritis

The Tai Chi for Arthritis program is an EBP proven to improve balance, increase muscular strength, improve mobility, increase flexibility, improve psychological health, decrease pain, and prevent falls in older adults.<sup>25</sup> Older adults after 8 weeks participation demonstrated significant improvement in psychosocial measures including helplessness, sleep, and satisfaction in participation in social roles.<sup>26</sup>

### Baseline and Outcome Assessments

While prior studies focused on physical outcomes of participation in the EBPs outlined above, we aimed to assess their impact on participants' loneliness and social isolation. We measured social isolation and

**TABLE 1. Summary of Evidence-Based Programs**

Instructors Trained by Master Trainers	Arthritis Exercise Yes	EnhanceFitness Yes	Tai Chi for Arthritis Yes	Healthier Living Yes
Exercise based	Yes	Yes	Yes	No
Class size (max)	25	25	15	12
Length of session (min)	45	60	45	150
Sessions per week	2	3	2	1
Duration of class (weeks)	8	8	8	6

loneliness through two validated questionnaires: the Duke Social Support Index (DSSI)<sup>27</sup> and the UCLA 3 item Loneliness Scale.<sup>28</sup> The Duke Social Support Index is an 11-item questionnaire with a composite score of between 11 and 33, with higher scores indicating higher levels of social connectedness.<sup>27</sup> The UCLA Loneliness Scale is a three-item scale with scores between three and nine with higher scores indicating higher levels of loneliness.<sup>29</sup> Participants completed baseline questionnaires on self-reported medical history and demographics. We administered questionnaires upon enrollment, after completion of the 6 to 8 week group health class, and at 6 months.

### Statistical Analyses

Data are presented as frequency (percentage, %) for categorical variables and mean ( $\pm$ SD, standard deviation) or median (IQR, interquartile range) for continuous variables. Univariate associations between variables were examined with analysis of variance (ANOVA), Wilcoxon-rank sum test, or Spearman rank correlation as appropriate. Primary outcomes were Duke social support index (DSSI) total score and UCLA Loneliness score. DSSI scores were considered valid with up to two missing values, which were then replaced with mean imputation. UCLA Loneliness scores were considered valid only if all 3 items were answered. Individual outcomes assessed at baseline, 6-week and 6-month were modeled to examine if there is a change in outcome measures over time using a generalized additive model for location, scale and shape (GAMLSS) with patient as a random effect<sup>30</sup> with and without adjustment for baseline covariates. A log normal distribution with an identity link function was used to model both outcomes. Unadjusted estimated value of each endpoint at each timepoint is graphically presented. The goodness of fit of each model was examined using residuals and the generalized Akaike information criterion (GAIC) such that the most adequate response distribution is chosen.<sup>31</sup> Model selection was performed using a stepwise variable selection procedure based on GAIC. Baseline covariates considered for inclusion included age, gender, race/ethnicity, marital status, living alone, number of chronic conditions, education level, income level, self-rated health status, household size, caregiver, and composite fall risk.

All analyses were performed using R package version 4.0.2 with two-sided tests at a significant level of 0.05. Significance was not adjusted for multiple outcomes.

