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Staying Strong on the Job: Physical and Psychosocial Benefits of Exercise for Agricultural Workers

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ABSTRACT

Objectives: Roughly 70% agricultural nursery workers report musculoskeletal dysfunction and fall-related injuries. Exercise has been shown to improve musculoskeletal health and fall risk, but the literature on the benefits of exercise in nursery workers is rare. This mixed-methods feasibility study aimed to elucidate the benefits of an employee-sponsored exercise class for nursery workers.

Methods: Twenty-five workers were randomized into either the Stay Strong, Stay Healthy (SSSH) resistance training program ($n = 14$) or control group ($n = 11$) for 8 weeks. Those assigned to SSSH performed eight exercises twice weekly at their workplace during business hours, while controls were asked to maintain their habits. Pre/post eight-week measures included health, pain, and sleep surveys and functional performance tests of static and dynamic balance, strength, and flexibility. Finally, interviews were conducted pre/post to gauge participants' perceptions of barriers and facilitators for health behaviors such as exercise. Statistical analyses included independent *t*-tests to assess baseline differences and two-way, mixed repeated measures analyses of variance models to observe interactions and main effects of time and group for all measures, $\alpha \leq 0.05$. Inductive thematic analysis was conducted on interview data.

Results: There were no baseline differences between SSSH and controls (all $p \geq .061$). Participants were on average 39 years old, had a BMI of 25.5 kg/m^2, reported poor sleep quality (PSQI 6.2), and 220 min/wk of physical activity. Over time, timed-up-and-go, 5 sit-to-stand, hand grip strength, and lower-body flexibility improved (all $p \leq .019$). Post-hoc analyses revealed pre/post-performance changes only in the SSSH group (all $p \leq .035$). Further, qualitative interviews suggest that employee-sponsored SSSH programming improved many areas of nursery workers' physical, interpersonal, and psychological health. Specifically, four themes emerged, which included labor-intensive job demands as a barrier to exercise engagement, multidimensional health benefits of SSSH, improved job performance after SSSH, and inspiration and insufficiency of SSSH. For example, those in the SSSH group noted improved personal confidence to complete work-related tasks. Conclusion: Employee-sponsored SSSH improved physical performance associated with falls and injury risk and most participants noted a general enjoyment of and benefits from SSSH pointing to the potential value of it to improve nursery workers' injury risk and health.

KEYWORDS
Functional capacity; labor-intensive; mixed-methods; musculoskeletal health; onsite exercise

Introduction

The agriculture industry is critical for the United States (U.S.) economy, contributing $1.3 trillion to the gross domestic product in 2021.[1] Despite its economic importance, agriculture remains one of the most dangerous industries globally, with approximately 170,000 work-related deaths reported each year.[2] In the U.S., there were 18,750 nonfatal agricultural injuries reported in 2020.[3] Of these, 47% were musculoskeletal injuries such as strains, sprains, and fall-related incidents.[4] Nursery workers, a subset of agricultural workers, experience an even higher rate, with 70% reported injuries being musculoskeletal and fall-related.[5]

Much of the musculoskeletal dysfunction stems from low-back pain often caused by repetitive work-related movements and poor muscle strength and flexibility, while the falls occur due to unsafe work environments, as many nurseries contain trip hazards, such as hoses, carts, and plants.[6] These injuries and

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Supplemental data for this article can be accessed online at https://doi.org/10.1080/1059924X.2025.2579637 falls often lead to missed workdays, negatively impacting workers' finances and productivity.[7] Thus, solutions to remedy these work-related injuries in nurseries are critically needed for both employees and employers.

The U.S. National Institute of Occupational Safety and Health (NIOSH) has promoted several ergonomic solutions in nursery workers, such as bucket-carrying systems, taller weeding flat tables, and back belts. Other researchers have implemented design initiatives for nursery pot-hole punching and transport carts, improving ergonomic movements and reducing strain.[8] However, improving one's functional capacity through exercise is key to reducing the risk of work-related musculoskeletal injuries and falls.[9–12] For instance, Martin-Diener et al.[10] found 12 studies that used exercise interventions to reduce musculoskeletal dysfunction in forestry and other labor-intensive occupations. The researchers concluded that most interventions improved health and work-related outcomes. Further, 11 of the 12 programs used resistance training, a type of exercise that may offer greater benefits to functional capacity and subsequent musculoskeletal and fall-related injury.[13–15] Nevertheless, only three of the studies included agricultural workers, and none used nursery workers. Thus, a critical research gap exists on the benefits of exercise for improving nursery workers' health, despite their elevated injury risk.

