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Rest break interventions in stoop labor tasks

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Abstract

Hand cultivation and harvest of agricultural products constitute strenuous physical tasks. Working with labor–management ergonomics committees in agricultural settings, the UC Agricultural Ergonomics Research Center (AERC) tested an experimental rest and recovery protocol for its impact on symptoms and productivity during two types of work tasks. The experimental condition consisted of adding a 5 min rest break to every working hour in which there was no other scheduled break (e.g., lunchtime). This resulted in an additional 20 min of rest per workday. We tested the intervention in two trials: Trial one compared workers ($n = 66$) randomly assigned to an experimental or a control group during the harvest of commercial strawberries. Trial two utilized a cross-over design ($n = 16$ pairs of workers) to compare experimental and control conditions while workers inserted bud grafts into young 18″ high citrus trees. For both trials, workers under the experimental condition reported significantly less severe symptoms than workers under control conditions. The order in which the intervention was given, however, appeared to result in variations in productivity. We conclude that the introduction of frequent, brief rest breaks may improve symptoms for workers engaged in strenuous work tasks.

Keywords: Rest breaks; Stooped labor; Agriculture

1. Introduction

Hand cultivation and harvest of fruit, vegetable, and horticultural (FVH) products have long been recognized in agriculture as strenuous manual material handling (MMH) tasks. Despite this, few improvements have occurred to the tools, implements, or work practices used in FVH agriculture. Although engineering controls are the most desirable ergonomics solution for MMH hazards, "off-the shelf" products or innovative engineering controls are not always available, or may not be feasible or cost effective. In many cases in the agricultural setting, challenges to engineering redesign have been difficult to overcome. In other cases, however, sociocultural aspects of agriculture have slowed the pace of change. MMH jobs in agriculture, as in many industries, are often characterized not only by high physical job demands, but also by a low wage, non-English speaking, immigrant workforce and work traditions that affect job control and the pace of work—organizational and psychosocial factors known to influence musculoskeletal (MS) disorders (National Research Council and Institute of Medicine, 2001). Thus, intervention to reduce occupational MS disorders in the agricultural work environment poses multiple challenges for investigators.

Documented ergonomics risks in fruit and vegetable cultivation and harvest include (1) heavy lifting (e.g. bins of harvested grapes typically weigh over 50 pounds), (2) awkward sustained postures (e.g. stooped labor for long periods during strawberry harvest), (3) highly repetitive tasks (e.g. a worker grafting citrus trees averages 1600 cuts/shift), and (4) the frequent use of force (e.g. hand-held shears are used to prune vines and trees) (Janowitz et al., 2000). Occupational health researchers have reported that similar heavy physical tasks with repeated forward and lateral bending and twisting, and especially the velocity of those movements, are associated with high risk for back disorders (Ayoub and Mital, 1989; Fathallah et al., 1995;

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Norman et al., 1998; Punnett et al., 1991). In studies of workers performing manual lifting tasks while wearing a spinal electrogoniometer (the Lumbar Motion Monitor™), for example, Marras and colleagues identified five risk factors that predicted increased risk of injury in both medium and high risk jobs: lifting frequency, load moment, trunk lateral velocity, trunk twisting velocity, and sagittal angle (Marras et al., 1992, 1995). In addition to these measurable ergonomics risks, FVH work is also characterized by a demanding and fast work pace—because of the need to preserve fragile commodities—which is often stimulated by an incentive piece rate pay system. Furthermore, during harvest season, rest periods and usual days off are often ignored. Along with exacerbating the physical risks of jobs, the demanding pace of hand cultivation and harvest is likely to increase requirements for vigilance, rapid decision making, and precision.

The combination of psychological and physical stressors, together with the potential of inadequate time for recovery, places farm workers at considerable risk for MS disorders. The National Research Council and the Institute of Medicine, for example, have documented a "clear relationship between back disorders and physical load, that is material manual handling, load moment, frequent bending and twisting, heavy physical work, and whole body vibration." They have also noted that low back disorders are associated with work organizational or psychosocial factors related to "rapid work pace, monotonous work, low job satisfaction, low decision latitude, and job stress"(p. 9) (National Research Council and Institute of Medicine, 2001).