## RESULTS

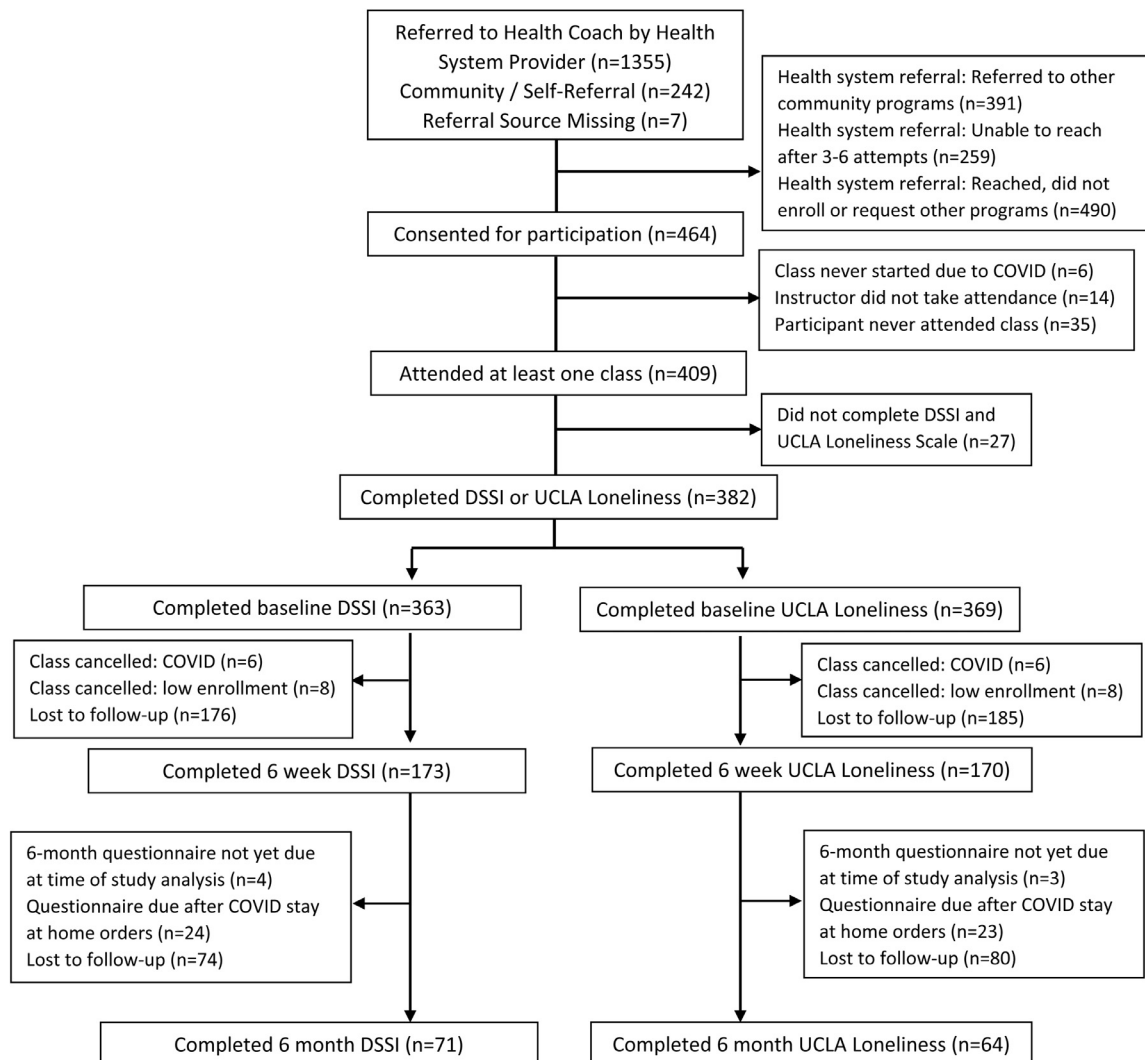
### Enrollment

The program health coach received 1355 health system referrals and subsequently consented and enrolled 464 participants. The older adults who elected not to enroll in the study were offered information for other community-based exercise classes and activities. Fifty-five participants did not ever attend a class and were not included in the analysis. Of the remaining 409 participants, 27 did not complete the UCLA Loneliness Score or the DSSI, leaving 382 participants for the analysis (Fig. 2).

### Baseline Characteristics

The mean (SD) age of participants was 76.8 (9.1) years (range 52–104 years); 315 (83.1%) were female, 173 (45.9%) were Non-Hispanic white, and 143 (37.9%) were Non-Hispanic Black (Table 2). At baseline, 173 (46.1%) of participants reported living alone, 73 (20.7%) reported acting as a caregiver, and mean (SD) household size was reported as 1.7 (1.0). The plurality of participants reported being widowed at 125 (32.9%), while 105 (27.6%) were married, 93 (24.5%) were divorced, and 52 (13.7%) were single. 320 (85.1%) participants reported some college education; and 98 (27.7%) reported an income of \$30,000 or less. Participants self-reported a mean (SD) of 3.5 (2.2) chronic conditions and 285 (76.6%) self-reported their health as Excellent/Very Good/Good, while 87 (23.4%) reported their health as Fair or Poor. Using a composite fall risk which indicated positive fall risk if the participant endorsed a fear of falling, feeling unsteady, or a fall in the past 4 months, 280 (74.1%) of participants were assessed to be at increased risk of falls.