An efficacious, resistance training exercise program that may improve nursery workers' functional capacity is Stay Strong, Stay Healthy (SSSH). SSSH is an eight-week community-based program developed by University of Missouri faculty and propagated through University Extension networks across the U.S. The program was designed for older adults (age >60 years), a population, like nursery workers, with high incidences of musculoskeletal disorders and falls.[16,17] To meet this critical community need, SSSH was designed to be accessible and cost-effective. Thus, SSSH has reached hundreds of rural and urban counties over the past two decades, and numerous studies have demonstrated its ability to improve muscular strength and flexibility, gait speed, static and dynamic balance, body composition, sleep quality, and fall risk.[13,14,18]

Due to benefits and accessibility, SSSH may serve as an effective nursery-sponsored exercise program; however, no study has measured the efficacy of SSSH or onsite community-based exercise programs in this at-risk agricultural cohort. Further, there is little research on agricultural workers' experiences and perceptions regarding exercise, health, and worksite performance. Therefore, this mixed methods feasibility study employed two aims: (1) quantitatively measure the effectiveness of the SSSH program for improving nursery workers' functional capacity and general health and (2) qualitatively explore participants' perceived benefits with onsite exercise. It was hypothesized that those randomized into the SSSH group would improve health outcomes more than those in a control group and the program would be well received by employees who would note benefits from participation.

Methods

Study design and participants

This block-randomized, controlled, longitudinal, feasibility study was approved by the Oklahoma State University Institutional Review Board (IRB #-23–388) and was in accordance with the Declaration of Helsinki.[19] Further, all participants provided written informed consent before group assignment and participation. Twenty-five nursery workers (female, $n = 15$; male, $n = 10$) were recruited from a well-established garden center in Oklahoma through verbal interception and flyers. The center cultivates, grows, produces, and distributes a wide variety of plants, flowers, trees, and vegetables.

After recruitment, block randomization into an SSSH or control group occurred to ensure equal distribution of age, sex, and job-type. This resulted in 11 participants being assigned to the control group and 14 to the SSSH group. Unfortunately, three controls failed to complete the post-data collection session; two refused, and the other quit. Therefore, the post-sample size for the control group was eight. Those in the control group were asked to maintain their current physical activity habits, while those in the SSSH group performed 8 weeks of SSSH onsite. Data were collected before and after the 8-week program.

Sssh level I

The program, which was adapted from Baker et al.,[13] required participants to meet twice a week for 1 hour at a time for 8 weeks. Each class was conducted onsite during regular business hours, which allowed participants to stay clocked in and earn their normal wage while exercising. This was a primary reason many agreed to be in the study and demonstrated great support from TLC Garden Center owners.

Each SSSH class included a light warm-up, eight core exercises, and a cool-down. The core exercises, shown in Figure 1, targeted all the major muscle groups using a 2:4 second tempo. The instructor, a SSSH certified Extension Educator, closely adhered to the progression chart outlined in Figure 1. Additionally, a bilingual Spanish translator helped to ensure effective communication with all participants.

Descriptive, anthropometric, and survey measures

Descriptive questions included job type, sex, age, and ethnicity, while anthropometric data consisted of self-reported height and weight measured via Livongo Smart Scale. Next, an in-house general health questionnaire detailing physical activity habits and fall risk status, was followed by the Pittsburgh Sleep Quality Index (PSQI). The PSQI, a 10-item survey with seven scored components, was used to quantify participants' sleep habits during the past month. Scores ≥5 were indicative of clinically poor sleep quality. Finally, to assess baseline levels of musculoskeletal dysfunction, the Nordic Musculoskeletal Questionnaire (NMQ) was completed.

Functional capacity assessments

Eight functional capacity assessments were completed at the pre- and post-testing sessions. The 30-second sit-to-stand (30STS) was reported as the number of full chair-stands a participant completed

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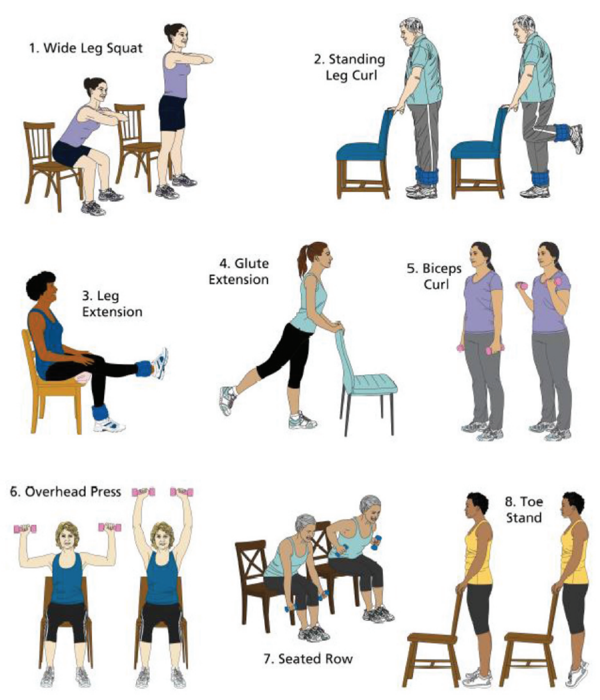

