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Outcomes of Participatory Ergonomics and Self-management in Commercial Clam Farmers with Chronic Low Back Pain: A Feasibility Study

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ABSTRACT

Purpose: Participatory ergonomics engages workers in the development of strategies to reduce workplace-related pain, offering a flexible and practical option to create individualized context-specific strategies. This paper describes the outcomes of a feasibility study using a participatory approach for self-management of low back pain in clam farmers. Methods: A within-subject time-control design with repeated baseline and post-intervention assessment was used. After refining individual and team-based strategies, stakeholder interviews, and rapid prototyping, workers selected three strategies to use for 8 weeks. Frequency and ease of use for strategies are described. Pre-post paired t-tests were used for analysis of pain-related disability, difficulty and pain with work tasks, pain-related fear, self-efficacy, and coping. Analysis of improvements exceeding published and individual variability was calculated. Results: Participants chose both team and individual strategies, most using strategies 5 days a week >50% of the time. Significant improvements in pain-related disability, pain during specific tasks, pain-related anxiety, and coping were seen after 8 weeks of implementing strategies. No changes in task difficulty, fear, self-efficacy and average resting pain were reported. Pain improvements > MDC_{95} were reported by 74% with 56–64% > personalized MDC_{95} for lifting tasks. Conclusions: Pain-related disability, work activity pain ratings and related pain anxiety and coping improved beyond individual variability in this feasibility study. Multiple strategies allowed workers to choose relevant self-management options. Introduction of work-related changes in the workplace, visual demonstration, review of team videos and reminders were helpful. Further studies of this approach are needed.

KEYWORDS
Low back pain; self-management; participatory ergonomics; clam farmers

Introduction

Chronic low back pain (LBP) has been widely studied in populations seeking medical care, with less focus on management in physically demanding occupations for individuals who are working despite pain.[1] Musculoskeletal disorders are especially problematic when lifting, pulling or pushing high loads or when repetitive movements are required.[1] There is a high prevalence of LBP in seafood workers who often face additional stressors of condensed and time-dependent production cycles, job uncertainty and limited medical care.[2–7] Commercial clam farmers in the Florida Gulf Coast area[8] have reported LBP as a major problem for quality of life and longevity in the industry. Pain is often considered "part of the job" and farmers often ignore pain, with potential for lower productivity and long-term disability. Developing targeted strategies for seafood workers in isolated areas therefore provides a unique challenge.

The multifactorial nature of LBP supports an individualized approach that builds capacity to manage pain while addressing factors that contribute to interference with work requirements. Participatory ergonomics involves workers in problem-solving to assist with identifying modifications of work processes and alternatives for reducing injury risk.[9] The justification for this approach is that workers are best equipped to identify alternative work solutions and involvement leads to more acceptable approaches than top-down initiatives. This approach has been used in rehabilitation,[10] injury prevention,[11–13] and ergonomic programs,[11,13–15] with reports of increased

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productivity[16] and improved health outcomes.[14,17] Targeted strategies using participatory methods are therefore worthy of further study in commercial clam farmers.

Self-management approaches have been advocated for patients with chronic LBP[18] with moderate quality evidence for effective reductions in pain intensity, and small to moderate effect on disability.[19] Self-management also improves self-efficacy, which in turn enhances adherence to long-term care plans in chronic diseases such as arthritis and pain.[20,21] High pain-related self-efficacy reduces the impact of pain-related negative cognitive and affective factors. In contrast, pain-related cognitive and affective factors such as limited coping,[22] fear avoidance,[23] and pain anxiety,[24] have all been found to negatively impact pain-related behaviors and lead to worse outcomes. Both positive and negative cognitive and affective factors are potentially different in workers in physically demanding occupations who continue to work despite pain, compared to individuals seeking medical management or disability. Participatory approaches may therefore be a useful method to introduce individualized selection of appropriate self-management strategies in subgroups.

The purpose of this pragmatic study was therefore to investigate the feasibility of self-management individual or team ergonomic and movement adjustment strategies. This paper presents the outcomes of the strategies identified using a participatory ergonomic approach in commercial clam farmers.

Methods

This pragmatic study used a within-subject time-control approach with analysis of individual improvements beyond minimum important difference. The project was approved by the Institutional Review Board and registered as a Clinical Trial NCT03524378.

Clam farmers were recruited through the Cedar Key Aquaculture Association in Cedar Key Florida. Participants who reported LBP > 3/10 for more than 3 months, no history of any surgery in the past 3 years and working full time in the clam aquaculture industry were included in the study. Participants were excluded if they did not meet the average pain criteria in the 4-week baseline timeframe, and if they discontinued working in the industry due to other medical or personal reasons. The within-subject time series involved three stages: 1) 4-week baseline, 2) 8-week intervention, and 3) 2-week post-intervention periods (Figure 1).

Outcome measures

Baseline measures (pre-intervention)

Oswestry Disability Index, difficulty with work tasks (Patient-Specific Functional Scale), pain with work tasks (Visual Analog Scale associated with each work task), and average of the average,