The most popular programs were Arthritis Exercise with 172 (45.9%) participants and EnhanceFitness with 148 (37.6%) participants, followed by Tai Chi for Arthritis with 48 (12.8%) participants, and the Healthier Living Workshop with 14 (3.7%) participants.

**FIGURE 2. Flowchart of patient enrollment and follow-up for DSSI and UCLA Loneliness Scale.**

After completing their initial program, 181 (47.4%) of participants repeated a class.

### Primary Outcomes

At baseline, the mean (SD) DSSI score was 26.9 (4.0) with a median of 28 (24–30). The mean (SD) UCLA Loneliness score was 4.8 (1.8) and the median was 4 (3–6). Participants who completed baseline surveys but never attended a class had a mean (SD) DSSI score of 27.1 (4) and median of 28 (24–30); and a mean UCLA Loneliness Score of 5.2 (1.7) and median of 5 (3–6).

On univariate analysis, estimated DSSI score increased by 1.8% (0.5 points) at 6-week compared to the baseline and remained improved by 3.4% (0.9 points) at 6-month (Fig. 3 and Table 3). On multivariable analysis after adjusting for gender, race/ethnicity, income, self-rated health, and household size, DSSI remained improved by 2.4% (0.6 score) at 6-week compared to the baseline, and 3.3% (0.9 score) at 6-month (Table 4).

On univariate analysis, while there was no change in UCLA loneliness score from baseline to 6-week, UCLA loneliness score decreased by 5.7% (0.26 points) at 6-month (Fig. 4 and Table 3). On multivariable analysis

**TABLE 2. Demographic and Clinical Characteristics of the Study Participants at Baseline**

Variable	N = 382
Age (Years)	
Mean ( $\pm$ SD)	76.78 ( $\pm$ 9.08)
Median (IQR)	76 (71–83)
Missing	47
Gender	
Male	63 (16.62)
Female	315 (83.11)
Prefer not to answer	1 (0.26)
Missing	3
Race/Ethnicity	
Non-Hispanic White or Caucasian	173 (45.89)
Non-Hispanic Black or African American	143 (37.93)
Other/Multiracial	55 (14.59)
Prefer not to answer	6 (1.59)
Missing	5
Live alone	
Yes	173 (46.13)
No	202 (53.87)
Missing	7
Caregiver	
Yes	73 (20.68)
No	280 (79.32)
Missing	29
Class type	
Arthritis exercise	172 (45.0)
EnhanceFitness	148 (38.7)
Tai Chi for arthritis	48 (12.6)
Healthier living workshop	14 (3.7)
Marital Status	
Single (never married)	52 (13.68)
Married, or in a domestic partnership	105 (27.63)
Widowed	125 (32.89)
Divorced	93 (24.47)
Separated	5 (1.32)
Missing	2
Household size <sup>a</sup>	
Mean ( $\pm$ SD)	1.7 ( $\pm$ 0.97)
Median (IQR)	1 (1–2)
Missing	25
Education	
Some college or higher	320 (85.11)
High school graduate or lower	56 (14.89)
Missing	6
Income	
\$30,000 or less	98 (27.68)
\$30,001 or more	128 (36.16)
Prefer not to answer	128 (36.16)
Missing	28
Number of chronic conditions	
Mean ( $\pm$ SD)	3.53 ( $\pm$ 2.17)
Median (IQR)	3 (2–5)
Missing	17
Self-rated health	
Excellent/Very good/Good	285 (76.61)
Fair/Poor	87 (23.39)
Missing	10
Composite fall risk	
Positive	280 (74.07)
Negative	98 (25.93)
Missing	4

(continued)

**TABLE 2. (continued)**

Variable	N = 382
DSSI total score at baseline	
Mean ( $\pm$ SD)	26.87 ( $\pm$ 3.95)
Median (IQR)	28 (24–30)
Missing	19
UCLA Loneliness score at baseline	
Mean ( $\pm$ SD)	4.82 ( $\pm$ 1.83)
Median (IQR)	4 (3–6)
Missing	13

Data are presented as number of patients (%), mean ( $\pm$  SD) or median (IQR, interquartile range).

<sup>a</sup>Three subjects reported “6 or more” and 10 subjects reported “prefer not to answer,” which were considered as “6” and missing data in analyses, respectively.

after adjusting for age, gender, race/ethnicity, live alone, number of chronic conditions, income, and self-rated health, UCLA loneliness score did not change at 6-week, but decreased by 6.9% (0.23 points) at 6-month (Table 4).