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Class Number	Sets x Repetitions	Weights	Exercise Execution
1	1 x 5	No weights	5 reps R, rest; 5 reps L, rest*; Repeat for **
2	2 x 5	No weights	5 reps R, rest; 5 reps L, rest; 5 reps R, rest; 5 reps L, rest*; repeat for **
3	2 x 6	No weights	6 reps R, rest; 6 reps L, rest; 6 reps R, rest; 6 reps L, rest*; repeat for **
4	2 x 6	Add weights	6 reps R, rest; 6 reps L, rest; 6 reps R, rest; 6 reps L, rest*; repeat for **
5	2 x 8	Weights	8 reps R, rest; 8 reps L, rest; 8 reps R, rest; 8 reps L, rest*; repeat for **
6	2 x 10	Weights	10 reps R, rest; 10 reps L, rest; 10 reps R, rest; 10 reps L, rest*; repeat for **
7	2 x 10	Weights	Same as class 6
8	2 x 10	Weights	Same as class 6
9	2 x 10	Weights	Same as class 6
10	2 x 10	Weights	Same as class 6
11	2 x 10	1-2 adaptations with weights	10 reps R, rest; 10 reps R, rest; 10 reps L, rest; 10 reps L, rest*; repeat **
12	2 x 10	Same adaptations with weights	Same as class 11
13	2 x 10	1-2 adaptations with weights	Same as class 11
14	2 x 10	Same adaptations with weights	Same as class 11
15	2 x 10	1-2 adaptations with weights	Same as class 11
16	2 x 10	Same adaptations with weights	Same as class 11

Figure 1. All eight exercises used throughout the eight-week level I sssh classes are shown on the left. The progression chart used during the eight-week level I sssh classes is shown on the right. The weight used is self-selected by the participants, including any increases in intensity. * refers to the standing leg curl, leg Extension, and glute Extension exercises. ** refers to the wide leg squat, biceps curl, overhead press, seated row, and toe stand exercises.

in 30 seconds, while the 10-foot timed-up-and-go (TUG) was measured as the time in seconds it took a participant to rise from a chair, walk around a marker 10 feet away at a self-selected pace, and return to the seated position. Upper- and lower-body flexibility were tested using the back-scratch and Sit-n-Reach (SnR), respectively, and both were reported in centimeters. Balance was assessed using the Stork Stand Balance Test, where participants were required to hold a single leg pose for as long as possible, with a maximum time of 300 seconds. Muscular strength was measured using hand grip dynamometry, while muscular power was measured with the five-sit-to-stand test. For hand grip dynamometry, participants were seated with their elbows bent at 90°. The test was performed on both arms and the peak force was recorded and averaged between limbs. Finally, self-selected gait speed was determined with the 10-meter walk test. Many of these tests have been used in past SSSH literature, and intraclass correlation coefficients ranged from 0.948 to 0.967.[13]

Interviews

Most interviews were conducted alongside quantitative data collection sessions, where participants would finish the questionnaires and functional capacity assessments prior to an interview that would last up to 1 hour. In-person interviews were conducted onsite in warehouses, offices, and break rooms, primarily free of distractions, while some interviews were conducted by telephone to accommodate participants' schedules.

Semi-structured interview questions were developed in thematic sections that included background/role, physical activity/movement, health descriptors, and program participation for those in the SSSH group. These thematic sections allowed for both common areas of inquiry as well as additional individualized organic questions, probes, and prompts. Additionally, all interviews were recorded, transcribed, and de-identified for analyses. All participants were given pseudonyms which are used here. Interview notes were also taken during interactions and thematic memos were developed across interviews. See Table 1 for a semi-structured interview protocol guide.

Statistical analyses

All quantitative statistical procedures were performed using IBM SPSS (v28.0, Armonk, New York), and significance was denoted with an $\alpha \leq 0.05$. Descriptive statistics were reported as mean and standard deviation (SD). Baseline musculoskeletal dysfunction was compared between sex and job-type using Fisher's Exact Test and Likelihood Ratios (G^2). Independent *t*-tests were used at baseline to assess group differences. Two-way, mixed repeated measures analyses of variance models (RMANOVA) were utilized to assess potential interaction effects or main effects for group and time for outcome variables. Significant main effects of time were decomposed with paired *t*-tests. For magnitude inferences, Cohen's *d* effect sizes were calculated for *t*-tests and interpreted as small (0.20–0.49), medium (0.50–0.79), and large (≥0.80), while partial eta-squared were calculated for RMANOVAs and interpreted as small (0.01–0.05), medium (0.06–0.13), and large (≥0.14).[20,21]

Clarke, et. al (2015) suggest that thematic analysis is appropriate for data focused on perspectives, practices, and experiences.[22] Three researchers used inductive thematic analysis, considered discrepancies, and reached consensus on qualitative findings.

Table 1. Semi-structured interview protocol guide.

Thematic Section	Questions	Prompts
Background/Role	Tell me about some of the work you do here at the nursery? How did you come to work at TLC?	What is the official name of your position? What do you like about your work?
Physical Activity/Movement	Describe some of the ways you engage in physical activity outside of work? What other kinds of activities do you do?	What prevents you from engaging in these activities? What are the benefits of these activities? (Psychological, Spiritual, Physical?)
Health Descriptors	How would you describe your overall health? What kinds of health challenges do you face?	How would you describe the quality of your sleep? What interrupts your sleep?
Program Participation (for SSSH group only)	How are you feeling about starting the Stay Strong, Stay Healthy program? How did you decide to get involved?	What do you hope to get out of the program? (Psychological, Spiritual, Physical?)