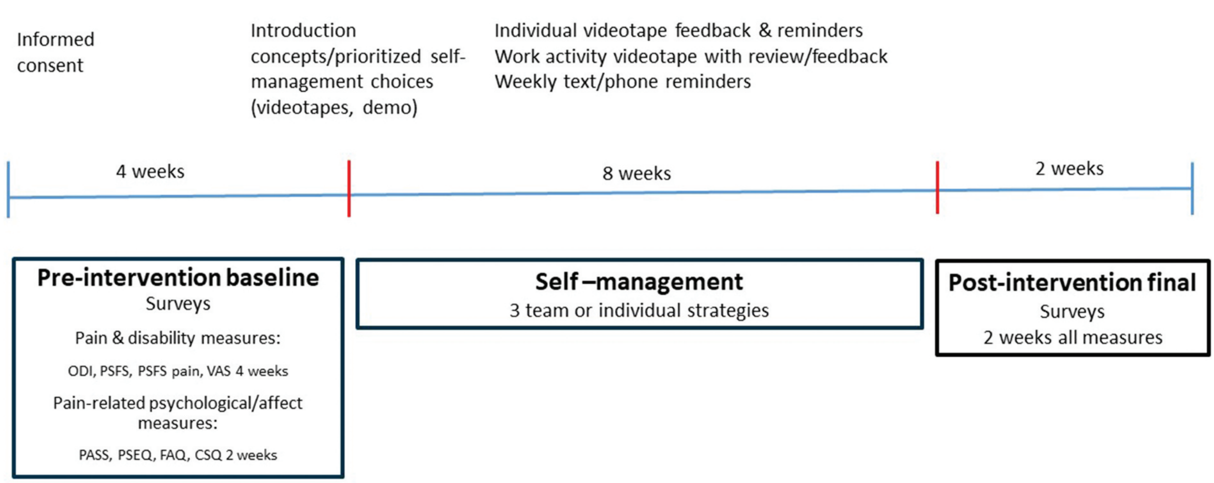

Figure 1. Within-subject time series research design, outcome measures and intervention timing.

least and most pain (VAS) were collected once a week for 4 weeks. Collecting baseline data for 4 weeks allowed calculation of individual variability expressed as a minimal detectable change score. We had no hypotheses regarding variability in pain-related affect; therefore, Pain Anxiety Symptom Scale, Pain Self-Efficacy Questionnaire (PSEQ), Fear Avoidance Questionnaire (FAQ), and Coping Strategies Questionnaire (CSQ) were collected during weeks 1 and 4 of this period.

Final measures (post-intervention)

Given that all measurements were collected at least twice in the pre-intervention period, all post-intervention measurements were collected weekly for 2 weeks. Surveys were completed in paper format or online through REDcap (v9.1.1, Vanderbilt University, TN).

Pain, function and disability measures

The Oswestry Disability Index (ODI) is recommended for measurement of LBP related functional ability with good reliability and small measurement error.[25] The ODI has 10 questions, is scored out of 50 points and expressed as a percentage. The minimum detectable change (MDC_{95}) ranges from 11% to 13%.[26,27]

The Patient Specific Functional Scale (PSFS) has excellent reliability and responsiveness for chronic and mechanical LBP and has been validated in patients claiming compensation.[28] Study participants rated three most problematic work tasks from a list of tasks derived from open-ended questions generated from earlier surveillance observations, interviews and observations. Participants reported 1) difficulty with work tasks, 0 = *cannot perform*, 100 = *no issues*, 2) pain level related to work tasks using a visual analog scale (PSFS pain), 0 = *no pain*, 100 = *most excruciating pain possible*, and 3) average, highest and lowest pain in the past week. MDC_{95} for the PSFS is 13 points and 15 points for pain VAS scales.[29]

Pain-related psychological factor measures

Pain-related psychological and affective factors were measured using the Pain Anxiety Symptom Scale (PASS),[24] short form Patient Self-efficacy Questionnaire (PSEQ-2),[30,31] a single item FAQ,[32] and the CSQ.[21,22] The PASS-20 consists of 20 statements reflecting four subscales (cognitive, escape/avoidance, fear, physiological anxiety items) for a total of 100 points.[24] The PSEQ-2 consists of two questions reflecting confidence in the individual's ability to work and live a normal lifestyle besides the pain.[30] The FAQ single item asks for agreement with: "I should not do physical activities that might make my pain worse".[32] The CSQ questions ask participants to rate how much control they have and how much they are able to decrease their pain: "Based on all the things you did to cope or deal with your pain during the last week".[21,22]

Strategy implementation and ease of use

In the final surveys, frequency of use of strategies was reported (number of days, percentage time 0, 25, 50, 75, 100% in the final 2 weeks, number of weeks >50% of work time), as well as a question on how easy or difficult it was to implement each strategy (0 = very easy, 100 = extremely difficult) and whether they would recommend the use of the strategy for others (yes, no, possibly).

Interventions

Development of list of self-management strategies

A list of preliminary strategies was developed by the investigators. The strategies were refined and prioritized using key stakeholder interviews (workers and supervisors), early observations by investigators, and review of videotapes of work tasks (in the water, on the boat, moving product on and off the boat, sorting, cleaning and packaging clams as well as operating equipment). A list of individual and team options was provided for participants to select three preferences for their work requirements and personal preferences were discussed, prioritized and refined after worker input and suggestions (Table 1).

Introduction of strategies

Team and individual movement and ergonomic concepts (adjustment of work process, equipment, lifting and pacing) were introduced at the team's processing location for members of the same team who agreed to participate in the study. Individual strategies included options to reduce or disperse

Table 1. Interventions (individual and team strategies).

