DEVELOPMENT AND VALIDATION OF A PROACTIVE ERGONOMICS INTERVENTION

TARGETING SEASONAL AGRICULTURAL WORKERS

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Dedicated to my loving wife, Jessica, and to my beautiful children. Thank you for your patience.

Thesis Abstract:

Seasonal agricultural workers hired for physically demanding tasks are especially at risk of experiencing work-related musculoskeletal disorders, the most common of all non-fatal agricultural injuries. Best practices in ergonomics can prevent work-related musculoskeletal disorders. Seasonal agricultural workers can be protected from musculoskeletal disorders through the applied use of reactive, proactive, and prospective ergonomics. Ergonomics in agriculture needs to identify the occupational tasks that could cause work-related musculoskeletal disorders seasonal agricultural workers, develop and test practical solutions for protecting these workers (including increasing musculoskeletal tissue tolerance by implementing exercise interventions), and provide a solution for intervention adoption within the industry. A manual weed removal study was conducted to determine the occupational risk of injury for seasonal agricultural workers hired for canola crops. A proactive exercise intervention was developed for seasonal agricultural workers to use as a preseason training program. Recommendations for implementing this work into the canola industry of Canada are provided in the concluding chapter.

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1.1 Introduction

Occupational health considers all aspects of health and safety in the workplace, and has a strong focus on minimizing risk factors that lead to musculoskeletal disorders (MSDs)[1]. MSDs are defined as the group of injuries that affect the musculoskeletal system, including the nerves, tendons, muscles, and supporting structures such as intervertebral discs[2]. Suffering from MSDs resulting from occupational hazards is highly problematic. Affected workers, along with their families, can be challenged with physical, psychological, and social strains. Injuries amongst experienced workers also affect absenteeism and overall productivity, proving costly to employers and the healthcare system[3,4].

MSDs may result from extreme acute loading, where single incident events such as slips, falls, cuts, or contact lead to trauma. Many organizations work diligently to reduce the frequency and intensity of acute work-related injuries. Risk exposure assessments can be effective in quantifying the characteristics of acute injury concerns at the workplace[5]. Working populations are also becoming increasingly aware of acute injury risks, through publication of pertinent research, media exposure, safety awareness programs, and, perhaps unfortunately, personal experience. Increased awareness joined with expanded occupational health and safety efforts has successfully reduced frequency and severity of acute work-related injuries.

MSDs may also stem from chronic occupational loading, consisting of cumulative exposure to musculoskeletal stressors. Unlike acute loading, where single events are easily identifiable and preventable, chronic loading has no single defined instance where the occupational loading causes the MSD. Instead, cumulative sub-threshold loading applied over time (without appropriate rest and recovery) leads to progressively decreasing tissue tolerances, and eventually injury. This cumulative causation leads many individuals to believe that the chronic work-related discomforts and MSDs they experience are acceptable because they are an inevitable "part of the job"[6]. One viable solution for decreasing MSDs is through increasing tolerance to work-related musculoskeletal loading by improving employee health with exercise interventions.

Athletes often use best practices in exercise training to prepare for season-specific demands while increasing their potential to outperform the competition. Athletic exercise interventions deliver three main effects applicable to musculoskeletal conditioning for work: *cumulative*, *delayed*, and *residual*. *Cumulative* training effects are those changes in body state and level of motor or technical abilities resulting from a series of workouts[7]. *Delayed* effects are those abilities attained over a given time interval after a specific training program[7]. *Residual* effect is the retention of changes in body state and motor abilities after cessation of training beyond a given time period[7]. Workplace exercise interventions could potentially train employees with similar best practices used amongst athletes, protecting workers from MSDs by improving their health and soft tissue tolerances while increasing overall production capabilities[8].

Beyond increasing individual tolerances for physical occupational demands, exercise interventions could potentially improve the biopsychosocial structure of the entire workplace. Properly designed workplace exercise interventions may improve the health status of employees thereby reducing the risk of chronic work-related MSDs[9], assisting in the prevention

1.2 Work and Health In Agriculture

Agriculture has a unique composition of physical and environmental exposures that may contribute to MSDs[16]. The National Institute for Occupational Safety and Health (NIOSH) identifies reducing incidence and prevalence of MSDs amongst agricultural workers as a high priority[17]. MSDs are the most common of all occupational injuries and illnesses for farm workers, especially for those involved in labour intensive practices[18, 19]. Researchers have identified lifting and carrying heavy loads (over 25 kg), sustained or repeated full body bending or stooping, and highly repetitive hand work (hoeing, clipping, picking) as top agricultural tasks requiring assessment and risk reduction[20-23]. Many of these risk factors have been associated with low back discomfort[20, 21, 23], and prevalence of low back discomfort amongst agricultural workers is higher than national average[20, 24]. Depending on the specific agricultural industry, many SA workers may also be exposed to prolonged periods of severe neck deflection, especially when involved in hand harvesting of ground plants or weed pulling[16]. Additionally, SA workers are often exposed to long working hours (> 60 hours per week) during peak production, a rate that has been associated with a threefold increase in likelihood of injury[25]. These chronic risk factors are often a substantial part of SA workers' daily physical demands during intensive crop production.

Although NIOSH has placed a high priority on reducing the prevalence of chronic MSDs amongst agricultural workers, the true impact of chronic physical loading and resultant MSDs in agriculture are not yet fully understood[26], and SA workers may not be receiving adequate training to readily self-identify signs and symptoms associated with chronic MSDs. One challenge of chronic musculoskeletal strain is that the MSD may develop or exist even while pain is not constantly present[22]. Systems for recognizing, reporting, treating, and reducing chronic MSDs are not generally a component of agricultural operations[15, 16, 22]. Despite little investigation of the long term effects of chronic loading in agricultural occupations, researchers have been working towards an understanding of the common types and causes of MSDs affecting agricultural workers[15, 16, 18, 22]. Understanding what the risks are could help develop strategies for reducing the impact of chronic loading. Recent epidemiological research of chronic loading risks associated specifically with MSDs amongst crop production SA workers is outlined in Table 1.1. Column 1 (Ergonomic Risk) identifies some of the ergonomic risk factors in various production crop operations, and column 2 (MSDs) identifies specific MSDs that may occur amongst agricultural workers, associated with the identified ergonomic risk factors. Table 1.1 indicates that agricultural workers have physically demanding materials handling tasks that put them at risk of experiencing several different types of MSDs. These tasks, and their resultant MSDs, may continue to plague the agricultural industry unless regulators, employers, and employees within the industry seek to implement interventions aimed at reducing MSDs[16].

Table 1.1. Ergonomic Risks and associated MSDs for SA workers.