Notes. TLC: TLC was the garden center participants worked at. *Abbreviations*: SSSH: Stay Strong, Stay Healthy.

Following Braun and Clarke (2006), researchers reviewed data multiple times, identifying initial codes and repeating ideas (patterns), then generating, refining, and finalizing themes.[23] The five thematic findings articulate the meaning derived from these analytic processes, which supplemented and triangulated understandings of our quantitative analysis.

Results

Demographic data

Whole group descriptive data is displayed in Table 2. Participant ethnicities included Hispanic ($n = 3$), Asian ($n = 1$), Native American ($n = 1$), Biracial ($n = 1$), and White ($n = 19$). Within this cohort, 68% did not use tobacco and none of them had joint replacements. Regarding females ($n = 15$), 30% were on or had been on some form of hormone replacement therapy. Additionally, 64% participants worked more labor-intensive jobs. These labor-intensive jobs included production and warehouse workers, while less labor-intensive jobs included sales and managerial workers. Despite the disproportionate number of more labor-intensive jobs, only 48% participants, on and off the job, were meeting national physical activity guidelines.[24] Furthermore, 72% of participants did not experience a fall within the past 12 months, which was reflected in their low fear of fall scores and good functional capacity. Although fall risk was low and functional capacity was good, mean sleep quality scores were within the clinically poor category.

Descriptive musculoskeletal dysfunction

The NMQ was used to describe baseline musculoskeletal dysfunction and is shown in Figure 2. The most commonly reported body areas that participants noted pain and functional impairments included the lower back (52%), neck (40%), shoulders (36%), knees (36%), ankles/feet (32%), hips/thighs (28%), wrists/hands (24%), upper back (18%), and elbow (4%). Those who worked more labor-intensive jobs were more likely to hurt their necks than their coworkers who reported working less labor-intensive jobs ($p = .027$; $G^2 = 5.442$, $p = .02$). Furthermore, female nursery workers were more likely to experience lower back, neck, shoulder, knee, and hip/thigh dysfunction than male nursery workers (all $p \leq .040$; all $G^2 \geq 5.442$, $p \leq .02$).

Quantitative analyses

Fall and performance comparisons between the SSSH and control group are displayed in Table 3 and Figure 3. Block randomization was successful as there were no baseline differences for age, physical activity levels, falls, fear of falling, PSQI scores, or functional capacity between groups (all $p \geq .061$). After running RMANOVA, there were no interactions or group effects for any dependent variables. However, there were significant main effects of time as hand grip, 5STS, TUG, and SnR all improved (all $p \leq .019$) as shown in Figure 3. After paired t-tests, only the SSSH group had changes in hand grip, 5STS, TUG, and SnR performance (all $p \leq .034$). Additional clinical relevance was found as three SSSH participants improved their 30STS scores from a high risk of falls category into a low risk.

Qualitative analyses

Five findings enhanced the understanding of nursery workers' perceptions of barriers to

Table 2. Baseline descriptive data.

Measures	Total ($n = 25$)	SSSH ($n = 14$)	Control ($n = 11$)	Baseline Ind. t-test/ES
Age (years)	38.8 (15.5)	42.2 (18.1)	34.4 (15.5)	0.264/0.46
Height (cm)	170.7 (7.6)	169.3 (8.2)	172.3 (6.9)	0.346/0.39
Weight (kg)	73.8 (15.5)	73.2 (12.3)	74.6 (19.4)	0.838/0.08
BMI (kg/m^2)	25.5 (5.1)	25.7 (4.8)	25.3 (5.5)	0.735/0.14
Total Weekly Physical Activity (min/wk)	222.2 (217.1)	232.5 (221.2)	222.2 (221.7)	0.795/0.11
Number of Falls Per Year	1.8 (5.2)	2.1 (6.6)	1.3 (2.8)	0.743/0.13
Fear of Falling (AU)	9.8 (3.1)	10.4 (3.7)	9.1 (1.9)	0.286/0.44
Sleep Quality (PSQI)	6.2 (4.1)	5.8 (4.0)	6.8 (4.5)	0.545/0.25

Note. Total, SSSH, and Control group descriptive data displayed as mean (SD). There were no differences at baseline between the SSSH and Control group. Effect sizes were reported as Cohen's *d*. *Abbreviations*: SSSH, Stay Strong, Stay Healthy; ES, effect size; BMI, body mass index; AU, arbitrary units; PSQI, Pittsburgh Sleep Quality Index.