Individual strategies		Examples
Breaking up repeated positions and activities	(1) Adjust body position when sitting or standing for long periods	Position reversals (eg if flexed returning to vertical or extension)
	(2) Small breaks or break up tasks	
Lifting	(1) Small breaks during lifting	
	(2) Avoiding flexion/ rotation during lifting	
	(3) Movement techniques for lifting	Using body and legs for lifting rather than only arms Progressive steps Timing for lift power Setting core/trunk muscles prior to lift, with neutral spine position Establishing grasp and upper body connection prior to lifting
	(4) Positioning for lifting	Distance to load, wide base of support, avoiding positions requiring twisting
Team strategies (work-related adjustments impacting team)		
Equipment	(1) Using mechanical equipment as much as possible/feasible	Use of forklifts, hoists, pulleys to move bags on the boat or from the boat to the tumbler, mobile platforms.
	(2) Adjust or organize equipment to decrease physical stress for workers	Adjusting the height of tumbler or sorter, decreasing distance for transportation of loads, using additional platforms to decrease vertical height, positioning of equipment for biomechanical advantage
Team lifting	(1) More than one person lifting boxes, bags, baskets	
Work flow/ process adjustment	(1) Rotate work tasks to break up repetitive stress	
	(2) Match tasks to worker height or strength	
	(3) Organize work flow/ space to limit distances loads are moved	

accumulation of stress through breaking up repeated positions or activities and lifting techniques. Team strategies involved using or adjusting mechanical equipment, team lifting or workflow/ process adjustment (see Table 1 for options and examples). The first author, a Physical Therapist Certified Orthopedic Specialist, explained the goals of minimizing and distributing stress from lifting and repetitive work rather than achieving complete pain resolution, and led discussions using photographs and short videos of the clam farming process collected from previous teams in the preparatory phase. Lifting techniques, movement modification and positioning were demonstrated by a research assistant with previous experience working in the industry. Participants reviewed, discussed, and commented on the feasibility of strategies for their team.

Selection of strategies, video feedback and reminders

Participants were then asked to select three strategies to use in their work activities for 8 weeks. On a different occasion, each group was video recorded performing work tasks. Participants received individual feedback with options to improve efficiency of movement and positioning as appropriate. They also received weekly text or phone reminders from the research team.

Analysis

Repeated baseline and post-intervention measures were averaged to create single measures that were compared using t-tests. For function (ODI, PSFS difficulty), and pain (PSFS pain, average pain), the baseline (4-weeks) and post-intervention averages (2-weeks) were used. The changes in average final measures (final 2 weeks) and baseline measures (week 1, week 4) were also compared for pain-related affective measures (PASS, PSEQ2, FAQ, CSQ). The frequency of individuals who reported average improvements greater than published MDC_{95} values for ODI, PSFS difficulty (>13), PSFS pain (>15), and average pain (>15) was reported for both individual measures and for average PSFS and PSFS pain.

After large variability in pain reports was observed, a post-hoc decision was made to compare variability during baseline and final assessment periods using the individual co-efficient of variation for Wilcoxon signed ranks test. In addition, we calculated individual variability for each participant during the repeated baseline period for pain during the tasks determined to be most problematic by the worker. These measures of variability were used to create personalized within-person minimum detectable change metrics for current pain during a specific activity with a 95% confidence interval (MDC_{95}). The difference in average pain from baseline to the final assessment period was compared to the MDC_{95} to calculate the proportion of workers who exceeded this individual threshold for changes in pain. Analyses were performed using IBM Statistics (v25). The threshold for type 1 error was set at 5%.

Results

There were 28 participants from 8 teams (ranging from 2 to 6 workers per team) recruited, with 19 completing the study. There were teams where some clam farmers elected not to participate or did not meet eligibility criteria. Participants were excluded if they reported insufficient pain during baseline (n = 3), were no longer working fulltime in the clam industry (n = 3) or developed other unrelated medical conditions (n = 3). Demographics are reported in Table 2. Participants reported mild disability (ODI 16.8%), mild to moderate difficulty with the most difficult work activities (PSFS 65.1/100) and moderate pain levels (PSFS pain 44.2/100, average/least/most VAS 42.2/100) (Table 3). Overall, this group of active workers reported high self-efficacy (8.6/10) and low fear avoidance (1.8/4), mild to moderate anxiety (21.1/50) and low to moderate coping strategies (6.5/12) (Table 3). Participants chose both team and individual strategies (Table 1), with most strategies used for >75% of the time in the final 2 weeks (Figure 2). On average, most used strategies for >50% of the time possible in 6 of the 8 weeks (range 4 to 8) and between 3.4 and 6.7 days in the past week (Figure 3). The most common team selections were team lifting (n = 11), rotating tasks (n = 9), use of mechanical equipment (n = 8) and for individual strategies, breaking up repeated tasks (n = 8) and positioning for lifting (n = 6). While team strategies were chosen more often, individual strategies were typically used slightly more than team strategies (Figures 2, 3).

Participants rated strategies as relatively easy to use ranging from very easy (5/100 for adjusting equipment) to moderate difficulty for breaking up repeated activities (42/100), rotating tasks (43/100) and changing workflow (45/100) (Figure 4). Participants were also asked if they would recommend the strategies for others, not recommend or possibly recommend with specific circumstances. There was strong support for the use of strategies; 74% were recommended and 19% recommended with specific circumstances.

Table 2. Demographics.

	Mean (SD/%)	Range
Demographics		
Age (years)	33.7 (SD 11.6)	18–52
BMI	26.6 (SD 5.5)	19.7–39.1
Race		
Caucasian	28 (94.7%)	
More than one	1 (5.3%)	
Education		
10th grade	3 (15.8%)	
High school graduate	9 (47.4%)	
Beyond high school	7 (36.8%)	
Work History		
Time in seafood industry (years)	10.4 (SD 8.1)	0.3–28
Time working in heavy lifting jobs (years)	13.4 (SD 8.9)	1–30
Average work hours (per week)	40.7 (SD 16.9)	20–80
Health History & Habits		
Age of low back pain onset	24.1 (SD 7.5)	16–40
Length of time back pain (months)	50.7 (SD 48)	3–132
Medical insurance	9 (56.3%)	
History of major injury	11 (61.1%)	
Major health conditions	5 (27%)	
Pain in other areas	13 (72.2%)	
Alcohol use	13 (68.4%)	
Tobacco use	8 (42.1%)	

Within-subject group differences *(Table 3)*

Paired *t*-tests showed small but statistically significant improvements in disability (mean ODI difference 4.96%, Standard Deviation (SD) 7.0 $p < 0.01$). A significant difference was also present for PSFS pain (mean difference 16.1/100, SD 18.8; $p < 0.01$) with mean change >MDC_{95} of 13. No significant changes in PSFS difficulty or average pain were noted. There were significant improvements in pain anxiety (PASS mean difference 8.9/50, SD 12.9, $p < 0.01$) and total coping (−1.9, SD 2, $p < 0.01$), but no significant changes in fear avoidance and self-efficacy.