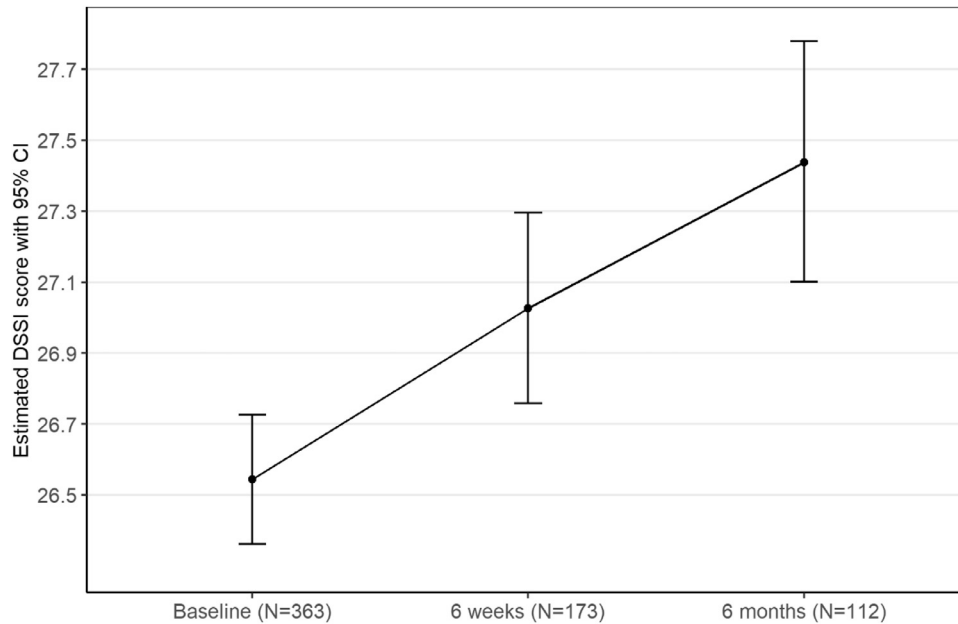
On univariate analysis, the percentage of classes attended and the total number of classes attended during the initial program session were not associated with a change in DSSI score from baseline to 6 weeks (Spearman correlation coefficient, CC:  $-0.127$ ,  $p = 0.095$ ; CC:  $-0.064$ ,  $p = 0.404$ , respectively) nor with UCLA loneliness (Spearman CC:  $0.045$ ,  $p = 0.556$ ; CC:  $0.007$ ,  $p = 0.926$ , respectively). Repeating the class after the initial 6 to 8 week session completed was also not associated with a change in DSSI (mean change [ $\pm$ SD]:  $0.62 [\pm 2.73]$  versus  $0.83 [\pm 3.38]$ ; ANOVA  $p = 0.743$ ) or UCLA loneliness Score (median change [IQR]:  $0 [-1, 0]$  versus  $-1 [-1, 0]$ ; Wilcoxon rank-sum test  $p = 0.066$ ) from baseline to 6 months.

Participants who completed baseline questionnaires only and were subsequently lost to follow-up were likely to have lower baseline social isolation score (median [IQR]:  $27 [24–29]$  versus  $28 [25–30]$ , Wilcoxon rank-sum test  $p = 0.043$ ) and higher baseline loneliness score (median [IQR]:  $5 [3–6]$  versus  $4 [3–6]$ , Wilcoxon rank-sum test  $p = 0.087$ ) compared to participants who completed follow-up though the association with UCLA loneliness score was not statistically significant. Besides this, there was no difference in demographics between the two groups of participants.

### Secondary Outcomes

Of participants who completed the assessment at class completion, 116 (72.5%) reported a decreased



**FIGURE 3. Unadjusted estimated DSSI scores with 95% confidence interval.**

fear of falling; and 131 (75.7%) gave a rating of 10 out of 10 when asked if they would recommend the program to a friend or colleague.

## CONCLUSION

Community-dwelling older adults who met with our community health coach and participated in an EBP reported decreased loneliness as measured by the UCLA Loneliness Scale and improved social connectedness as measured by the Duke Social Support

Index at 6 months compared to their baseline scores. Participants demonstrated improved social connectedness on the DSSI, but not on the UCLA Loneliness Scale at 6 weeks. It may be that loneliness requires more time to change than social connectedness, given its subjective and personal nature. While the change on each scale was small, these may still represent meaningful changes in the experience of loneliness and social isolation in older adults.