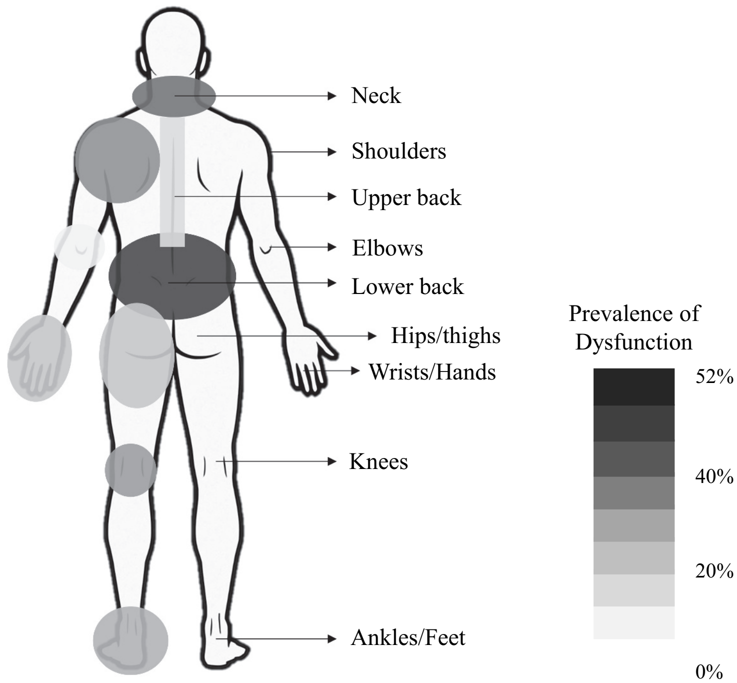

Figure 2. Visual representation of baseline NMQ data across all participants ($n = 25$). Body map, with all nine body parts labeled, is shown on the left, and a prevalence histogram is shown on the right. Abbreviations: NMQ, nordic musculoskeletal questionnaire.

Table 3. Performance comparisons between SSSH and control groups.

Measures	Time	SSSH ($n = 14$)	Controls ($n = 11$)	Inter. sig. (p)/ ES	Time sig. (p)/ ES	Group sig. (p)/ ES
30STS (reps)	Pre	19.5 (6.8)	24.8 (6.0)	0.862/0.00	0.059/0.18	0.065/0.17
	Post	21.7 (5.7)	26.7 (4.1)			
■ TUG (seconds)	Pre	8.2 (1.2)	7.2 (1.6)	0.462/0.03	0.009/0.29	0.259/0.06
	Post	7.6 (1.4)	7.0 (1.2)			
Mean BS (cm)	Pre	−6.1 (12.5)	0.1 (4.6)	0.890/0.00	0.407/0.04	0.140/0.11
	Post	−4.3 (13.2)	3.1 (7.6)			
■ Mean SnR (cm)	Pre	0.2 (14.0)	4.1 (10.2)	0.977/0.00	0.019/0.25	0.488/0.00
	Post	7.9 (7.6)	10.2 (5.3)			
SSB (seconds)	Pre	88.0 (90.9)	136.6 (93.3)	0.407/0.04	0.144/0.10	0.200/0.08
	Post	136.4 (116.4)	173.1 (103.3)			
■ 5STS (seconds)	Pre	8.4 (3.5)	7.0 (2.9)	0.862/0.00	0.005/0.33	0.379/0.04
	Post	7.1 (3.3)	5.8 (1.8)			
■ Hand Grip (kg)	Pre	35.9 (11.7)	37.0 (11.4)	0.985/0.00	0.010/0.29	0.827/0.00
	Post	38.6 (13.3)	39.8 (10.8)			
10MWT (seconds)	Pre	7.9 (1.1)	7.1 (1.0)	0.861/0.00	0.116/0.12	0.270/0.06
	Post	7.6 (1.2)	7.1 (0.8)			

Data are shown as mean (standard deviation). There were no group differences at baseline or interactions or main effects of group over time. There were significant main effects of time for TUG, Mean SnR, 5STS, and Hand Grip (all $p \leq .019$). ■ These data are also graphically represented in Figure 2. Effect sizes were reported as partial eta-squared. *Abbreviations*: SSSH, Stay Strong, Stay Healthy; Interaction significance p value; ES, effect sizes; 30STS: 30 sec sit-to-stand; TUG: 10 foot timed up-and-go; BS: back scratch; SnR: sit-n-reach; SSB: stork stand balance test; 5STS: 5 second sit-to-stand; 10MWT: 10 meter walk test.

exercise in their roles and participants' perceptions of the program's efficacy: (1) difficulties maintaining exercise outside of work given job demands; (2) SSSH program's multidimensional health benefits; (3) program beneficial for job performance; (4) program insufficiency for some roles; and (5) program as inspirational. Example quotes for the multidimensional benefits of SSSH can be found in Table 4 and Supplementary Table S1.