Individual improvements using published MDC_{95} for participants with LBP

As only four participants had average ODI exceeding MDC_{95} at baseline, individual improvements in ODI were not possible to evaluate but

Table 3. Baseline and final disability, pain and pain-related affective factors (n = 19).

Measure (Total)	Baseline mean (SD)	Final mean (SD)	Mean difference (SD)	95% CI difference Lower	95% CI difference Upper	t (df = 18)	p
Disability (ODI/50)[1]	16.8 (9.1)	11.8 (9.7)	4.96 (7.0)	1.6	8.3	3.10	0.01*
Functional difficulty (PSFS/100)[2]	65.1 (20.2)	72.6 (19.3)	7.5 (28.2)	−21.1	6.1	−1.16	0.26
Work task pain (PSFS pain/100)[3]	44.2 (19.5)	28.1 (18.0)	16.1 (18.8)	7.0	25.2	3.72	0.00*
Mean pain (VAS/100)[4]	42.2 (15.1)	37.1 (17.4)	5.2 (17.3)	−3.2	13.6	1.31	0.21
Average pain	44.7 (15.6)	39.6 (20.0)	−5.1 (20.7)	−4.9	15.1	1.07	0.3
Most pain	54.6 (17.7)	48.1 (20.5)	−6.5 (20.9)	−3.6	16.6	1.35	0.19
Least pain	26.7 (17.7)	23.3 (18.4)	−3.4 (17.4)	−5.0	11.8	0.85	0.41
Days experiencing pain (/7)	3.9 (1.9)	3.4 (2.0)	−0.5 (2)	−4.8	1.5	1.07	0.35
Pain anxiety (PASS-20/100)[5]	21.1 (13.4)	12.2 (10.5)	−8.9 (12.9)	2.7	15.1	3.0	0.01*
Cognitive (/25)	8.4 (5.5)	4.8 (4.5)	−3.7 (5.6)	0.9	6.4	2.8	0.01*
Avoidance (/25)	5.2 (4.0)	3.5 (3)	−1.7 (3.2)	0.17	3.3	2.3	0.03*
Physiological anxiety (/25)	2.7 (2.4)	1.9 (2.4)	−0.8 (2.3)	−0.3	1.9	1.5	0.14
Fear (/25)	4.8 (4.8)	2.1 (2.2)	−2.7 (4.6)	0.5	4.9	2.6	0.02*
Fear avoidance (FAQ/4)[6]	1.8 (1.2)	1.8 (1.2)	0 (1.5)	−0.7	0.8	0.76	0.94
Self-efficacy (PSEQ/10)[7]	8.6 (1.0)	8.9 (1.5)	0.3 (1.2)	−0.9	0.3	−1.1	0.28
Coping (CSQ/12)[8]	6.5 (2.6)	8.3 (2.4)	−1.9 (2.0)	−2.9	0.9	−4.2	0.00*
Coping control (CC/6)	3.8 (1.3)	4.5 (1.3)	0.7 (1.3)	−1.3	0.0	−2.1	0.047*
Coping ability (CA/6)	2.6 (1.5)	3.8 (1.3)	1.2 (1.4)	−1.9	0.5	−3.8	0.00*

*Comparisons using paired t-tests ($p < 0.05$).
1. ODI – Oswestry Disability Index.
2. PSFS – Patient Specific Functional Scale average difficulty of 3 work tasks (0 = cannot perform, 100 = no issues).
3. PSFS pain – Visual Analogue Scale for each of the most difficult work tasks identified in the PSFS (0 = no pain, 100 = most excruciating pain possible).
4. VAS – Visual Analogue Scale (0 = no pain, 100 = most excruciating pain possible).
5. PASS-20 – Short form Pain Anxiety Symptom Scale, subscales for cognitive, avoidance, physiological anxiety, fear.
6. FAQ – Short-form Fear Avoidance Scale.
7. PSEQ – Patient Self-efficacy Questionnaire.
8. CSQ – Coping strategies Questionnaire, subscales coping control, coping ability.