MS disorders are the most common of all occupational injuries for farm workers (Villarejo, 1999). In fact, production agriculture ranks among the top 10 of industry subsectors for back pain (Clemmer et al., 1991; Guo et al., 1999). Strain-and-sprain is the most common disabling injury in California agriculture, accounting for 43% of all agricultural injury (AgSafe, 1992), and is the leading injury nationally in the production of fruits and vegetables (33%) (NIOSH, 2001). Workers in the nursery and wine grape industries, for example, have a high risk for back strain and other MS problems (Janowitz et al., 1998, 2000; Meyers et al., 1995, 1997, 1998, 1999). Overall, fruit and vegetable work accounts for more lost time injuries among hired workers than any other agricultural commodity. The majority (67%) of those injuries occur to Hispanic workers, a NIOSH "Special Population"(NIOSH, 2001).

Previous studies of the characteristics of work organization have found that limited rest break opportunities are significantly related to MS symptoms. Bergqvist et al. (1995), for example, found that limited breaks increased symptoms by 2–3 fold. Similarly, Skov et al. (1996) found an increased risk related to lack of control over time. Shortcomings in work-rest schedules have been found to aggravate the effect of job demands among excavation workers (Van der Grinten and Houptman, 2000) and increase the likelihood of near miss and injury events among forestry workers (Lilley et al., 2002). Nonetheless, when workers are given voluntary control over rest breaks, they tend to return to work before full physiological recovery (Henning et al., 1989). Trials of modified rest break schedules have resulted in significant reductions of symptoms among office workers (Galinsky et al., 2000; Sauter et al., 1997; Swanson et al., 1989) and also in food processing (Dababneh et al., 2001), with modest or no impacts on productivity. In NIOSH studies of office settings, workers were provided with five 5-min breaks in addition to the regularly scheduled breaks–one break added to each hour in which a break was not already scheduled (Galinsky et al., 2000; Sauter et al., 1997; Swanson et al., 1989).

The Agricultural Ergonomics Research Center (AERC) of the University of California brings together a multidisciplinary research team to develop and test engineering, administrative, and training interventions to reduce the incidence of MS disorders and the severity of related symptoms among the farm workforce. In the study reported here, AERC addressed multiple aspects of the agricultural work environment to reduce high rates of MS symptoms associated with prolonged stoop or squat labor in two FVH job tasks. As part of a larger study of several cooperating work settings, research team members engaged with farm workers and growers or managers in a participative research process to address the incidence of MS disorders. The resulting joint labor–management ergonomics teams investigated ergonomics hazards and injury records, identified potential solutions, and facilitated the implementation of intervention trials. Ergonomics teams in two of these work settings could not identify effective engineering solutions to address the ergonomic risks of prolonged stooped or squat labor, and selected an alternative rest break pattern as a feasible work organization intervention to test. Two trials testing the impact of the alternative rest break pattern are reported here.

2. Methods

Two trials of the alternative rest breaks were completed in two commodities, strawberry harvest and the cultivation of citrus-bearing fruit trees. The designs, samples, specific methods and results for each trial are discussed separately below. In each cooperating work site, a labor–management ergonomics committee was implemented. Farm workers and management representatives were provided 8–10 h of training in ergonomics by research team members in their native languages (Spanish or Punjabi). Team members participated in the processes of hazard identification, generation of alternative solutions, and evaluation of intervention feasibility. They also facilitated worker involvement in intervention trials and provided input about the intervention implementation process.

The standard or control condition in these studies followed California law, which required that a 10 min rest period be provided for every 4 h of work and a 30 min meal period for every 4 h or work. Within the requirements, the precise timing of breaks typically varies with the work crew and workers often may opt out of the early breaks, especially when paid on a piece rate system. In the trials reported here, the required breaks were offered after the second and sixth hours, with the lunch break coming after the fourth hour; and workers did not opt out of any breaks.

The alternative rest break protocol, based on previous work by NIOSH investigators (Galinsky et al., 2000; Sauter et al., 1997; Swanson et al., 1989), called for an additional 5 min break for every working hour in which there was no other scheduled break as required by law (e.g., lunchtime). Given an 8 h workday, this resulted in an additional 20 min of rest per work shift. Thus, 5 min breaks were given after the first, third, fifth and seventh hour of work, in addition to the required breaks. Workers were asked to stop their work at the sound of a whistle; they could stand, stretch, walk about or assume a comfortable sitting position. Return to work was also signaled with a whistle.