Ergonomic Risk	MSDs	Reference
Frequent grasping	carpal tunnel syndrome (a, d, p)	a) Stal, Pinzke, Hansson, & Kolstrup[27]
Kneeling, squatting	hand and wrist disorders (a, c, d, f, g, h)	b) Palmer,[28] Stal & Englund[29]
Carrying full buckets	shoulder disorders (e, i, k, l)	c) Duraj, Miles, Meyers, et al.,[30] Earle-Richardson, Jenkins, Slingerland, et al.,[31] Salazar, Keifer, Negrete, et al.,[15] Weigel & Armijos[32]
Repetitive grasping of hand tools	hip and knee arthritis (b, c, j, l, n, p)	d) Meyers, Miles, Faucett, et al.,[33] Roquelaure, Dano, Dusolier et al.,[34] Earle-Richardson, Jenkins, Slingerland, et al.[31]
Arms raised and flexed above shoulder	low back pain (c, f, g, i, j, k, l, p)	e) Meyers, Miles, Faucett, et al.,[33] Roquelaure, Dano, Dusolier et al.[34]
Carrying bags while hand picking	ankle strains/sprains (c, n)	f) Meyers, Miles, Faucett, et al.,[33] Earle-Richardson, Jenkins, Strogatz, et al.[35]
Weeding, Pruning below waist	neck strain (j, o)	g) Palmer,[28] Meyers, Miles, Faucett, et al.[36]
Repetitive contact stress on hands		h) Janowitz, Tejeda, Miles, et al.,[37] Wakula & Landau[38]
Reaching over shoulder to pick		i) Duraj, Miles, Meyers, et al.[30]
Stooped postures (prolonged and/or repetitive)		j) Meyers,[33] Fathallah,[18] Weigel & Armijos[32]
Moving equipment		k) Fulmer, Punnett, Slingerland, & Earle-Richardson,[39] Earle-Richardson, Jenkins, Strogatz, et al.[35]
Heavy lifting		l) Duraj, Miles, Meyers, et al.,[30] Meyers, Miles, Faucett, et al.,[33] Earle-Richardson, Jenkins, Slingerland, et al.,[31] Wang, Myers, & Layne,[40] Sprince[41]
Sustained awkward postures		m) Meyers, Miles, Faucett, et al.,[36] Holmberg, Stiernstrom, Thelin, & Svardsudd,[42] Rosecrance, Rodgers, & Merlino[20]
Walking on uneven and/or wet fields		n) Meyers, Miles, Faucett, et al.,[33] NIOSH,[43] Salazar, Keifer, Negrete, et al.,[15] Wang, Myers, & Layne[40]
Tractor operations		o)Nonnenmann, Anton, Gerr, et al.[44]
Aging		p) Weigel & Armijos[32]

1.3 Ergonomic Controls

Applying the science of ergonomics may reduce many of the musculoskeletal risk factors associated with SA work. In some common agricultural tasks, such as tool use, equipment maneuvering, and bag or bucket handling, preferred practices for change include the introduction of engineering controls, administrative controls, and personal protective equipment[22]. These changes require minimal employee motivation for change[22]. Engineering controls in agriculture may include modifying materials, tools, or machinery to alleviate musculoskeletal strain caused by work tasks[22, 45]. Administrative controls on a farm include work process changes such as limiting the number of hours worked or changing a task procedure[22]. Personal protective equipment may be worn in agriculture to protect workers from exposures to chemicals, weather conditions, equipment vibration, or from falling objects[46].

For other risks, such as sustained stooped postures, walking on uneven and/or wet terrain, grasping tasks, and repetitive movements, behaviour modification strategies may be more effective and appropriate for SA workers. Behaviour modification may be either a direct manipulation of how a worker completes a task, or a holistic worker performance change. An exercise intervention introduced as a holistic performance change may increase SA workers tolerance to occupational loads that can cause MSDs[47]. The SA work cycle is similar to an athlete, annually experiencing phases of pre-season, in-season, and off-season physical demands. Athletic exercise training is designed to increase an athlete's physical conditioning from a baseline level to safely meet initial demands, then provide the athlete with the best opportunity to physically peak during the most demanding periods of the season[7]. Exercise interventions for SA workers should be similarly designed so that the workers are physically ready for the start of production season and most physically capable during peak production periods.

Participatory ergonomics could be a critical, supportive framework for an exercise intervention amongst SA workers. Participatory ergonomics involves early and active collaboration amongst relevant stakeholder representatives, including workers, employers, and specialists[48]. Stakeholder representatives work together to produce an intervention with four key components for successful workplace health promotion: risk identification, intervention development, intervention implementation, and program evaluation[49]. The participatory approach involves pre-identifying the criteria and barriers for designing and implementing an intervention, and providing workable solutions to these challenges. Stakeholder groups may have different levels of involvement during various phases of an ergonomic intervention[48]. Typically employer representatives are heavily involved in both the initial stages and the evaluation of the intervention, while specialists focus on directing intervention development, and worker representatives commit the workforces to assist in developing, adopting, and evaluating the intervention.

Participatory ergonomics can be done within one business, or it can be done on an industry-wide scale. The BC sawmill industry, for example, followed an industry-wide participatory ergonomic process to identify risks and develop changes that have saved the industry millions through significantly reducing the risk of work-related MSDs[50]. Agriculture could similarly turn to an industry-wide intervention strategy, including exercise interventions, to increase SA workers' physical risk tolerance, thereby reducing work-related MSDs. The Canola Council of Canada, for example, is one Canadian agricultural network that has membership from growers, suppliers, exporters, processors, and manufacturers, with a mission to advance the growth and outlook of the industry[51]. This nationwide network has the membership structure to initiate and sustain an effective industry-wide participatory ergonomic intervention. The final chapter of this thesis details a canola industry intervention solution facilitated by the Canola Council of Canada

Stakeholders involved in a participatory ergonomics intervention for SA workers may have several factors to consider to maximize a successful implementation of an ergonomic intervention. Table 1.2 presents factors that each stakeholder group (workers, employers, and specialists) should consider as possible challenges in a participatory ergonomic intervention for SA workers. The following several sections will address potential solutions for each challenge from multiple stakeholders' perspectives.

Table 1.2. Stakeholder challenges for participatory ergonomics with SA work.

Factors	Worker	Employer	Specialist
1.4.1 Environmental Challenges			
1.4.1.1 Rurality	⍰	⍰	⍰
1.4.1.2 Season	⍰	⍰	⍰
1.4.1.3 Access to fitness equipment		⍰	⍰
1.4.1.4 Resources	⍰	⍰	
1.4.2 Biological Challenges			
1.4.2.1 Young workers	⍰	⍰	⍰
1.4.2.2 Gender	⍰		⍰
1.4.2.3 Migrants	⍰		
1.4.3 Social Challenges			
1.4.3.1 Language	⍰	⍰	⍰
1.4.3.2 Literacy	⍰	⍰	⍰
1.4.3.3 Experience	⍰	⍰	⍰
1.4.3.4 Employee-Employer relations	⍰	⍰	
1.4.3.5 Cultural norms	⍰		
1.4.4 Organizational Challenges			
1.4.4.1 Safety culture		⍰	
1.4.4.2 Training		⍰	⍰
1.4.4.3 Long working hours	⍰	⍰	
1.4.4.4 Regulations		⍰	⍰
1.4.4.5 Labour shortages		⍰	
1.4.4.6 Cost-benefit trade-off		⍰	

1.4.1 Environmental Challenges

The success of an exercise intervention may depend on how well the stakeholders are able to address the challenges associated with the setting. The environment is the first major challenge to be incorporated into a workplace exercise intervention amongst SA workers. SA workers live and work in rural environment, which can create a unique set of challenges in comparison with urban settings[52]. Environmental challenges for a rural exercise intervention include the access and availability of resources, as well as the constraints surrounding the timelines of SA work. Intervention location, particularly in consideration of where the employees generally live and work and how they travel between home and work, can be a critical and determining factor in the success of an exercise intervention[12, 13]. An exercise intervention must be designed to work within the available environment to maximise success for SA workers.

1.4.1.1 Rurality

Reality for SA workers is that they live and work in a rural environment. The downside of rural lifestyle environment is an increased challenge to remain healthy and get treatment for MSDs[52, 53]. Canadian provinces have structured their healthcare systems so that more expensive health care solutions, including access to specialists, are most easily available in urban centers. Access to health care services diminishes for people who live further from hospitals[53]. Fitness facilities and personal trainers are also generally less readily available in rural settings[53]. These restrictions may be a contributing factor to agricultural workers reporting higher instances of self-treatment for injury, when compared to their urban counterparts[16]. Unless there are ergonomic interventions in the workplace, SA workers may be left on their own to learn about and to prevent MSDs.