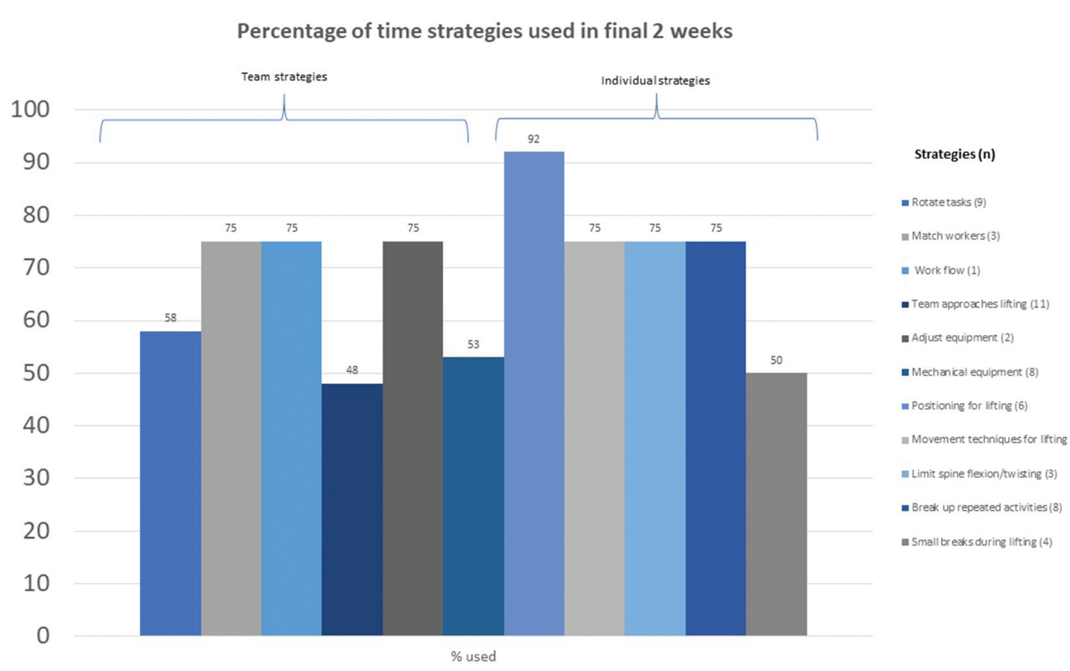

Figure 2. Percentage time strategies used post intervention.

we were able to compare changes in PSFS difficulty and PSFS pain for individual tasks to published MDC_{95} (Table 4). Of the 57 tasks, improvements in function > MDC_{95} of 13 points were noted for 22 (39%) and decreased pain with tasks > MDC_{95} of 15 points for 29 (51%).

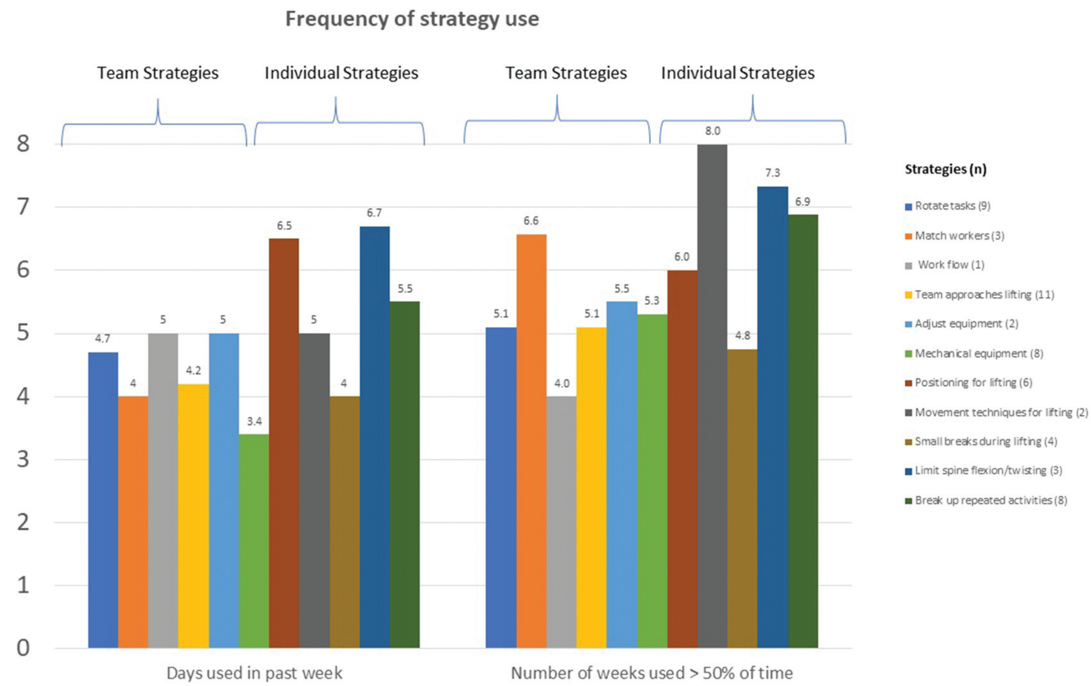

Figure 3. Frequency of strategy use.