To measure the farm workers' experiences of MS symptoms, a survey instrument was used that had been developed and tested for its appropriateness given the language, culture and literacy levels of Mexican and other immigrant workers in California agriculture (Faucett et al., 2001). It was administered to Spanish, Punjabi or English-speaking workers by trained interviewers who were at least bilingual and bicultural. Study participants were asked to describe their symptoms at the end of each workday by coloring a body diagram to indicate the presence of three types of MS symptoms (aching, sharp pain, numbness) and overall fatigue. A pain faces scale, previously shown to be acceptable and valid for use with this adult study population, was used to describe the severity of each of these symptoms (Faucett et al., 2001; Wong and Baker, 1988). For each symptom, workers were asked to select one face from among six simple faces that portrayed degrees of distress from pain or fatigue ranging from symptom-free to tearful, yielding a 6-point scale. A composite measure of pain severity was computed that is a multiplier of the extent of the body affected by MS symptoms and the severity of those symptoms. Overall fatigue was measured using the simple 6-point scale of severity.

3. Trial one: strawberry harvest

3.1. Design and procedures

The first trial of the rest break protocol was a 3 day pre-post intervention trial with random assignment to the Experimental group (Es), who received the intervention or Control group (Cs), who were provided only the legally required rest breaks. At the end of the baseline day, data were collected from workers about their MS symptoms and fatigue. Workers were then randomly assigned to the E and C groups. Symptom survey data were gathered at the end of each workday for Days 1 and 2. Productivity was assessed by using company measures. The company collects individual level data on productivity by swiping barcodes from an ID pin on the worker's shirt as the worker brings each full flat of strawberries to unload at a collection truck.

3.2. Subjects

Seventy-two Spanish-speaking field workers employed by one strawberry grower in Southern California agreed to participate, and 66 of them provided complete data for analyses (Table 1). No workers declined to participate. Participants were predominately men (Total men in sample: 79%; Control: 75%, Experimental: 83%), 65% of whom had worked in strawberry production for 2 or fewer years. The experimental group was significantly younger than the control group ($t = 3.02$, $df = 64$, $p < 0.01$), but did not differ significantly on gender, education or experience with strawberry production.

3.3. Work task

The first trial was implemented with a small strawberry production operation (60 acres) specializing in early season fresh market and processing fruit. In strawberry picking, the worker moves along furrows (approximately 12″ wide and 300 yards long) between raised beds (14–18″ high) and pushing or carrying a wire cart with a strawberry flat in it (Fig. 1). Berries are twisted from the vine with a pinch grip and placed in boxes in the flat. Normally pickers remain in a stooped or crouched posture for the length of a row. Workers are paid on incentive basis and move as fast as possible. A work cycle for strawberry harvest begins with the worker's entry into the field with a wheeled cart filled with an empty strawberry flat and ends with the worker's return to the collection truck with a full flat. Ergonomics characteristics of the task include:

- severe trunk flexion,
- sustained neck extension,
- shoulder and elbow flexion,
- highly repetitive pinch grips with both hands,
- constant deviation of both wrists, and
- contact pressure on knees from kneeling on bed.

A survey conducted in the previous year of 52 similar harvesters at this strawberry site showed that 70% reported

Table 1
Demographics of strawberry harvester sample (Orange County, 2001)

	Control ($n = 36$)	Experimental ($n = 30$)
Years of age	28.0 (10.0)	21.8 (6.3)
Years of education	4.4 (3.3)	5.1 (2.8)
Years working strawberries	3.4 (6.1)	3.3 (5.1)

Mean (standard deviation).