Employers of SA workers should readily recognize the challenges these workers face in terms of rurality. Resources available in urban centers are costly to bring to the rural setting[54], and exercise interventions are no exception. Rural agricultural employers may not be compelled to protect their workers through ergonomic interventions, as much of North America is currently without a federal or provincial support network (or mandate) to provide healthy solutions for SA workers[55-57]. Unlike urban businesses that typically have a single 'bricks and mortar' location, jobsites for SA workers are often outside where they migrate from field to field. This challenges the organization with developing an exercise intervention that will be successful within the dynamic and secluded working environment.

Exercise specialists need to be sensitive to the circumstances of the rural environment. An urban-style exercise intervention with proposed broad access to state-of-the-art fitness facilities is not a feasible solution for SA workers. Specialists should be designing interventions for SA workers that are compatible with the rural setting.

1.4.1.2 Season

SA workers are usually hired to perform the most physically demanding tasks, during the most intensive production season, generating a defined period of musculoskeletal loading with little or no paid preparatory time for training or acclimatization. Given that schedule, SA workers may be more susceptible to MSDs, as people are more likely to sustain a MSD during peak periods of physical loading[31]. Seasonal work is highly crop dependant, and may last for as little as 2-3 weeks or extend as long as 8 months of the year[58]. It is not uncommon for SA workers to be hired for multiple serial crop varieties, each with a short, labour-intensive seasons[59]. Given that serial employment, SA workers must remain healthy to perform a variety of labour intensive tasks for the duration of their working season, regardless of the length of the season of one crop variety.

Another important aspect of seasonal work is the off-season. SA workers might experience a range of work and total physical activity in the off-season. They could be unemployed, potentially living a sedentary lifestyle. Perhaps they are working at another seasonal occupation[60]. They could use the off-season to continue with education. Others may view the end of the season as a determining factor for seeking out new employment on a different schedule, although some SA workers do return to the same summer employer year after year[61]. The fact that SA workers are not performing the same labours throughout their career, or even throughout the year, means that these workers could be more acclimatized to change than a regular full time employee. The seasonality of this workforce could also be a contributing factor in promoting and adhering to dynamic exercise interventions matched to the demands of the working seasons.

Employers hiring SA workers are often constrained by fairly tight seasonal timelines. Employers often expect SA workers to understand and meet their physical work demands from the first day of the working season[15], despite these workers typically not being hired until they are needed for intensive labour. Training from the employer, therefore, is typically brief, directed to scheduling and production expectations and acute safety policies of the workplace.

Specialists should consider the seasonality of agricultural work as a great opportunity for delivering a dynamic exercise intervention. An exercise intervention for SA workers could be modelled according to athletic training principles. A current best practice in athletic training involves athletes entering training camps that physically prepare them for the demands of sporting competition. Pre-season training has two main goals: promote healthy choices and meet the physical performance demands[7]. Pre-season training is an especially important phase for athletes, to retrain their bodies for optimal seasonal performance[62]. The athletic off-season affects athletes' musculoskeletal systems, with athletes losing some of their conditioned ability within 5 weeks post season[63]. Seasonal agricultural work could be considered an athletic occupation. Pre-season exercise training for the intensive work season of SA workers should begin months before they are required to be in the field[7]. That training should be designed to meet the physical demands their occupation places upon them for the duration of their season. Preseason exercise training, modelled after athletic training, seems a logical solution for meeting the production demands placed upon SA workers. Indeed, those that complete fitness training should be considered agricultural athletes, as they are likely to be more physically capable of meeting their occupational performance demands.

1.4.1.3 Access to Fitness Equipment

In rural settings, there is simply not the same access to fitness equipment or training tools that there is in urban centers[64]. Employers looking to improve employee wellness and prevent worker MSDs in a rural environment need to consider how practical it is to provide their employees with a traditional, equipment-centered exercise program and/or access to exercise equipment. It would be difficult for rural workers to commute to urban centers for the purpose of exercise training, as time constraints are the leading barrier to exercise participation[64, 65]. Some SA workers are completely reliant on their employer for both work- and non-work-related transportation[58], further reducing the feasibility of urban training outside work hours. In many rural situations, it may not be feasible for employers to purchase exercise equipment for the sole use of rural workers. This may be especially true for SA workers, as they are not always working or living in a central location (although some migrant workers may live centrally, as will be discussed in section 2.3).

Specialists should be sensitive to rural equipment limitations and design an exercise intervention that requires little to no specialized fitness equipment. Any exercise equipment investment for SA workers' use needs to be both practical and cost effective. Minimizing equipment required for exercise interventions might also encourage more SA workers who are typically novice and unfamiliar with programmed individual exercise. Miller and Miller (2010) suggest that complicated equipment may restrict exercise participation, creating feelings of intimidation amongst inexperienced exercisers[66].

1.4.1.4 Resources

SA workers are hired in multiple ways. Sometimes agricultural employers hire directly from the local rural communities. Increasingly, there is a trend in agriculture to contract out the hiring of SA workers to third party human resource firms. In California, for example, it is estimated that 70% of SA workers were hired through human resource firms, rather than by individual farms[22]. These human resource firms may share labourers among farms and other agricultural operations as available[59].

While there are several benefits to using a third party hiring system, there also needs to be a clear understanding in that model as to who is responsible for the occupational health of employees. SA workers may be hired and paid by one company (the human resource firm, or recruiting agency), working for a second operation (the farmer or farm business), whose crop is owned by a third operation (an agricultural technology corporation)[59]. This creates challenges for workers in understanding their direct administration, reporting responsibilities, and authority and resourcing for identifying and preventing MSDs. SA workers need to know who shares the responsibility for protecting them from injury, what types of injuries may be work-related, but also how to file an injury claim if needed. SA workers tend to display high levels of commitment to human resource firms, indicating that these contractors need to work closely with the other employers to provide a clear understanding to the SA workers of which organization is accountable for the health and safety of the workers[60]. Failure to establish a responsible line of health and safety authority could create chaos in risk management, which may result in the ultimate failure of permanent disability or death for an employee[67].

Organizations with an accountable safety leadership become a resource for knowledge dissemination in delivering an exercise intervention to worker groups[67]. Employer organizations have a responsibility to provide the best practicable MSD reduction resources to their workers, and workers should be trained in why, when, and how to use these resources[68]. Employers of SA workers may need to provide their employees with access to targeted informative prevention resources, such as books and health care offices, which have previously been less available in rural agricultural settings.

1.4.2 Biological Challenges

Recognizing the physiological parameters of people hired as SA workers is just as important as accounting for the environment that they come from when developing an exercise intervention. There are three major factors in the biologic make-up of SA workers: age, gender, and migration[16]. Young workers (under the age of 20 years) comprise the majority of the SA workforce[69, 70]. Agriculture, like many industries, is seeing an increase in the number of females being hired[71]. In the United States migrant workers comprise 42% of all crop workers[16], while Canada is continuing to see a yearly increase in migrant SA workers[57]. Understanding the needs amongst this worker group is necessary for the success of an exercise intervention for reducing MSDs.

1.4.2.1 Young workers

Rural youth seek employment as SA workers during peak agricultural seasons, either because it is culturally expected (as will be discussed in section 3.5)[16], or as a local way to make money. Youth SA workers may still be in school, and seasonal work happens to be available during summer breaks. Youth may not understand that they have both opportunity and responsibility to cooperate with their employers to protect themselves from excessive work-related risks of occupational injury[72]. This includes chronic loading for repetitive work tasks, which are highly prevalent in SA work and can cause cumulative MSDs[16]. Current occupational health and safety governance relies on employers and employees to collaborate on safe work practices to avoid work-related injury[72].