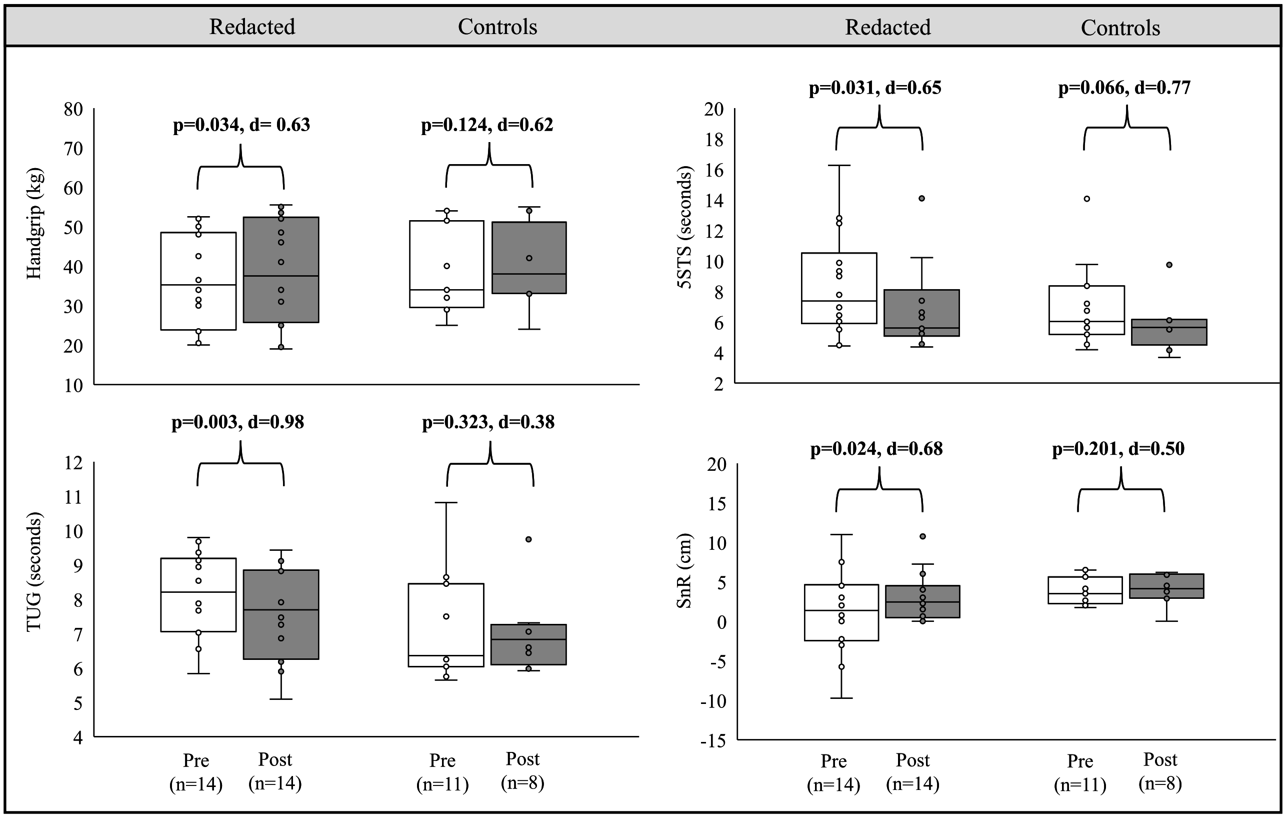

Figure 3. Group changes over time for handgrip (top left), 5STS (top right), tug (bottom left), and SnR (bottom right). Significant main effects of time (all $p \leq .019$) may have been driven by the sssh group as post hoc paired *t*-tests revealed changes in the sssh group, but not in the control group as shown above. Effect sizes were reported as Cohen's d. *Abbreviations*: 5STS, 5 sit-to-stand; tug, timed-up-and-go; SnR, sit-n-Reach.

Demanding work roles intrude on additional exercise

Most participants worked in labor-intensive positions in plant cultivation and production, greenhouse care and maintenance, and warehouse work. Some worked in service involving significant walking, standing, and lifting. These roles demand strength and flexibility to withstand musculoskeletal pressures. Workers' labor increases drastically during peak season (spring/summer) with varied implications for their overall health and movement outside work. Aaron said, "I'm exhausted most days. Just from picking up bags of grass seed .... they weigh like 50 pounds and … you [can] do that 30 times in a row multiple times a day." Another said, "no way" she would exercise: " … that first day off after working the physicality of our job is basically just trying to recoup." Although most participants described having generally good health, some described their movement as limited to their jobs with 11 out of 25 reporting no additional exercise outside of work. Fourteen described regular activities such as stretching, hiking, or walking, but only 7 described intense weekly exercise of lifting weights, boxing, exercise classes, or running.

Multidimensional program benefits

Participants found the program beneficial physically, psychologically, and interpersonally. All who participated appreciated the program in some way, whether through its physical benefits, the break it provided from work, or the opportunity to learn new techniques and skills. Overall, 100% of participants believed the program was beneficial. Most commented positively, from enthusiasm, "it was great, I loved the program," to saying they "enjoyed it," it was "good," "fun," "alright," and "everything was helpful." James appreciated the challenge: "I liked doing the exercises… sometimes there was more control,

Table 4. Multi-dimensional benefits of Stay Strong, Stay Healthy as represented in qualitative interviews.