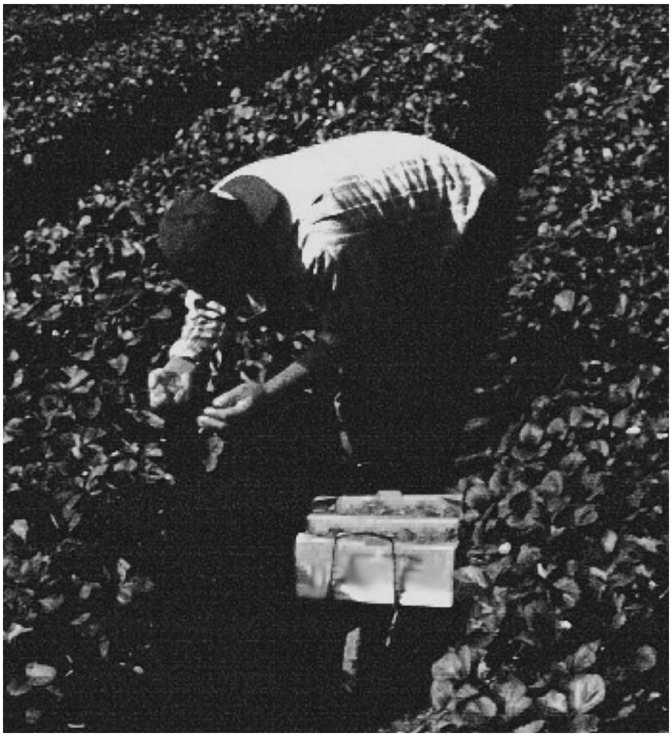

Fig. 1. Strawberry harvest (Orange County, 2001).

pain or discomfort in the mid or lower back at the end of the season and 30% reported lower extremity pain.

3.4. Results

For each day of the rest and recovery trial, following the baseline day, Es reported less severe symptoms than Cs, but were also less productive (see Table 2). These differences were not significant using tests of repeated measures ANOVA (with or without controlling for age); they also suffered from low statistical power.

We examined whether workers' symptoms improved, worsened or stayed the same over the course of the trial. Using χ^2 tests, significant differences between Es and Cs were obtained for changes in musculoskeletal symptoms, but not for fatigue or productivity. A total of 38 workers indicated either an increase or a decrease in symptoms and 28 reported no change in musculoskeletal symptoms (Table 3).

Table 2
Symptoms and productivity scores for three data collection periods (Orange County, 2001)

	Control ($n = 36$)	Experimental ($n = 30$)
MS symptoms		
Baseline	1.72 (4.50)	2.30 (2.62)
Day 1	1.06 (2.22)	0.50 (1.41)
Day 2	2.08 (3.56)	1.03 (2.14)
Fatigue		
Baseline	1.36 (1.44)	1.40 (1.30)
Day 1	1.58 (1.00)	1.47 (1.01)
Day 2	1.69 (1.09)	1.60 (0.97)
Productivity		
Baseline	2.24 (3.56)	2.05 (0.32)
Day 1	2.86 (0.57)	2.70 (0.46)
Day 2	2.59 (0.41)	2.35 (0.26)

Mean (standard deviation) MS musculoskeletal.

Table 3
χ^2 tests comparing controls with experimental subjects on changes in musculoskeletal symptoms, fatigue and productivity over the course of a 3 day trial

	Controls	Experimentals	Pearson χ^2 (df)	p-value
Musculoskeletal symptoms				
Worsened	14	4	8.86 (2)	0.01
No change	16	12		
Improved	6	14		
Fatigue				
Worsened	17	17	3.30 (2)	0.19
No change	10	3		
Improved	9	10		
Productivity				
Worsened	23	22	0.82 (2)	0.66
No change	6	3		
Improved	7	5		

4. Trial two: tree nursery

4.1. Design and procedures

Following our experience with strawberry workers and to strengthen the design, we selected a cross-over trial for use in the tree nursery, using 16 pairs of workers. The trial began with a baseline day of data collection, followed by random assignment into two groups. The intervention was delivered in two periods of 3 days each. In the first period, Group One was provided the intervention rest breaks (E Condition) as described above for three days, while Group Two was provided only the legally required breaks (C Condition). After a weekend break, the second period began in which Group Two was provided the intervention breaks (E Condition) while Group One was provided the legally required breaks (C Condition). In this manner, each of the two groups experienced the intervention and each also served as a control group during one of the two test periods. Symptom survey data were collected at the end of each day. Productivity data were collected by counting the number of trees processed by each of the 16 pairs of workers over the course of the workday.

4.2. Subjects

Thirty three Spanish and Punjabi speaking field workers employed by one nursery owner in Northern California volunteered to participate in the second trial, and 32 provided complete data for analyses (Table 4). No workers

Table 4
Demographics of tree nursery sample (Yolo County, 2001)

	Subjects ($n = 32$)
Years of age	40.5 (8.3)
Years of education	7.6 (2.9)
Years working in tree nursery	8.4 (6.8)

Mean (standard deviation).

Fig. 2. Budding and tying of young citrus trees (Yolo County, 2001).

declined to participate. Women constituted 72% of the sample and 65% had worked in the nursery industry for 4 or more years. The two groups did not differ significantly on age, gender, education or experience with tree nurseries.