Young SA workers also may not understand that they have a responsibility to protect themselves from work-related injury[72]. This is partially evidenced by the fact that 71% of youth farmworkers may suffer a farm-related injury by age 17[73]. There are several reasons that young workers get injured so often in agriculture. They may not have adequate training to understand the risks of the farm, or they may not be using experienced 'work hardened' techniques when performing manual handling tasks[15]. Physically, they are not as developed as adult males for whom the tasks may typically be developed for, and employers might expect young workers to perform tasks that are above the physiological limits of younger populations[69].

A study of urban youth workers revealed that occupational MSD complaints were an issue for approximately one-third of young males and half of all young females, but these workers did not have a solid mechanism for working with their employers to prevent work-related MSDs[6]. Responsibility may primarily rest on those employing young workers to ensure that these inexperienced employees have the authority and training tools that they need to reduce the risk of MSDs.

Young workers might be more susceptible to MSDs, but the same factors that could potentially injure them also could make them more willing to learn how to protect themselves. These workers may have fewer preconceived notions in regards to change in the workplace, as they likely will not have the mentality of "this is the way things have always been done"[6]. In some cases, young workers may identify risks because of physiological limitations that adults may have overlooked[6, 74]. Young workers are highly trainable[75], and are often motivated to please both their employer and their families. In comparison with older workers, young workers take less time to recover from chronic muscle fatigue[32], a recovery time which becomes problematic for older workers. Youth that are equipped with information on occupational hazards are better able to assert their right to safely act in a way that reduces the risk of chronic MSDs[6].

For an intervention to be effective in preparing youth SA workers for highly physical labour, specialists should design exercises according to age-appropriate guidelines[76]. Key considerations for youth-specific training include exercising 3-5 days per week for 60 minutes or more under trained supervision to prevent overtraining and inappropriate techniques[76, 77]. Compressive forces associated with specialized exercises at appropriate loading levels have favorable influences on a developing adolescent's skeletal tissue, while exceeding loads may have detrimental consequences[77]. Consequently both in training and in the workplace youth should not be expected to work with loads equivalent to capacities of fully-developed adult males.

1.4.2.2 Gender

Like young workers, female employees generally have lower physiological strength capabilities in comparison with adult males. Currently about 30% of agricultural workers in the United States are female[16]. Physiological differences between males and females could result in higher prevalence of MSDs as more females enter the SA workforce. Worker groups have a responsibility to work with employers to develop interventions that prepare for occupational physical loading that is within their biological constraints. For as long as workloads are within tolerable biological limits, an exercise intervention could adequately prepare these workers for seasonal occupational demands.

Specialists must also consider vast inter individual differences of the workers, when designing an intervention that meets their physiological needs. Females may need to start an exercise intervention at lighter loads than adult males. Regardless of age and gender the end goal must be for all workers to progress to a point where the risk of work-related MSDs is at a minimum. Exercise training should therefore be dynamic, catering to individual differences, including gender specific traits.

1.4.2.3 Migrants

Migrant workers present an attractive workforce for many agricultural employers. Migrant SA workers can be seen as a way to solve labour shortage issues (see section 1.4.4.5) and reduce overall costs (see section 1.4.4.6). In the United States governance of migrant workers allows for both documented and undocumented migrants to perform agricultural labour[15, 16, 22, 26]. Migrant SA workers in Canada are most often hired through the Seasonal

Agricultural Worker Program or the Low-Skilled Agricultural Worker Program[57, 78]. Workers hired through these seasonal programs are usually leaving behind family members and send any earnings they receive to their home countries[57]. These Canadian programs do not provide an opportunity for migrant workers to apply for citizenship, even if they return year after year to the same employer for seasonal labour[79]. Migrant SA workers typically do not arrive at their employment until there is imminent need for their labour, especially if they are hired through human resource contractors.

In comparison with other agricultural workers, migrant SA workers are considered higher risk for MSDs[15, 22]. Migrant SA workers may have specific social constraints (as discussed throughout section 1.4.3) that make them more vulnerable to suffering from an MSD. Migrant workers also have a history of being unwilling to report MSDs for fear of job loss or lack of compensation[15]. This problem may be more prevalent for undocumented workers in the United States, as these workers fear deportation and consequently report being more willing to tolerate poorer working conditions[15].

In Canada and in the United States, migrant workers are often housed by their employer in shared accommodations. Centralized migrant employee housing presents the opportunity for some common space in the living quarters to be designated as the primary location for an exercise intervention. If opportunities were provided for better health protection through exercise interventions for migrant workers, it might be added incentive to return to field work year after year, adding workforce stability and decreasing recruitment costs for employers.

1.4.3 Social Challenges

Exercise interventions need to be designed to work within the social structure of the target group. Most SA work involves transient employment, low decision-making but high physical intensity, factors that contribute to hiring young workers and migrants[57, 74, 80]. Migrant SA workers may also have language and literacy barriers[81]. Young and/or migrant SA workers may have limited labour experience prior to employment as a SA worker, or there may be social barriers between the workers and the employers[15, 52] (a factor which is not unique to SA work). The workforce, particularly migrants, immigrants, and youth, may also have cultural norms that are different from the regional population[81, 82]. This section examines the critical social considerations for developing an exercise intervention for SA workers.

1.4.3.1 Language

Fitness training for SA workers needs to be delivered in their preferred language. Agricultural employers in Canada and the United States primarily operate in English. For many migrant or immigrant workers, however, English is not their first language[81]. Some SA workers may rely on crew members to translate information to and from their supervisors because they speak little or no English. Exercise intervention development should include directions from worker representatives about addressing specific language considerations amongst the target SA workers.

Employers need to be highly aware of the language considerations of their employees. Failure to provide adequate training that employees understand could result in role confusion, a lack of understanding and adherence to safety precautions, and increased risk of injuries of all severities, including death[80, 81]. Necessary safety information, including exercise intervention documents, should be prepared in multiple languages to reduce the risks associated with miscommunication.

Specialists should also consider the language of intervention delivery as vital to its success. Intervention participants will be more likely to attend and adhere to some language training guidelines, as there is a concerted effort at clearly communicating expectations and procedures[12, 81, 83]. Available language resources, such as hired translation, should be part of the intervention development package that exercise specialists provide for SA workers.

1.4.3.2 Literacy

SA workers generally neither need nor have high education levels to perform their occupational tasks[81]. Currently available safety training materials may not account for the low literacy amongst SA workers[84]. The discrepancy between available safety materials for SA workers and their comprehension level can leave these workers more vulnerable to the health and safety risks associated with their employment[67].

Employers have a responsibility to provide safety materials that match employees' comprehension levels[85]. To prevent SA workers from misunderstanding the occupational risks they will face, employers should adapt risk training materials to match the low literacy levels of SA workers.

Language and literacy barriers may prevent SA workers from understanding occupational risks if they are verbally explained to them as part of training. Specialists designing exercise interventions for SA workers should not design an intervention that is more complex than can be handled by low literacy levels[67]. One possible solution is to use interactive theatre tailored to language and literacy needs as a method of health and safety training (which will be detailed in section 1.8)[84, 85].