Health Benefit	Qualitative Quote
Self-efficacy	"This program helped me realize, *I can do it*…I don't have to give up because of my age…you have to find out what you can do, and don't sit" (Labor-intensive-role, female in her 70s)
Interpersonal	"You know, it's a nice camaraderie thing. It's kind of fun for all of us to get together plus it helped you know loosen us up, and you know stretching and stuff" (Stephanie, labor-intensive, 40s).
Learning	I feel refreshed more so after doing some workouts and more knowledgeable because I didn't know what to do in those [first] workouts, like the sets and everything that we were doing (Less-intensive role, female in her 20s)
Self-Assessment	I wanted to see how [exercise] would fit me…[and] to give me a sense of my own fitness level. (Labor-intensive, female in her 60s).
Mobility	I feel the change, I feel myself lighter … I can move a little bit easier … I feel more flexible … more relaxed, in better condition. (Labor-intensive, female in her 50s).
Pain reduction	I'm not as achy when I wake up, you know. I'm sleeping the same hours but I'm waking up feeling better." (Less-labor intensive, female in her 20s).
Energy	I have more energy 'cause I'm sleeping better…. In these…last eight weeks…I feel happier. (Labor-intensive, female in her 50s).
Improved job performance	Before, rolling up those [greenhouse] walls [with a hand crank] was really hard. I mean, you'd have to take …lots of breaks….I mean, I can do it better now. I still have to take *some* breaks, but before it was a lot more…lifting things is easier. Because we have to lift, I don't know, 20-pound bags of fertilizer….Those don't seem very heavy anymore. (Labor-intensive, female in her 40s).

like it was slower, so it was harder to do. I liked making it a challenge." The benefits were multidimensional in providing a challenge, supporting self-efficacy, enhancing work relationships, contributing to learning, and inspiring them to continue exercising after the program.

Job performance benefits

Furthermore, some found the program valuable for their daily job performance and experiences. One clear benefit for some was increasing strength and endurance and learning safer lifting techniques. Hector, who was in his 50 s, described his increase in "confidence" in bending down to lift heavy objects from doing squats and weights during the program. This confidence helped appease fears about injury from work tasks. James valued increasing body awareness for his job: "I started to become more aware of certain muscles, within certain workouts, and I could utilize that outside at work."

Program insufficiency for some nursery roles

Despite widespread appreciation for the program's diverse benefits, four participants in labor-intensive roles reported the program did not challenge them enough for the type of labor they performed. Participants making those comments ranged in age from 21 to late 40 s; no participants 50 or older shared these thoughts. Even though Aaron found it "beneficial," for instance, he thought "it's more suited for an older crowd." Mitch, who lifts weights, golfs, and hunts, said the program increased his flexibility but not his strength. Peggy described her preferred workouts as "really high intensity … for me to feel like I really got something out of it. I'm one of those, when I lift weights and stuff, if I don't get sore, I'm upset because I feel like I didn't do anything." SSSH does have more progressive levels that perhaps would be more beneficial for these participants, but to date they have not been evaluated in the workplace.

Inspirational for some workers

Others across work roles found the program inspirational. Most described wanting to continue to exercise and some attributed it to the program. Tessa described continuing the squats, stretches, and leg stands: The program "helped me enough that it made me want to keep doing the squats which in turn helps my back because of being able to use the upper body mechanics." All women over 50 described wanting to be intentional about activity and movement as they age. Tessa remarked, "Y'all's program made me very aware of how much staying active but doing it in a focused way can make a difference as we age in how we age." Several planned to buy weights and one said, "I've bought weights. I started at 2 pounds and now 5 pounds is too light (laughter)." Hector's "courage" increased: "[the] benefited me because it does give me the courage to do it again, either in a program or by myself."

Discussion

This feasibility study contributes to scant research on nursery workers' experiences with exercise programs for improving health. Workers' descriptions of their labor and its physical effects underscore this work sector's extensive demands.[8,25,26] These requirements necessitate ample physical function to ensure worker safety and industry vitality, while at the same time, many workers perceived labor intensity to interfere with energy and motivation to exercise outside of work. This preliminary investigation aimed to quantitatively evaluate the effectiveness of an onsite exercise program and qualitatively explore nursery workers' perceived benefits with onsite exercise. We hypothesized that participating workers would improve functional capacity and that the program would be well received. Overall, the findings highlight the value of onsite exercise programs in supporting nursery workers' health through both measured and self-perceived improvements in functional capacity.

At baseline, over half of the participants reported musculoskeletal dysfunction, reflecting current data on nursery workers.[5] This dysfunction was most prevalent in the lower back, neck, shoulders, and knees, which are common problem areas due to job-related tasks such as stooping, reaching, and constant walking.[6,8] These job tasks are performed more frequently in those who work more labor-intensive jobs at the nursery, which may explain why they were ~5 times more likely to experience neck dysfunction than those who worked less labor-intensive jobs such as sales and management. Furthermore, females were ~7 times more likely to experience low back, neck, shoulder, knee, and hip/thigh dysfunction than males, which may be attributed to 10 of the 15 females working more labor-intensive jobs. Despite the high prevalence of pain, qualitative analyses revealed reductions in pain following SSSH, a finding supported by Jakobsen et al.,[27] who quantitatively reported reductions in musculoskeletal dysfunction following onsite exercise in healthcare workers.