4.3. Work task

Trial Two took place in a large nursery for orchard trees and focused on the task of inserting and tying buds on young developing citrus trees (approx. 18″ high). Budding requires a crew of two workers who squat or kneel almost continuously and crawl from one tree to the next: one worker cuts a precise incision, the second worker inserts the new bud and ties it in place (Fig. 2). They process approximately 1600 trees per shift and, because of the precision of the task, are paid by the hour. Ergonomics characteristics of the task include:

- sustained kneeling to reach the required work area,
- highly repetitive, high force pinch grips to make cuts, insert buds, and tie off graft (18/min),
- trunk flexion up to 80°, with simultaneous trunk twisting up to 15°,
- elbow flexion up to 90°, and
- static flexion of the neck, trunk, and lower extremities for periods of up to 2 h.

Survey data collected at this worksite during the previous year from workers performing budding indicated that 67% of the workers reported pain or discomfort. Over 60% reported MS symptoms in the lower extremities and 57% reported MS symptoms of the mid and low back.

4.4. Results

The data were analyzed using repeated measures ANOVA analyses, with the Greenhouse-Geisser correction, to test for group differences in the symptom and productivity scores over the baseline and 6 trial days (Table 5). Musculoskeletal symptoms (Fig. 3) were significantly better during the E Condition ($F = 7.34$, $df = 3.35$, $p \leqslant 0.01$). Likewise, fatigue scores (Fig. 4) were significantly better with the E Condition ($F = 3.78$, $df = 3.12$, $p \leqslant 0.02$). Productivity (Fig. 5) did not vary significantly by condition, although this test was underpowered ($F = 0.93$, $df = 2.87$, $p > 0.10$). In fact, productivity diminished in the second period as compared with the first, regardless of condition.

Table 5
Symptom and productivity scores for two groups during two conditions, using a crossover design (Yolo County, 2001)

	Group 1	Group 2
Musculoskeletal symptoms		
Baseline day	10.5 (12.2)	9.4 (13.4)
Period 1		
Day 1	**7.8 (7.5)**	12.3 (17.1)
Day 2	**9.5 (8.6)**	15.9 (12.3)
Day 3	**8.2 (11.4)**	18.7 (11.9)
Period 2		
Day 1	15.6 (8.8)	**4.3 (5.0)**
Day 2	14.8 (10.2)	**3.0 (3.1)**
Day 3	17.0 (10.2)	**5.1 (6.0)**
Fatigue symptoms		
Baseline day	3.2 (1.3)	2.5 (1.4)
Period 1		
Day 1	**3.0 (1.1)**	2.7 (1.3)
Day 2	**2.4 (1.1)**	2.3 (0.9)
Day 3	**2.4 (0.9)**	2.9 (0.9)
Period 2		
Day 1	3.4 (0.8)	**2.6 (1.2)**
Day 2	3.4 (0.8)	**2.0 (0.6)**
Day 3	3.5 (0.8)	**2.4 (0.5)**
Productivity		
Baseline day	1521.9 (611.8)	1475.6 (607.7)
Period 1		
Day 1	**1663.9 (180.1)**	1624.0 (325.0)
Day 2	**1615.0 (172.3)**	1571.1 (256.7)
Day 3	**1517.5 (615.2)**	1726.1 (126.2)
Period 2		
Day 1	1287.8 (507.1)	**1240.6 (144.3)**
Day 2	1518.1 (128.2)	**1350.2 (189.0)**
Day 3	1392.5 (111.2)	**1398.8 (241.6)**

Experimental condition indicated in bold.
Mean (standard deviation).