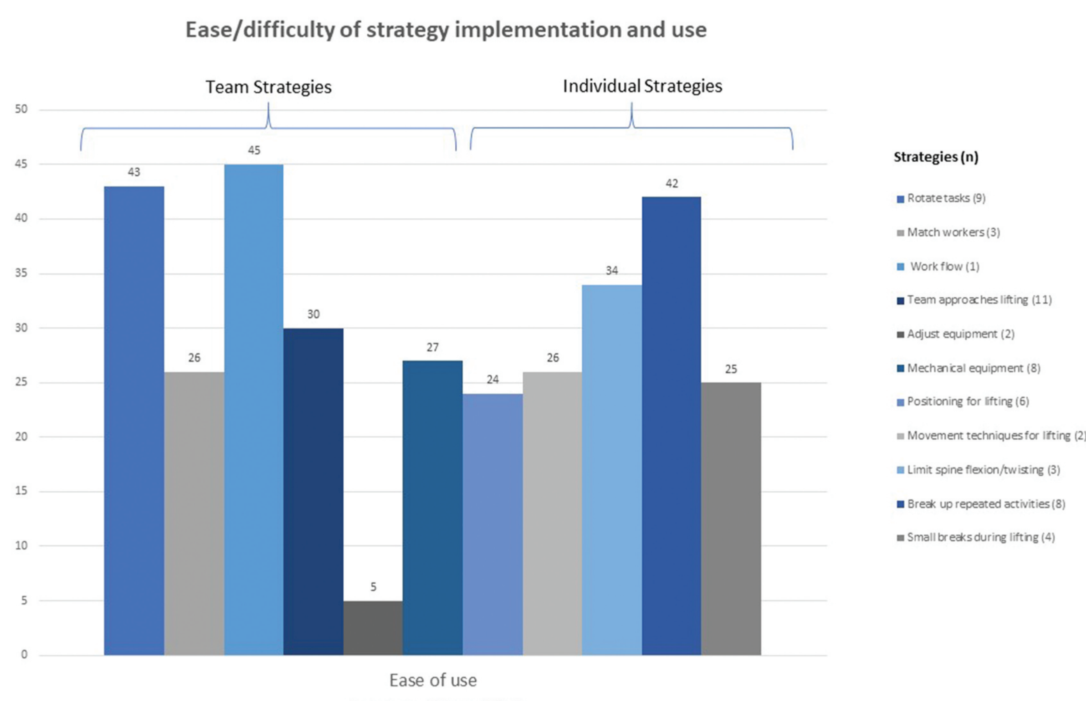

Figure 4. Ease/difficulty of strategy implementation and use.

Consistent with the variability in pain, 14 (25%) of the tasks were reported as being more difficult (PSFS > MDC_{95} of 13 points), but with only 7 (12%) tasks were more painful (PSFS pain >MDC_{95} of 15 points) (Table 4).

When average values for the three tasks were examined for each participant compared to the published MDC values, 14 (74%) reported less difficulty or related pain improvements, 7 (37%) reported both less difficulty and pain, and 7 (37%)

Table 4. Change in difficulty (PSFS) and pain (PSFS pain) with individual work activities > MDC_{95}.

Most difficult tasks	n (%)	PSFS Level of difficulty[a]					PSFS Pain with activity[b]				
Total 57 tasks		Baseline mean	Final mean	Mean Difference	Improved > MDC 13 (% for task)	Declined > MDC 13 (% for task)	Baseline mean	Final mean	Mean Difference	Improved > MDC 15 (% for task)	Tasks Declined > MDC 15 (% for task)
Moving baskets or boxes	16 (28%)	60.6	68.9	8.3	6 (38%)	4 (25%)	47.0	30.4	16.7	12 (75%)	2 (13%)
Lifting nets on & off boat [c]	13 (22.8%)	68.4	78.5	10.1	5 (38%)	3 (23%)	49.7	24	25.7	5 (38%)	2 (15%)
Lifting nets in the water/ Planting clams[c]	9 (15.8%)	70.4	74.4	4.0	5 (56%)	3 (33%)	35.6	22.1	13.5	5 (83%)	2 (22%)
Standing while working	10 (17.5%)	60.1	74.3	14.2	3 (30%)	2 (20%)	32.3	23.9	8.3	3 (30%)	0 (0%)
Sitting while working	6 (10.5%)	70.2	74.3	4.1	3 (50%)	2 (33%)	55.7	37	18.7	3 (50%)	1 (17%)
Lifting small bags & operating equipment	3 (5%)	69.2	70.3	1.1	0 (0%)	0 (0%)	39.3	23	16.3	1 (33%)	0 (0%)
Number exceeding MDC_{95}					22 (39%)	14 (25%)				29 (51%)	7 (12%)

a. Participants were asked to rate the 3 most difficult work activities using the PSFS scale with 0 = cannot perform, 100 = no issues.
b. Pain with most difficult tasks 0 = no pain, 100 = excruciating pain (Visual Analogue scale).
c. Options collapsed in category.

reported either decreased difficulty or pain with one or more tasks. There were 2 (11%) individuals who reported reductions in pain but increased difficulty, and 3 (16%) reported increased difficulty and increased pain with one or more tasks. Of the five individuals reporting higher difficulty or pain with one or more tasks, two had lower disability at baseline. There were 9 (47%) individuals reporting improvements in overall average/least/most pain, with 2 (11%) reporting increased pain exceeding MDC_{95}.

Variability in pain reported during the most problematic activity

The two most difficult tasks identified by most participants were "moving baskets or boxes" and "moving bags". Co-efficient of variation in pain for moving baskets ranged from 0.07 to 1.53 (median 0.48) at baseline, and 0 to 1.04 (median 0.32) during the final assessment period (p = 0.35). For moving bags, the difference in coefficients ranged from 0 to 1.45 (median 0.36) at baseline and 0.05 to 1.43 (median 0.20) during the final assessment (p = 0.51). As might be expected, personalized MDC_{95} values showed similarly broad ranges for both activities. The proportion of people exceeding their personalized MDC_{95} after 8-weeks of participation was 56% for "moving baskets or boxes" and 64% for "moving bags."

Discussion

Results from this pragmatic study provide insight into feasibility of participant selected self-management work strategies in commercial clam farmers. Importantly, these methods resulted in statistically significant improvements in disability and pain with work tasks, pain anxiety and pain coping and 74% of participants reported improvements in pain exceeding the published MDC_{95} for at least one task with 56–64% exceeding their personalized MDC_{95} for lifting tasks. There was relatively high self-reported frequency of use.

The research of musculoskeletal disorders in shellfish workers has focused on prevalence and impact of disability[2–6] with only one intervention study found.[33] In contrast to studies of artisanal shellfish workers who use manual techniques,[2–6] this cohort of commercial clam farmers was mostly male and the Florida clam industry involves planting and harvesting clams farmed in ocean leases.[8] The preliminary findings from this study contribute to early support for a practical option to address LBP in this group of workers and may inform future study of methods accounting for personal preferences and individual choices. As this was a feasibility study, further investigation of participatory workplace self-management strategies in larger cohorts in agricultural or seafood industries will be important.