1.4.3.3 Experience

Experience is often a key in reducing employee risk of MSDs. Inexperienced workers may fail to recognize the occupational hazards they might be exposed to[86]. For many young SA workers and for some migrant SA workers, this type of labour will be their first form of employment, leaving them inexperienced in understanding how to work safely and protect themselves while on the job[15]. Inexperienced workers should feel that they have the capability of addressing occupational concerns with their employers[6]. Without proper training and co-worker mentors, inexperienced workers could be at an increased risk of MSDs. Workers that have the opportunity to work with experienced mentors can be better prepared for the physical risks associated with tasks[87]. More experienced workers may have developed personal techniques to protect themselves from injury, including safe strategies for materials handling[88]. Experience may also increase knowledge for choosing the right type of equipment. Mentors could help as new workers begin to participate in exercise interventions. If the employees have a worker 'coach' for the intervention, specifically someone who believes in both the processes and the outcomes, then it becomes easier for co-workers to adopt a behavioural change into their working routines[67].

Employers should be able to provide opportunities for inexperienced workers to be mentored by veteran workers. The cycle of seasonal agricultural work creates an opportunity for employers to introduce mentors to less experienced workers prior to the demanding working season[89]. Training inexperienced workers in the pre-season has the potential to substantially reduce the risk of MSDs, as the workers will already have knowledge to recognize and reduce the risks before they are ever compromised in a risky situation.

Regardless of worker experience with occupational health and safety, an exercise specialist should develop interventions with the assumptions that participants will not be expert exercisers at the start of the intervention[65, 67]. This is not specifically a limitation for developing an intervention amongst SA workers, provided that the exercise training begins prior to the season. Pre-season training would allow specialists to develop an intervention that follows a progressive training model, where exercises start at a beginner level and advance to peak intensities that prepare SA workers for season-specific demands[90].

1.4.3.4 Employee-Employer Relations

Information for exercise interventions should flow both from employer to employee and from employee to employer, as health and safety is a joint responsibility of both parties[72]. Regular and open communication between workers and employers is an essential tool for avoiding work-related MSDs. Employee-employer relations need to provide opportunities for discussing and resolving health and safety concerns[81, 83].

Front-line workers, who are experiencing occupational risks first-hand, need to feel confident in informing their employer of occupational hazards[6]. This communication could be difficult for some SA workers, especially when human resource contractors are used[59]. As mentioned in section 1.4.1.4, human resource contractors may share labourers among various agricultural operations, making it difficult for SA workers to know which administration needs to be approached when occupational MSD risks are apparent[59]. Employers need to provide SA workers with the tools and resources to complete the exercise intervention[9, 68], including establishing clear lines of authority and communication on occupational health issues. Workers in turn need to provide employers with timely and constructive feedback on the physical and psychological effectiveness of the training. A two-way communication system would help optimize the effectiveness of exercise interventions (and health and safety programs in general) by meeting the needs of all involved.

1.4.3.5 Cultural Norms

Many SA workers come from a similar cultural background through geography, ethnicity, and religion[81, 91]. Cultural influence may affect norms and potential participation in exercise interventions[81]. Culture and beliefs amongst SA workers may also affect their opportunity and willingness to participate in an exercise intervention designed for health promotion at work.[81] It can also affect strategies for preventing and treating MSDs as cultural affiliations (including religious beliefs) may influence the type of acceptable healthcare.

Kirkhorn, et al., (2010) have indicated that SA workers generally report high levels of self-treatment for pain and comparatively low levels of discomfort[22]. That they are in discomfort, but self-treating it, may be an indication that these workers are being exposed to chronic loading causing MSDs, but are uninformed on symptoms or uncomfortable with seeking access to health care. Ethnographic research indicated that Latino agricultural labourers were culturally influenced to hide injuries from both employers and their families out of fear that they would lose patriarchal authority[92]. These Latino workers were discouraged from reporting pain or discomfort because it was perceived as a sign of weakness amongst the workers[80].

An increasing number of SA workers in southern Alberta, including young workers, come from families of the Mennonite faith who have recently immigrated from Mexico to rural communities in Canada[82, 91]. Their culture combined with their immigration are contributing factors to low literacy levels[82, 91]. Low German Mennonites are often only encouraged to achieve a grade 9 education, and working to support the family is often preferred to higher levels of education. Many female Mennonites will wear a traditional dress while working in the fields, although some families have chosen to adopt more modern western-style of clothing. While working in Canada, Mennonite SA workers work and learn primarily in English, which may be their third language, behind Low-German and Spanish. Mennonite SA workers are often hired in groups, creating a group cohesion not found in typical single-person hires. Cultural group hiring does allow people of similar backgrounds to have an immediate connection with each other. These cultural similarities could create an effective work team with a built-in social support system during the implementation phase of an exercise intervention.

1.4.4 Organizational Challenges

The structure of agricultural organizations that employ SA workers is the final key factor in developing and implementing an effective exercise intervention to reduce MSDs. Safety management is affected internally by an organization's safety culture, training, policy, and working hours[25, 68, 93]. External factors, such as governmental regulations within the agricultural industry, labour shortages, and the costs-benefits of interventions all influence organizational approaches to MSD risk management[78, 94, 95]. When the combined internal and external organizational factors are addressed, employers should have the resources necessary to provide an effective exercise intervention that eliminates barriers and could reduce MSDs amongst SA workers.

1.4.4.1 Safety Culture

Workplace safety culture represents the strong convictions and actions that influence safety attitudes[93]. It is generated through work attitudes, habits, and company practices[96]. Few agricultural organizations have attempted to institute a culture of work safety[81, 97]. Agricultural operations may have limited understanding of either the physical risks that they are placing their SA workers in or the physiological limits of their workers[26]. Without a safety culture, SA workers are in a precarious situation where there may be little chance of improving occupational health and safety conditions.

This lack of safety culture may stem from the agrarian myth, which is the continuing belief that agriculture remains one of the healthiest, most wholesome occupations that a person can do[98]. While the agrarian myth has deep seated traditions in North America, research suggests that agricultural occupations are actually at higher risk for both acute and chronic MSDs, in comparison with most other industries[16, 42, 99]. The agrarian myth may obscure the need for a safety culture in agriculture, both within the industry and with regard to legislation to protect agricultural workers. One of the challenges in the struggle against the agrarian myth is that many injuries and health-related problems are not reported, in large part because workers fear the consequences if they do report their symptoms[15, 16].

Research indicates that when employers show care for the well-being of their workers, employees show a reciprocal increase in safety citizenship behaviour[100]. Interestingly, work by Mearns and Reader (2008) found that supervisor support for health practices provided increased worker safety performance, and was also a stronger indicator of safety behaviours than co-worker support for health[100]. An exercise intervention could be a solution for agricultural employees to initiate a safety culture designed to reduce MSDs.

1.4.4.2 Training

Safety training needs to begin as a top-down process. Managers and supervisors have a primary role in eliminating unsafe working conditions and should be trained in occupational health and safety risk management[6]. Supervisors can be more effective in identifying, reducing and eliminating MSD risks when they are capable of recognizing the signs and symptoms associated with chronic musculoskeletal overloading[101]. Employers should seriously consider worker MSD complaints, as these issues may have serious long-term health effects. In a study of the construction industry, worker safety training resulted in a 42% reduction in compensation claims for participants 16-24 years old, compared with those who did not receive training[102]. Currently in agriculture, health and safety training is not common[16, 25]. Adequate worker training is necessary for the reduction of MSDs occurring in the SA workforce.

Specialists can be influential in developing training where it does not exist, as they can provide the education and intervention tools to initiate the process of reducing MSDs. The caution for specialists is to use current best practices on training development and implementation[67, 103]. As new exercise information becomes available it should be incorporated into the intervention to avoid training stagnation, which occurs when workers are no longer motivated by the intervention[100]. Specialists should help develop constructive feedback systems so that the intervention has long term benefits for SA workers.