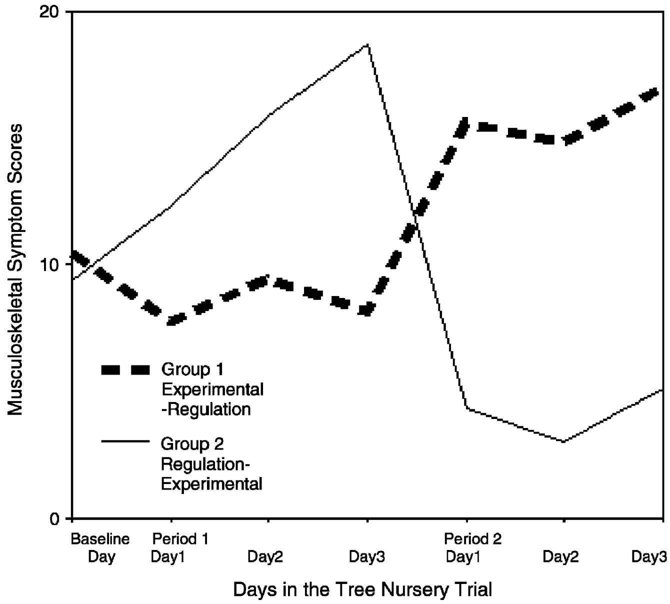

Fig. 3. Scores for musculoskeletal symptoms for two groups exposed to experimental and regulation rest break patterns during a cross-over trial.

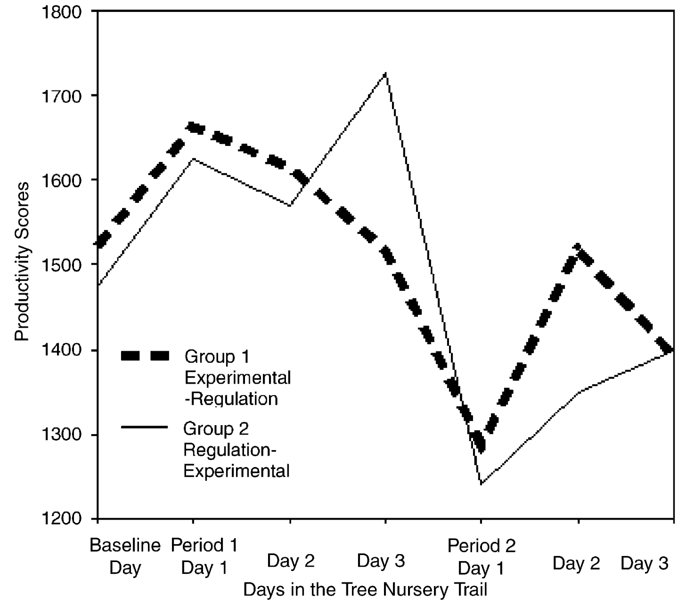

Fig. 5. Scores for productivity for two groups exposed to experimental and regulation rest break patterns during a cross-over trial.

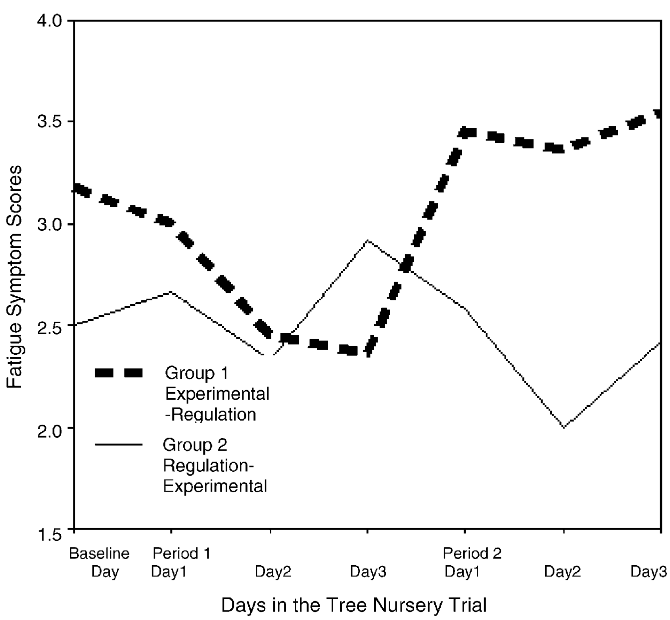

Fig. 4. Scores for fatigue for two groups exposed to experimental and regulation rest break patterns during a cross-over trial.

Figs. 3 and 4 show that for both MS symptoms and fatigue, each group fared better with the E Condition. The crossover, as the groups changed conditions, is readily apparent in the figures. The order in which groups participated in E may have influenced their production: Group One, who received the intervention during the first period, demonstrated greater productivity under E as compared to C; Group Two, on the other hand, who received the intervention during the second period, demonstrated less productivity under E as compared to C. Fig. 5 shows that both groups decreased their productivity in the second period. Fatigue and MS symptoms, on the other hand, were consistently in the expected direction for both groups—less severe under E. Analysis of covariance shows that when both group and productivity variates are controlled, there is a highly significant ($p \leqslant 0.01$) change in MS symptom outcomes attributable to E. Additionally, changes in MS symptoms were associated with changes in fatigue ($r = 0.62$, $p \leqslant 0.01$) over the 3 days of each trial. This association increases when the productivity is partially out ($r = 0.69$, $p \leqslant 0.01$).