Participatory ergonomic strategies can be aimed at macro-level organizational and systems or micro-level individual strategies.[13] Our study offered options for micro-level team strategies including use of available equipment, modification of equipment and work processes or flow and team lifting, as well as individual strategies such as breaking up sustained positions and activities and adjusting lifting mechanics. Participants were able to choose multiple strategies they preferred and felt were feasible, with the goal of facilitating motivation and relevance. Of interest, participants chose more team than individual strategies, but individual strategies were used more consistently. Strategies that relied on others such as rotating tasks and changing workflow were considered slightly more difficult to implement. The cleaning, sorting and packaging process is extremely repetitive and of the individual strategies, breaking up repetitive activities was also more challenging.

While the National Institute of Occupational Health and Safety (NIOSH)[34] recommends workplace redesign above education or personal behavior modification, equipment and space adjustment as well as reengineering are often constrained by budget in the clam aquaculture industry in Cedar Key. It was therefore not surprising that few participants selected options to adjust equipment. Teams also reported having tried different options for equipment adjustments prior to the study. There was minimal interest in changing workflow extensively, attributed to productivity requirements and habit. This is important when comparing to other studies where workers contribute to ideas for development and implementation of equipment, processes or technology with financial and organizational support from employers, but did not necessarily make individual changes themselves.[13] Rivilis et al.[35] found 12 articles supporting participatory ergonomic strategies for improvements in musculoskeletal pain, reduction in injuries and workmen's compensation claims, and time off work while others have reported limited support for macro-level participatory programs.[36] The wide variety of participatory studies in different industries reported in the literature make definitive comparisons to results from this study very difficult.

Some of the strengths of this study were: 1) narrowing down the workplace strategies through early rapid prototyping with participatory involvement, 2) asking participants to choose multiple individual self-management strategies they felt would be useful; 3) introducing strategies and data collection in the workplace, 4) using video review, and 5) providing text and phone reminders. These components were intended to support buy-in and facilitate self-management while providing context-specific strategies. Several consensus studies have recommended that pain management be tailored to each person's experience by enabling self-management of pain[37,38] and addressing modifiable risk factors for LBP in the workplace.[39] Participants chose strategies that they felt would impact their specific needs without any researcher driven recommendations. This was a critical component of the intervention; participants were able to choose relevant individualized strategies that they perceived would address their unique needs and were able to implement immediately in the workplace. Significant improvements in pain anxiety and coping, along with the recommendations for others in the future, provide early support for further investigation of context-specific individual approaches.

Videos offered teams and individuals opportunities for self-analysis and awareness and were regarded as being especially useful by participants. There was a strong desire to improve their work capacity and high self-efficacy. This observation is supported by observations reported in international seafood safety conference of a noted desire for safety and willingness to adopt practical and relevant solutions.[40] The visual introduction of the strategies with the teams was optimal for movement-related strategies and created opportunities for developing team support and buy-in. The targeted reminders were as important with participants reporting barriers as "just needing to remember to use the options." Text reminders require minimal time, are relatively low cost and are feasible in areas with sporadic internet connectivity and availability.

The support and involvement of the supervisors was a major facilitator for both the involvement in the study and team strategy implementation. While not explicitly targeted, supervisors or owners of the businesses agreed to allow workers to participate, and in all but one team, the supervisors were involved either as participants or attended the discussion and introduction of the strategies in the workplace. The importance of supervisor involvement has been emphasized by others. Linton et al.[41] conducted a workplace intervention led by psychologists using similar concepts. Workers were encouraged to manage work factors, while the supervisors were trained to minimize psychosocial factors for chronic LBP and support workers. The intervention decreased work absence and health-care utilization compared to normal care, but no pain improvements were reported.[41] Supervisor involvement has also been recommended for other participatory ergonomic approaches[17] and to support seafood worker safety and health initiatives.[42]

Although recent LBP prevention and treatment guidelines include strong recommendations for exercise, staying active and early return to work,[38] commercial clam farmers are extremely active, frequently push beyond their limits and seldom regard pain as a reason not to work. Strategies were therefore geared toward modification of load, frequency and distribution of forces. Beliefs, cognition, attitudes and behaviors have been associated with outcomes for pain management and success of participatory approaches,[17] and we therefore included measures to reflect these constructs. In contrast to individuals with chronic pain seeking medical care, participants had low baseline fear avoidance and high self-efficacy. The culture of working "despite the pain" was consistent with high self-efficacy; however, workers reported mild to moderate pain anxiety and low to moderate pain coping or ability to control pain. While self-efficacy did not change, possibly related to the high baseline levels, there were improvements in coping and pain anxiety. Of interest, pain with work tasks and pain anxiety decreased while pain coping improved reflecting improvements in attitudes toward control over pain. For workers who consider pain as inevitable and part of the job, these constructs may therefore be important to study in similar populations.

Pain-related disability was relatively low in this group of workers, despite moderate levels of reported pain and pain with activity. This finding also matched low to moderate levels of baseline negative affect but contrasts high pain levels accompanied by negative affect in individuals with chronic LBP.[23,32,43] Nevertheless, workers showed improvements in both disability measures and reported pain with specific work tasks with 70% of participants reporting improvements in abilities to perform difficult work tasks or pain perceptions with specific tasks. We were unable to examine relationships between the affective factors or causality due to the sample size, but even small changes in pain anxiety and improvements in coping may be important positive changes related to participatory self-management strategies.

Pain beliefs and constructs in individuals continuing to work in highly physical jobs may require different outcome measures compared to those seeking medical management for LBP. The participants reported moderate pain, but average disability was low with overall low fear avoidance, high self-efficacy. The improvements in pain experienced with specific work tasks, coping and PASS in this group suggest that these constructs and outcome measures might be useful in high functioning workers with LBP. The ability to adapt and self-manage work-related factors from team and individual perspectives and impact on coping, disability and pain perceptions are important future research directions.