1.4.4.3 Long working hours

Production crops have a specific seasonal timeline, along with production deadlines. These nature driven timelines necessitate long working hours (often <60 hours/week), especially during peak production[25]. Long working hours increase the risk of MSDs. Long hours also decrease the available time for any type of intervention. Workers and employers should work together to develop a schedule for an exercise intervention that can be completed within the constraints of seasonal timelines. Again, a pre-season model may be the most effective strategy for SA workers who should be physically conditioned to meet their working conditions prior to intensive crop production schedules.

1.4.4.4 Regulations

Just as the agrarian myth has influenced safety culture within agricultural operations, it has also suppressed risk identification and control issues in governmental agricultural safety policies[56]. Regulatory issues include the sweeping exclusion of agriculture from many North American workers compensation programs. Alberta, for example, currently has no health and safety protection for agricultural workers[55], largely due to lagging legislature that assumes that the majority of farms are small, family-run operations. Agricultural operations in the United States are not required to report injuries if the operation has fewer than 11 employees[22], which accounts for approximately 90% of all farming operations[16]. SA workers hired for labour intensive production may become victims of these out-of-date regulations.

Legislative agricultural policy has been slow to change in part due to the lack of injury statistics and compensation claims to support the need for change[55]. Where reporting has been available, agricultural workers have largely only been able to report acute injuries (i.e. broken limbs, hand-auger accidents, impalements, etc.)[16, 20, 21]. Acute injuries do not give a full assessment of the health concerns in agriculture. Chronic musculoskeletal loading, including muscle strains and low back pain, are often considered "part of the job" because they may be both frequent and slow developing amongst agricultural workers[15]. In addition, SA workers are often reluctant to report any chronic loading injury because of the workers' dependence on their employers for work and wages[19].

Migrant SA workers are also challenged with additional regulations. In Canada migrant SA workers hired through the Seasonal Agricultural Worker Program or the Low-Skilled Worker Program are limited in seeking additional employment while they are in Canada and they are required to return to their native country once their approved job is over[57]. While migrant workers in both Canada and the United States are permitted to access the health care system, their access may be limited because of employer control over health care cards for these workers[78]. Some of these workers may have been returning to the same employer and occupation for years, yet they have little or no chance to legally immigrate to Canada or understand their healthcare rights as a legally employed migrant[79].

Legislative policies need to change to address the chronic soft tissue injury issues agriculture faces. As these policies shift towards a more proactive system of injury prevention, agricultural employers are going to need government support in initiating and sustaining necessary operational changes[55]. Governmental support should provide SA employer and worker incentives for participation in opportunities that either reduce the risk of MSDs or increase the resistance against MSDs.

1.4.4.5 Labour Shortages

Crop production necessitates hiring numerous employees at once for short time periods, which can create a labour shortage[78]. This is especially problematic when there is such a short seasonal window of opportunity to harvest a crop. Labour shortages are a contributing factor for agricultural employers to use human resource contractors in filling SA worker requirements[59]. These labour shortages can become a barrier to training for two reasons. The first is that employers and contractors may spend too much of their time recruiting employees, instead of training those that they already have. The second barrier is that workers may be hired so close to the production season that they do not have time to physically or mentally prepare to perform their labour intensive tasks, potentially causing a significant increase the risk of MSDs[7].

A possible solution to SA labour shortages is to begin the hiring process sooner, and employ SA workers for longer time periods. An employer may not have sufficient work to hire SA workers at full time hours, but paying workers for pre-season training hours could reduce the overall health impact that labour shortages create while increasing the integration and interaction between workers, employers, and production.

1.4.4.6 Cost-Benefit Trade-Off

The single biggest constraint preventing an employer from implementing any type of intervention are the up-front and operating costs associated with it[67, 95]. While large agricultural companies have the financial capacity to experiment with interventions, most small agricultural operations function on a limited budget, subject to annual cycles of nature for income success or failure. Employers may choose not to invest in an exercise intervention because it is not perceived as an affordable option, even if there could be biopsychosocial benefits for their SA workers.

There are both direct and indirect benefits of an exercise intervention. Direct benefits may include decreased absenteeism, lower employee turnover, and optimized employee productivity[94]. Direct benefits are usually fairly easy to track, especially if records have been kept on employees prior to an intervention. For SA workers that are paid on piecework, for example, productivity could be analyzed to determine if there was an improvement in the number of pieces for intervention participants[19, 104]. Indirect benefits could include lower worker compensation claims, a happier SA workforce, and fewer employees working while suffering from a work-related MSD[102]. While indirect benefits are harder to identify, they should still be important motivators for implementing an exercise intervention.

Aldana (2001) conducted a review on the financial impact of workplace health promotion interventions and found that the return on investment was, on average, $3.48 for every dollar spent[95]. Properly designed interventions may have up-front costs, but long term return on investment should be the employers' main financial focus. Reducing exercise equipment needs would also keep intervention costs to a minimum.

1.5 Overcoming Daunting Factors

Stakeholder representatives from employer groups, worker groups, and specialists have several factors to consider when addressing the risk of chronic MSDs for SA workers. Some of these factors are complex and require a best practice approach to prevent these factors from limiting an intervention success. A participatory ergonomics approach could provide the ability for the three separate stakeholder groups to address these factors systematically. Stakeholders could work collectively to reduce risk of occupational MSDs where possible and increase SA workers' musculoskeletal capacity to enhance tolerance against MSDs where practical.

The following three case studies will illustrate how following current best practices of participatory ergonomics can be instrumental in developing and implementing successful exercise interventions. Case study #1 addressed lifting concerns in fruit packaging warehouses in Washington State[85]. The second case study involved a corporation which used group- and personal-goal setting to improve physical fitness[83]. Study #3 used best practices in an urban setting for a 12 week occupation-specific exercise intervention[9]. The breakdown for each case study consists of an overview and an analysis. The overview highlights what was done as an intervention. The analysis addresses how aspects of each case study could be tailored to meet the needs of SA workers, including underlining words or phrases that relate to the ergonomic controls previously discussed.

1.6 Case study # 1 - Dora Evelia (Holmes, Pui-Yan, Elkind, Pitts, 2008)

1.6.1 Overview

Holmes et al. (2008) used a multidimensional, educational approach to address biomechanical lifting issues amongst fruit warehouse workers in Washington State[85]. The project included injury prevention and general safety education, body mechanics education, and an incentive to execute safe occupational kinematics on the job. The training program included a previously tested video entitled *Dora Evelia,* a theatre fotonovela presented in Spanish with English subtitles (approximately 95% of workers were predominantly Spanish speaking), followed by a live demonstration and practice of proper lifting techniques[84]. Each participant was also given supplemental lifting mechanics pamphlets for personal review.

The 178 participants from 3 different employers were evaluated pre-intervention and two weeks post-intervention on lifting behaviours (based on observations from the research team), and a knowledge test, which consisted of each participant answering a series of questions. Results indicated that lifting behaviours significantly improved on 7 of 10 measures, and knowledge significantly improved for the prevention of back and shoulder injuries, as well as for safe methods of standing for long periods. These results suggest that practice focused on movement mechanics specific to job applications could be a critical contributor to achieving and retaining safe lifting techniques. It was concluded that workers given appropriate demonstration and training, reinforced with take home materials, would maintain safe bending and lifting behaviours. This, in turn, can potentially reduce work-related lifting injuries. This study did not include a longitudinal follow-up, tracking whether or not there had actually been a reduction in lifting injuries.