As injuries from falls are common in nursery workers, employees require strength, power, balance, and mobility to remain productive. SSSH participation improved dynamic postural change, lower and upper body strength, power, and flexibility. These gains corroborated qualitative findings which revealed that some participants perceived improvements in their job performance, for instance, one participant reported being able to carry a 20-pound bag of fertilizer more easily after the program. This finding is consistent with studies like those by Burton et al.[28] and Coulson & Field,[29] which demonstrated enhanced work output in individuals who participated in onsite exercise programs. Furthermore, the functional improvements support the qualitative reports of reduced perceived injury risk. For example, one participant noted SSSH improved his ability to bend down and pick up heavy objects, which also happened to abate his fear of injury. This reduction in fear may be linked to the strong correlations between poor functional health, musculoskeletal dysfunction, and falls. Additionally, Legge et al.[30] found that functional capacity was able to predict musculoskeletal-related injuries in mineworkers. As such, the Centers for Disease Control and Prevention have developed fall risk thresholds based on 30STS performance in older adults.[31] In the present study, three participants, two of whom were under 60 years old, were considered at high risk for falls based on 30STS scores. However, after onsite exercise, all of them had moved into a low-risk falls category. Exercise, performed onsite or offsite, is a potent stimulus for enhanced functional capacity; a finding consistently reported in the SSSH literature[13,14,18] and in studies involving onsite exercise.[9,32] These exercise-induced gains resulted in self-reported improvements in job performance and injury risk and may positively impact other job types in the agricultural industry; however, there is still a paucity of literature on these benefits in high-risk cohorts.

Aside from program benefits, the qualitative findings offer insight into the barriers to exercise, the motivational power of onsite exercise, and workforce-specific exercises to accommodate the range of employees' physical needs. First, the most commonly reported barrier to exercise was demanding job tasks. Numerous workers cited during interviews that the demands of their job prevent them from performing additional exercise outside of work, especially during the production season (later winter, spring, and summer). Although this is the first study to observe this barrier in nursery workers, it has been observed in other labor-intensive jobs.[33] Thus, the timing of program implementation, both time of day and season, is a critical factor to consider for future studies and agricultural entities offering workplace programming for their employees.

Second, the findings reflect the motivational power of SSSH to inspire participants to continue exercising outside of the program. Many participants felt encouraged to perform some exercises on their own after beginning SSSH. This finding is supported by Miller et al.,[18] who found that older adults increased their independent engagement in resistance and aerobic exercises, and maintained these positive habits for upwards of 1 year despite no in-person contact due to COVID-19. These programs can cultivate positive lifestyle behaviors and leave lasting impacts on participants. Therefore, future research should conduct long-term follow-ups, ideally utilizing in-depth quantitative assessments and qualitative interviews to gain a more comprehensive understanding of the impacts onsite exercise programming may have on agricultural workers' overall well-being and job performance.

Finally, four participants felt SSSH was not challenging enough given the demands of their job roles. These individuals either worked in the warehouse or on the production line, both of which involve a high degree of manual labor. Due to these physical demands, SSSH was perceived as too easy; thus, altering the program to sufficiently challenge these participants is paramount as they carry the highest risk of work-related musculoskeletal dysfunction. Crane et al.[34] discovered that personalized onsite interventions had the greatest effects on cardiometabolic health measures in labor-intensive workers. Participants involved in future offerings of onsite SSSH should be urged to use heavier weights and perform more advanced movements to ensure the program is equally challenging to all participants. SSSH levels II and III may be sufficient to adequately stimulate performance improvements in these individuals, but no data exists in a workplace setting.[35]

There are a few key limitations to consider for future research. The relatively small sample size and the fact that the controls increased their exercise engagement may have contributed to the lack of interactions in the functional capacity variables. Also, the analysis was conducted by the researchers rather than using qualitative analysis software. Furthermore, the sample lacked diversity as most of the participants in the present study were Caucasian (80%). Despite these limitations, our study serves as a proof of concept for the feasibility of onsite exercise in nursery settings. Future studies should build on these findings by expanding recruitment across multiple nurseries, and including a more representative sample of agricultural workers. In addition, future work should consider other variables, such as climate, work-related psychosocial aspects, and mental health. Finally, a more in-depth quantitative analysis of musculoskeletal dysfunction should be conducted at baseline, post-intervention, and after months of follow-up to better understand the acute and potential long-term impact of the current findings.

Conclusion

In conclusion, an onsite exercise program, which overcomes the inability of nursery workers to exercise offsite due to job demands and time constraints, was able to improve many areas of nursery workers' health. This included quantitatively assessed functional capacity and qualitatively assessed self-efficacy, interpersonal, and psychological aspects. Furthermore, many participants reported movement deficiencies at baseline that were improved following SSSH. These multi-dimensional benefits translated to improved job performance; therefore, onsite exercise programs may be valuable assets for the agriculture and nursery industry employees and employers. Given these promising outcomes, future program offerings for nursery employees should be scheduled in the fall and held on four separate days at varying times to encourage greater participation and company buy-in. Finally, programs should ensure the exercise intensity is sufficient to elicit meaningful improvements.

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Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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