Work disability prevention studies often use outcome measures such as time off work, productivity, and work-related limitations.[44] There were only a few participants in our study who experienced symptoms interfering with their work that would be classified in the lowest level Type 1 disability described by Young et al.[44] The majority reported pain but minimal difficulty with specific tasks while carrying a full workload and likely would be classified as no disability in the classification scheme. Despite three workers reporting previous spinal surgery, only two different individuals limited their tasks to cleaning and sorting tasks rather than lifting on the boat due to LBP, and no participants reported missing work due to LBP, limiting the use of restricted duties, time lost or other work limitations as an outcome measure.

Limitations

As with all pragmatic studies, the complexity of human and environmental factors requires larger sample sizes for more robust multifactorial statistical analysis. A randomized control comparison was not possible due to availability of participants in the area and difficulty blinding participants in the same workspace, teams or even in the surrounding areas.

There was considerable variability in productivity deadlines along with frequent job changes in the industry, factors that make larger scalability and recruitment complicated. The initial intent for collecting baseline data for 4 weeks was to calculate individual MDC, but ideally the final data collection should have been collected for the same timeframe for pre-post comparisons. Longer term studies are costly, and retention is an issue. Future studies may therefore need to consider similar within-subject designs but with more intensive and frequent data collection periods. There was also no long-term follow-up, but frequent job changes in the industry are another limiting factor for the ideal research design.

The study was underpowered to address relationships between changes in disability, pain and affective measures or moderation of multiple variables. Subsequent work should be powered to examine the extent to which pain-related anxiety and coping are treatment effect modifiers or prognostic factors, as well as how these affective factors can be most effectively addressed.

Future directions

The results from this small feasibility study can inform future research approaches and designs for limiting LBP and other MSDs in aquaculture farmers and could also be considered for groups with similar physically demanding manual farming. Future research of self-selected team and individual strategies on work capacity (hours), perceived load, health burden and subsequent productivity of workers would be useful. While participants were encouraged to match their selections to the most appropriate strategies for the most difficult work activities, specific guidance on which strategies were most suitable for different tasks or participants pain characteristics may have been helpful. Although the strategies included options for adjustment of equipment and work processes, these were limited based on availability of funds and expertise for engineering modifications. Options for more sophisticated but affordable engineering designs to decrease repetitive lifting or for adjustments tailored to individual worker anthropometrics would be ideal, although costs may not be practical for small teams often funded by single owners.

More sophisticated monitoring or objective observation methods to monitor use of strategies might also be useful in future studies. Although there were positive changes in ODI, PSFS and pain with work tasks, pain reports were impacted by work variability. The wide variation in workload and the potential for pain fluctuations is problematic. Other instruments are needed for studies of similar populations with low disability levels but high pain for individuals working in physically demanding jobs with productivity variability. The ODI is the most commonly used instrument in occupational health settings with strong psychometric properties,[25] but other investigators have noted similarly low scores in active working individuals.[45] Low disability scores were also found using the Roland Morris Disability Questionnaire (RMDQ) despite high pain severity reports in a study of artisanal clam gatherers.[3] This study used the physical component of the SF 36 which may be a useful addition for future studies.[3] The PSFS used in our study provided an individualized work-related outcome measure and has been found to be more responsive than the RMDQ for groups where activity limitation is low.[46] Pain scales attached to specific work activities also added useful specificity and linkage to the most difficult work tasks. Both the PSFS for specific work activities and related pain VAS measures are recommended for future studies. Similarly, given the high self-efficacy in this group alternative measures may provide stronger insight into the inter-relationship between self-management and self-efficacy. One of the strengths of this study was the comparison of change to published MDC values as well as comparison of individual variability to baseline and this approach is recommended for within-subject time series. Both decreased frequency of pain "spikes" or modulation toward a lower level of pain are positive outcomes and reporting pain variability or extent of individual change provide important measurements of impact.

Another area for consideration in future studies is determining best methods for ecological monitoring of strategy use. The estimates of strategy use frequency could have resulted in recall bias with high weighting of recently used strategies. Additionally, some of the strategies were dependent on team dynamics for successful implementation, and we were not able to compare the team unit impact on change. Team support, leadership and composition would be a consideration for further investigation.

Conclusions

This feasibility study provides preliminary information for future research investigating the impact of participatory self-management strategies for LBP in commercial clam farmers and similar groups with high physical demands. The participatory methods using onsite delivery of occupation-specific videos and video taping of participants provided opportunities to introduce, support and build worker and team buy-in, as well as increase the relevance of strategies. Individual choices of team and individual strategies improved LBP-related disability and pain with work tasks, but no change was reported in the difficulty of specific work tasks, or average pain intensity. Decreased pain anxiety and improvements in pain coping were also noted after 8 weeks of self-management implementation. However, definitive conclusions of effectiveness cannot be generalized to other groups due to sample size and lack of a control group.

Future studies should consider the natural variability in workload for groups with similar physical work and productivity demands. Similar within-subject designs are recommended but with more intensive and frequent data collection periods. Both the PSFS for specific work activities and related pain with work tasks measures are recommended for future studies as well as further investigation of pain anxiety and pain coping. Additional disability and work-related outcome measures are needed for participants who have such high physical demands. Use of MDC and comparison of individual variability in pain is recommended for similar groups. This study demonstrates the feasibility of participatory ergonomics for self-management in commercial clam farmers with chronic LBP. Further investigation of self-management options to adjust work-related activities and movement is recommended for seafood and agricultural groups with high manual physical demands and significant prevalence of chronic LBP.

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No potential conflict of interest was reported by the authors.

Ethics approval and Trial registration

Study was approved by the University of Florida IRB201702245 and registered as a Clinical Trial NCT03524378

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