1.6.2 Analysis

The worker group in this study had a major influence on the method of delivery for this intervention. Shaped by specialist observations of a sample worker group, the intervention addressed the need for the bulk of the material to be presented in a *language* (Spanish) with a *cultural* familiarity to it. While designing the intervention, specialists learned from previous research conducted amongst this population[84] that this group had a cultural affinity for fotonovela style theatre (a form of Latino "soap opera"). Although this study did not differentiate training success by gender, this Latino tradition of conveying important messages through low-literacy dramatization has been especially successful amongst predominantly *female* audiences[105]. It is noteworthy that females made up 71% of the participant population in this case study. This case study shows the importance of developing an intervention that operates through the culture of the workers. Interventions designed for SA workers could use this culture-driven approach to address the musculoskeletal concerns of working groups. Mennonite SA workers, for example, might have a higher intervention response rate from a Low-German theatre-style presentation or physical demonstrations than from a video presentation, as many traditional Mennonites are less familiar with modern media[82].

The workers in the *Dora Evelia* case study were responsive to the intervention, demonstrating safer work behaviour post-intervention. One limitation amongst the worker group was their unwillingness to practice the lifting techniques in the group training sessions, although the researchers determined in a separate portion of this study that practice was not a determining factor for correctly performing the prescribed lifts. SA workers may also be unwilling to practice exercises in a group setting. Given that exercise training may involve multiple techniques, successfully training SA workers may require initial exercise familiarization sessions to have a 1-on-1 approach, where each SA worker is given the opportunity to have a coach direct the exercise training.

Employer groups in this study were willing to use their own facilities to host the intervention, providing direct access to the *equipment* used in the intervention. Participation at each facility was considered *training*, and as such the employers provided the time necessary to minimize participant dropout. The rurality of SA workers may require that an exercise intervention be centrally located at employer facilities, such as a bunkhouse for migrant workers, or a meeting station for other SA workers. This would provide the best possible access to equipment for the employees. SA employers could be providing this equipment and establish an exercise training schedule that becomes a feasible proportion of the working day.

The interventions in this case study were conducted during peak production *seasons*, causing production loss during the 90 minute training sessions. Since there was a measurable improvement in lifting behaviour from pre- to post-intervention, however, the researchers assumed a *cost-benefit* for the employers by saving compensation claims (at least in the short term). A worker survey indicated that 56.3% had not been previously exposed by their employer to specific safety training, suggesting that this was a first attempt by some employers to initiate a *safety culture* at work.

The case study specialists were sensitive to both the worker needs, such as the *language* and method of delivery, and the employer constraints, such as the *season*-specific demands during the development and implementation of the intervention. The fotonovela was selected based upon feedback from *culturally* similar workers from a separate research study that primarily targeted female Spanish speaking agricultural workers[84]. The specialists delivered a short-term intervention with successful short-term results. Specialists should be comfortable adapting already available materials for SA workers, as was done in this study. When designing an exercise intervention for SA workers, specialists do not necessarily need to invent new exercises or training techniques. If specialists use a participatory ergonomics approach to identify risk of work-related MSDs amongst SA workers, the designed exercise intervention could be adapted from existing strength conditioning protocols to match the specific job requirements. These adaptations could include exercise interventions designed for beginners, group fitness training models, or include methods of athletic pre-season training, to build up SA worker musculoskeletal strength prior to peak production periods.

This case study provided a short term intervention effect within two weeks, but there was no examination of the longitudinal effects of the intervention. A similar study on biomechanical lifting training by McCannon et al (2005) showed that a well-designed two hour intervention can positively influence participants lifting behaviours even one year post-intervention[88]. This finding is encouraging for exercise intervention, as the required time for specialists to teach proper exercise techniques to SA workers can be minimized as long as the time is used efficiently. Unfortunately, a one-day training session is not enough to improve the musculoskeletal system sufficiently to increase its tolerance against MSDs[7], indicating that the choice to implement an exercise intervention should work into the safety culture of the workplace.

1.7 Case Study # 2 - Move to Improve (Dishman, DeJoy, Wilson, Vandenberg, 2009)

1.7.1 Overview

Assisted by Dishman et al. (2009), The Home Depot supported a large intervention initiative[83]. The intervention, titled "Move to Improve," involved 16 worksites that were randomized to receive the intervention (total workers = 664) or be part of the control group (total workers = 301). The volunteer participants represented an ethnically diverse background that was predominantly female (69%). The intervention was comprised of personal and team goal setting, leading to realistic and achievable graduated increases of physical activity involvement.

The intervention group was supplied with pedometers to track their step counts, and a participant handbook detailing the components, anticipated benefits, incentives, and duration of the goal setting walking intervention. In 12 weeks, the intervention group improved recorded steps per day by nearly 2000. The group significantly increased both moderate and vigorous physical activity when compared with the control group, and it raised the percentage of participants meeting the recommendations for moderate to vigorous physical activity by 20%.

1.7.2 Analysis

A major component in the success of this intervention was the overall *organizational* structure involved in both its design and implementation phases. During the early design stages of the intervention, joint *employee-management* steering committees were established at each site, and then maintained throughout the intervention to consult with specialists and coordinate the program. The steering committees were selected as a fair expression of the diversity of the selected sites, and included management, site-specific employee champions, males and females, less experienced workers, and multi-ethnic representation. These steering committees established group and organizational goals and incentives specific to each intervention site two months prior to the start of the implementation phase. The long-term steering committee was instrumental in developing a location-specific *safety culture*.

This case study included a two month installation phase as a component of intervention implementation. During the installation phase, management was encouraged to support employee participation. Each site was provided with *environmental* prompts that encouraged physical activity and illustrated associated health benefits. These prompts were posted throughout the worksite, especially in locations employees frequented, such as the staff rooms. These environmental prompts included promotional *resources* designed by the steering-committee and tailored to meet *gender*- and *culture*-specific needs at appropriate worker *literacy* levels.

Few individuals participating in the case study intervention initially met guidelines for recommended physical activity (24% in the control group; 31% in the intervention group). Targeting workers' physical activity inexperience became an important component in setting goals for improvement. The program was successful because it used a logical, stepwise progression to increase participants' daily step count by over 2000 steps per day over the 12 week duration. This progression might not have been as successful if it had immediately directed people to improve their average daily step count by 3000 steps per day. Pre-season training for SA workers should use a similar build-up approach, starting with basic exercise training and developing into the high intensity levels needed to increase tolerance against MSDs during peak production seasons.

Specialists took great care in this case study to direct the overall intervention according to best practices, to maximise the opportunities for program success. The specialists provided both orientation and *training* for the steering groups at each intervention location. Faulty *equipment*, primarily pedometers, was replaced within 24-36 hours after they failed (fewer than 5% failed overall).

Although the researchers did not specifically mention the costs associated with the program, it is assumed that the overall *investment* was small, as equipment was minimal and structural changes were not required for implementation. Minimalist solutions are appealing for reducing costs, but may not always be the best approach when the goal of the program is to improve whole-body tolerance against MSDs, as it can become difficult to develop an intervention that is both minimalist and whole-body effective. A minimalist solution would require a specialist capable of maximizing equipment cost solutions.

1.8 Case study # 3 - Prevention First (Brand, Schlicht, Grossman, Duhnsen, 2006)

1.8.1 Overview

Brand et al. (2006) developed an exercise intervention aimed at both blue and white collar workers in an initiative titled Prevention First[9]. It was developed as a best practice "exercise only" health promotion offer for employees with exercise to be done during their leisure time[9]. One of the central goals of the intervention was to influence well-being beyond the borders of the worksite. The three involved businesses promoted the intervention through their medical staff. They also covered the expenses of the 13 week intervention, which was located in an off-site medical facility. Participants were randomly selected for either the intervention group (total workers = 88) or the control group (total workers = 89).