The clinically significant change in DSSI, however, may be as little as 1 point based on a study of volunteerism in older women which found that the

**TABLE 3. Univariate Analyses of DSSI and UCLA Loneliness Scores**

Variable	DSSI		UCLA	
	Estimated Ratio (95% CI) <sup>a</sup>	p Value	Estimated Ratio (95% CI) <sup>a</sup>	p Value
Time				
6-week	1.018 (1.006, 1.031)	<b>0.004</b>	1.000 (0.973, 1.028)	0.983
6-month	1.034 (1.019, 1.048)	<b>&lt;0.001</b>	0.943 (0.913, 0.975)	<b>&lt;0.001</b>
Baseline	1 (Reference)		1 (Reference)	

Models were fit using a log-normal distribution with an identity link function including 648 observations for DSSI score and 643 observations for UCLA loneliness score.

p Values <0.05 appear in bold text.

<sup>a</sup> Estimated ratio (95% CI) is expressed as the change in the ratio of the estimated means of the outcome.

TABLE 4. Multivariable Analyses of DSSI and UCLA Loneliness Scores

Variable	DSSI		UCLA	
	Estimated Ratio (95% CI) <sup>c</sup>	p Value	Estimated Ratio (95% CI) <sup>c</sup>	p Value
Time				
6-week	1.024 (1.010, 1.038)	<b>0.001</b>	0.994 (0.962, 1.027)	0.713
6-month	1.033 (1.016, 1.050)	<b>&lt;0.001</b>	0.931 (0.895, 0.968)	<b>&lt;0.001</b>
Baseline	1 (Reference)		1 (Reference)	
Age (Years)			1.004 (1.003, 1.006)	<b>&lt;0.001</b>
Gender <sup>a</sup>				
Male	0.976 (0.961, 0.992)	<b>0.003</b>	1.048 (1.008, 1.089)	<b>0.019</b>
Female	1 (Reference)		1 (Reference)	
Race/Ethnicity				
Non-Hispanic Black or African American	1.046 (1.032, 1.059)	<b>&lt;0.001</b>	0.886 (0.859, 0.914)	<b>&lt;.001</b>
Other/multiracial	1.000 (0.982, 1.017)	0.977	0.992 (0.947, 1.038)	0.719
Prefer not to answer	1.085 (1.036, 1.137)	<b>&lt;0.001</b>	0.815 (0.728, 0.913)	<b>&lt;0.001</b>
Non-Hispanic White or Caucasian	1 (Reference)		1 (Reference)	
Live Alone				
Yes	<sup>d</sup>		1.049 (1.019, 1.080)	<b>0.001</b>
No			1 (Reference)	
Number of chronic conditions	<sup>d</sup>		1.030 (1.022, 1.037)	<b>&lt;0.001</b>
Income				
\$30,000 or less	0.939 (0.925, 0.953)	<b>&lt;0.001</b>	1.047 (1.008, 1.087)	<b>0.018</b>
Prefer not to answer	0.984 (0.971, 0.998)	<b>0.023</b>	0.955 (0.925, 0.986)	<b>0.005</b>
\$30,001 or more	1 (Reference)		1 (Reference)	
Self-rated health				
Excellent/Very good/Good	1.073 (1.057, 1.089)	<b>&lt;0.001</b>	0.900 (0.866, 0.935)	<b>&lt;0.001</b>
Fair/Poor	1 (Reference)		1 (Reference)	
Household size <sup>b</sup>	1.008 (1.002, 1.015)	<b>0.011</b>	<sup>d</sup>	

Models were fit using a log-normal distribution with an identity link function including 555 observations for DSSI score and 494 observations for UCLA loneliness score.

p Values <0.05 appear in bold text.

Marital status, education, caregiver, and composite fall risk at baseline were dropped out of both models.

<sup>a</sup> One subject reported “prefer not to answer” and it was considered as missing data in analyses.

<sup>b</sup> Three subjects reported “6 or more” and 10 subjects reported “prefer not to answer,” which were considered as “6” and missing data in analyses, respectively.