5. Discussion and conclusions

Other investigators, studying workers in diverse industries, have reported that modifying standard rest breaks improved workers' symptom reports and had modest impacts on productivity (Dababneh et al., 2001; Galinsky et al., 2000). We have found similar benefits in a sample of farm workers doing strenuous stoop or squat labor. Extensive research by the AERC engineering team confirmed that there were currently no acceptable tools or technologies that would alleviate either the stooped or the repetitive hand-picking exposures found in FVH agriculture. In situations where engineering controls for ergonomics hazards are unavailable, too expensive or too difficult to apply, or even in concert with engineering strategies, modifying patterns of work and rest may be feasible for employers and beneficial for employees. MS symptoms in two groups, and fatigue in one group, of farm workers were significantly reduced with the modified rest break pattern implemented in this study. Effects of the intervention on productivity were more mixed, although these variations may potentially be explained by limitations in the experimental design. Perhaps the most meaningful finding is that the workers and managers in the tree nursery decided together to continue the use of modified rest breaks during piece rate tasks in addition to hourly work tasks after the experimental trials were completed. They have altered the original protocol to include 3 min, instead of 5 min, added rest periods.

A significant number of FVH workers are placed at risk because of stooped labor. In California, fully 60% of agricultural production consists of FVH crops. To handle these commodities, California employs nearly 1 million hired farm workers each year, mostly Hispanic (Villarejo and Baron, 1999). Furthermore, between 1993 and 1997, the combined production of FVH commodities increased 14–25% and has continued to climb (Martin, 1998; Papademetriou, 1999). Fewer than 10% of these workers speak English, most have little or no formal education and 67% are functionally illiterate (Rosenberg et al., 1998; Villarejo, 1999). They rarely understand their legitimate access to public health resources or their rights as workers and, in keeping with the longtime culture of industry, accept the concept of prevention only with reluctance (Anderson et al., 2000). These characteristics pose significant challenges to the implementation of occupational health research.

In our experience, the adoption of preventive interventions in agriculture relies on partnering with farm workers in addition to cooperating growers and managers, and achieving credibility for a participative and collaborative research process (Rogers, 1983). The process of developing participative ergonomics teams in part addressed the need to include workers together with managers as interventions were designed, evaluated and implemented. Nonetheless, cultural, language, and literacy differences between researchers and workers meant taking time to build trust and credibility with the workers, develop and translate the survey questionnaire, and then deliver it by interview. A significant amount of time was spent identifying terms to use for pain, symptoms, and injuries and determining how best to introduce the questionnaire to the respondents. Similarly, the development of the modules of the ergonomics-training program took special attention. It was important to be responsive to seemingly unrelated questions about health and healthcare, community needs, and other agricultural tasks and machinery. Although workers and managers were accustomed to working together to solve some workplace problems, they had not experienced the collaborative and more methodical approach that the research team initiated. Finally, physical harvest and field conditions challenged research team members—who learned to work outdoors, starting in the very early morning hours under initially cold conditions, which often turned hot before midday; and to perform difficult work tasks with some skill to build credibility.

The validity of our experimental study designs may have been affected by sociocultural factors such as local labor–management relations and cultural differences between the workforce and management. Employer injury logs were of little use in evaluation because of probable under-reporting by these immigrant workers. Additionally, our attempts to evaluate productivity may have been hampered by inter-group competition, especially by the control groups. Some of these study limitations could be addressed by extending trials over a longer period of time, reversing the alternative rest break intervention or staggering its introduction, adding multiple control groups or data collection intervals, and reducing awareness between groups about the experimental conditions. Despite these limitations, the findings from our study demonstrate that alternative patterns of rest breaks, including brief rest breaks early in the work shift, may reduce workers' musculoskeletal discomfort and fatigue over the course of the day with modest impact on production. Although we tested the rest break intervention in agriculture, similar interventions are likely to benefit workers in other strenuous jobs such as construction and manufacturing.

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