<sup>c</sup> Estimated ratio (95% CI) is expressed as the change in the ratio of the estimated means of the outcome.

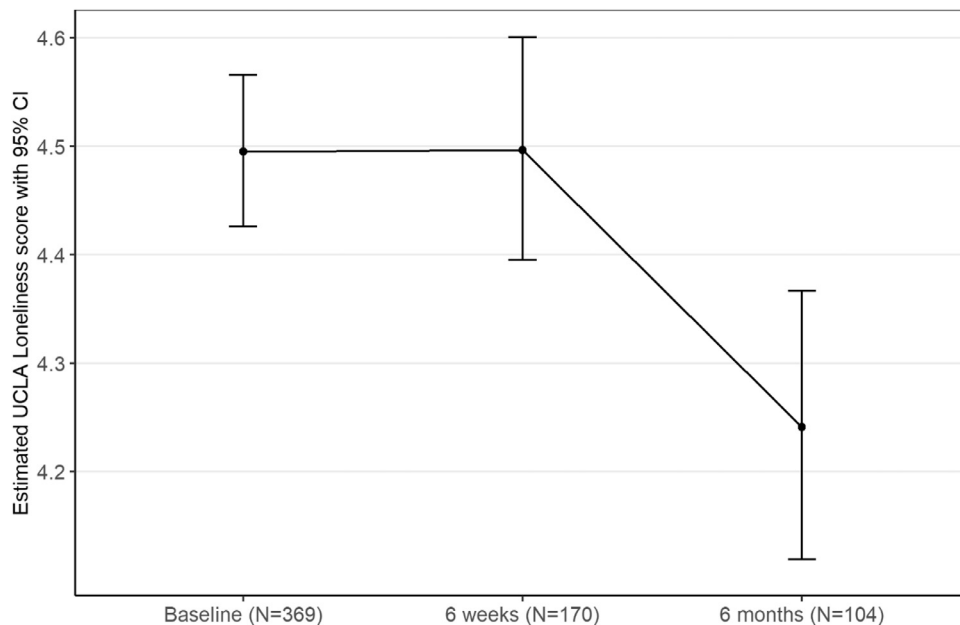
<sup>d</sup> Dropped out of the model.

likelihood of a woman volunteering increased by 35% for every 1 point increase in DSSI.<sup>32</sup> Therefore a 0.83 increase in DSSI may suggest the start of a meaningful change in social connectedness. In the National Social Life, Health and Aging Project, when the UCLA 3-item Loneliness Score was repeated after 5 years, participants reported an increase in loneliness on the UCLA Score from 3.96 to 4.11.<sup>17</sup> This suggests that loneliness in older adults may increase over time; therefore, the decrease in loneliness seen in our participants at 6 months by 0.26 points may also represent a meaningful change in their trajectory.

Unique features of our program included using a community health coach embedded within a geriatrics practice; direct referrals to EBPs using the electronic medical record from a variety of health care providers; and identifying accessible community locations with high concentrations of low-income

older adults. Using a program coordinator embedded in a health care system to enroll patients in EBPs was associated with decreased loneliness and social isolation in older adults, suggesting that this may be a possible successful intervention for further study and implementation.

Our use of group exercise incorporating peers may have provided a key element leading to the improvement seen in our participants, as a prior randomized controlled trial of providing one on one in-home exercise to address social connectedness did not demonstrate improvement as measured by the DSSI at 6 months.<sup>33</sup> Our findings are consistent with the benefits of a social support on participants' mental health highlighted in a pilot study of Latino older adults engaged in group exercise.<sup>34</sup> Additionally, the use of a coach to facilitate behavioral intervention has been shown previously to positively impact social

**FIGURE 4. Unadjusted estimated UCLA loneliness scores with 95% confidence interval.**

connectedness when compared to a friendly caller program.<sup>35</sup> Our program health coach functioned similarly to the “social prescribing” pathway recently described in England, where primary care providers can refer patients to a health coach for connection to community programming which led to decreased loneliness.<sup>36</sup> The purpose-driven nature of the classes<sup>12</sup> may also represent key element, contrasting with less successful approaches such as “Senior Meetings”<sup>37</sup> where the purpose is explicitly fostering companionship.

Our results add to the evidence regarding group exercise’s impact on social isolation and loneliness as a recent meta-analysis of randomized controlled trials of physical activity interventions for treatment of social isolation and loneliness found insufficient data to draw any conclusions and none of the U.S.-based studies had social isolation or loneliness as a primary endpoint.<sup>38</sup>

Our study has several limitations. First, this is a pre-post study conducted to evaluate and explore the impact of implementing EBPs within a health system on loneliness and social isolation. We aim to use the information gained through this study to power future randomized interventions. While examining

an intervention effect on two outcomes, we opted not to adjust for multiple comparisons. As our study was exploratory, a multiple test adjustment is not strictly required unlike in a confirmatory study in which results from multiple tests are combined in a single conclusion.<sup>39</sup> However, it is worth noting that irrespective of the study type, not adjusting for multiple comparisons may result in an inflation of a false positive rate. Second, the numeric score changes were small. We had estimated a change in DSSI of 4 points based on the hypothetical impact that attending classes would have on the quantitative portion of the DSSI. However, as mentioned previously a 1-point change may have significance in predicting behaviors such as volunteerism.<sup>32</sup> Prior studies utilizing the DSSI have not addressed change in DSSI over time, though our baseline scores on the DSSI were similar to prior studies that have demonstrated a mean (SD) baseline DSSI of 27.8 (3.0)<sup>40</sup> and 27.7 (3.5)<sup>41</sup> in older adults. Additionally, for the UCLA Loneliness scale, loneliness may increase in older adults over time<sup>17</sup> so that an intervention which decreases loneliness, though by only 6%, may still make a meaningful change over time. Our third limitation was our loss to follow-up, with only 47.7% and 46.1% of participants

completing 6-week follow-up for DSSI and UCLA Loneliness respectively; and only 19.5% and 17.3% completing 6-month follow-up. In analyses, missing data due to drop-out were handled with maximum likelihood estimation using a mixed-effects model (GAMLSS with a random effect) in which a random effect is used to capture individual level trajectories with missing data.<sup>42</sup> We selected a mixed-effects model due to its ability to handle missing data very well with maximum likelihood estimation. We employed a mixed-effects model to assess an intervention effect by examining changes in outcome values measured over time (preintervention, postintervention, and follow-up). Because this was a program evaluation, we analyzed our data without further implementation such as multiple imputation or Bayesian inspired estimation. This drop-out rate is consistent with prior findings that 50% of sedentary people who start an exercise program drop-out within 6 months.<sup>43</sup> Participants may have faced additional barriers due to difficulty with transportation to community locations and frailty with variable health status due to advanced age. Participants who were lost to follow-up had lower DSSI scores at baseline. This suggests that future programs may benefit from targeted efforts at retention for those with low social support scores upon entry to a program.

Additionally, participants were referred by a variety of health providers including social workers, pharmacists, and subspecialty physicians and may have had varying expectations of the programming. Also contributing to our loss to follow-up was the COVID-19 pandemic as participants under shelter at home orders were unable to return questionnaires in person or continue in classes with on-going easy access to study staff.

This study was halted in March 2020 due to safety concerns regarding group health classes. Group exercise classes are a high-risk activity for COVID-19

transmission – with a case report from South Korea demonstrating an attack rate of 25% in exercise students exposed to a COVID positive instructor.<sup>44</sup> Challenges to group programming will continue as long as older adults are asked to maintain physical distancing which can lead to increased social isolation and loneliness. In May 2020 our classes transitioned to being offered virtually via Zoom for both Arthritis Exercise and Tai Chi for Arthritis with future analyses to examine the transition from in-person to virtual programming. Upon completion of the study of virtual programming, the Cedars-Sinai Community Benefits office has committed to funding future classes and the position of program health coach in collaboration with existing community partners, therefore enabling program sustainability.

This program may provide a road-map for other health systems to consider implementing integrated referrals to community-based EBPs for older adults as in-person group health classes show promise as an intervention for addressing loneliness and social isolation in older adults. Future work is needed including randomized trials and evaluation of virtual alternatives.

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## AUTHOR CONTRIBUTIONS

*Study concept and design:* All authors. *Acquisition of data:* Mays, Au, Rosales, and Rosen. *Analysis and interpretation of data:* All authors. *Drafting of the manuscript:* Mays. *Critical revision of the manuscript for important intellectual content:* All authors. *Statistical analysis:* Mays and Kim. *Study supervision:* Mays and Rosen.

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