The intervention group participated in a 13-week, 26-session exercise intervention that was guided by a fitness coach and conducted in small group settings (6-8 persons per group), while the control group was wait-listed for the program. Both groups completed quality of life measurements and physical fitness measurements at baseline (T1) and post-intervention (T2), with the intervention group completing a third assessment three months post-intervention (T3). There was a significant medium to large intervention effect for the intervention group between T1 and T2, which did not persist at T3 but only for those who stopped exercising. There was also a large intervention effect in the increase of vertebral muscular strength for both flexor and extensor muscles, which significantly changed from T1 to T2 but not from T2 to T3. Less than one third of the intervention group continued exercising post intervention if they were not already previous exercisers, suggesting the program had diminishing returns.

1.8.2 Analysis

The Prevention First initiative provided two key *resources* that the previous two case studies did not have. The first was the use of internal medical staff to develop, promote, and supervise the exercise intervention. The second resource this study used was full *access to equipment* at an off-site exercise facility. The equipment access came through a partnership with the employers, who paid for the use of the exercise facilities during the intervention, and with the workers, who incurred their own travel costs and sacrificed leisure time to access the exercise equipment.

The exercise sessions for this intervention were guided by a *trained* fitness coach. Training the specialists enabled the guided exercise sessions to be tailored to the intervention group's level of *experience*. As with the previous two studies, initial participant experience with organized exercise was well below 50%.

There were specifically tracked *cost-benefits* for participants in this case study. Participants reported feeling healthier post-intervention and these feelings positively impacted work-related behaviours, including meeting occupational productivity goals. The exercise intervention took place in 6-8 person groups, which helped develop a worker support system for participation as part of the workplace *safety culture*. As the intervention group was tracked post-intervention, the researchers were able to determine that the psychological benefits of Prevention First were specific to the time that participants were involved in the intervention.

1.9 Case Study Implications for SA Work

Each of these case studies suggests that a well-developed intervention can provide positive workplace changes. Exercise interventions can be developed for SA workers by applying best practices from these and similar case studies. These case studies illustrate the importance of using a participatory ergonomics approach, involving all necessary stakeholders throughout the intervention[106]. As discussed previously, the lack of safety culture is common in the agricultural industry[81, 97], and should be addressed in developing interventions for SA workers. Employers of SA workers should realize that their intervention input can help develop a safety culture that complements training for seasonal production demands[93], and SA workers should be able to meet or exceed employer productivity demands after increasing their tolerance against work-related MSDs.

A long-term steering group for SA workers, consisting of a combination of employers, migrant workers, and young workers, could be formed at the end of the working season to begin addressing MSD issues throughout the off-season, in preparation for the following season. Specialists could use the information from the joint steering group to develop an intervention that can be initiated a few months prior to season start. Intervention implementation could include specialists training the steering group (including migrant worker representatives via internet conference) to direct regional pre-season exercises. The steering group directing a program for SA workers would need to be able to access and provide service to multiple rural locations to ensure that both program design and equipment could be maximally effective.

Organizational-level endorsement would be useful in developing an exercise intervention for SA workers as it would help initiate the importance of having a healthy lifestyle for work. Promotional exercise intervention participation materials for SA workers may need to be issued via mail, posted in human resource firm hiring centers, or other locations that SA workers frequent in the off-season. In-season promotional materials should be in locations where field crews gather often, such as a company transportation vehicle, migrant worker bunkhouses, and the human resource offices. Although slightly more complicated than a single-site intervention, a well-organized SA steering group could provide the necessary support to maximize intervention success.

A successful exercise intervention for SA workers would require proactive collaboration between workers, employers, and specialists for the most appropriate health resources and exercise equipment solutions. While it may not be a reality for SA employers to have full-time health and wellness staff, including trained health and wellness supervisors as part of the specialist consultant team, it would help to ensure exercises are designed to minimize risk of injury. Physiotherapists in out-patient clinics, for example, often prescribe exercises for their patients to perform unsupervised because of the therapists confidence in the prescription[107].

Deciding on the best solutions for access to exercise equipment in a rural setting would depend on the equipment already available, and the cost intervention organisers and participants are willing to incur to have greater access. Given SA workers low wages, education levels, migration, and rural location, it is reasonable to assume that these workers would have little experience with any exercise intervention. An exercise intervention needs to target SA workers with the goal for workers to benefit from participation by increasing the tolerance against MSDs.

SA workers could also benefit from an exercise intervention physically, socially, and psychologically, which together could contribute to worker productivity. Providing opportunities where possible for SA workers to exercise as a group, especially during pre-season training, could help create a cohesive field unit as well as creating a support system for the intervention. Using exercise to improve SA workers' quality of life could be a major contributing factor to these workers returning to the same occupation year after year, providing SA employers with an experienced, reliable, and happy workforce.

1.10 Conclusion

SA workers may be more susceptible to chronic occupational MSDs than workers in other industries. Lifting and carrying heavy loads, sustained or repeated full body bending or stooping, highly repetitive hand work such as hoeing, clipping, picking, prolonged periods of severe neck flexion or extension as it relates to hand harvesting of ground plants or weed pulling, and the long hours associated with farm labour, each contribute to high industry-wide risk of MSDs. These unique MSD risks may become more manageable as tailored interventions become available to SA workers. Pertinent stakeholders, specifically employer representatives, workers representatives, and industrial health specialists, need to coordinate the best practicable solutions for reducing MSD risks amongst SA workers. Where risks cannot be reduced, musculoskeletal tissue tolerance for labour intensive loading needs to be increased. Preventing work-related MSDs amongst SA workers is an urgent issue in agriculture, despite the current lack of resolve to change within the industry. Preventing MSDs in agriculture could be accomplished through occupation-specific exercise interventions. Protecting SA workers from experiencing occupational MSDs through exercise interventions could also improve psychological and social conditions of the workplace. An exercise intervention, designed along current best practices in participatory ergonomics and principles of athletic training, could provide a viable solution for increasing SA workers tolerance against occupational MSDs.

1.11 Thesis Outline

The following three chapters of this thesis demonstrate the potential application of participatory ergonomics in the agricultural industry, with a particular focus on SA workers employed in canola production. The three chapters focus on three current alternative models for applied ergonomics, specifically reactive, proactive, and prospective ergonomics. This section provides an orientation to these ergonomic strategies as outlined in Figure 1.1.

Reactive ergonomics is the classical approach to addressing musculoskeletal disorders in the workplace [101]. The reactive approach establishes a specific occupational task as the most probable cause of reported musculoskeletal injury and discomfort amongst the workforce, and that evidence justifies ergonomic investigation and correction[108]. Given this chronology, reactive ergonomics typically involves empirical assessment of MSD risk for the task(s) in question. Results of those assessments ideally shape subsequent risk controls[108]. Chapter 2 uses a reactive ergonomic approach, combining qualitative evidence of MSDs from a worker focus group with empirical measures from field and experimental task assessments to define physical demands. Modelling workplace tasks and identifying physical demands can help organizations more accurately prioritize ergonomic actions, based on quantitative evidence of potential musculoskeletal tissue loading and soft tissue injury risk associated with tasks and jobs.

Proactive ergonomics involves implementing interventions designed to promote biopsychosocial health through improving working conditions[101]. A primary goal of proactive ergonomics is to prevent injury and help employees remain healthy, satisfied, and productive[95]. Unlike reactive ergonomics, proactive ergonomics targets healthy workers directly. Reactive ergonomics can be helpful, even protective, for healthy workers, but they may not feel connected, or even enabled by a reactive intervention. The financial value of the proactive approach may be measured through decreased employee-related health care costs and absenteeism, plus increased worker satisfaction and return[95]. Chapter 3 details the development and validation of a targeted exercise intervention, designed to improve the health of SA workers by increasing musculoskeletal tissue tolerance during the pre-season.

The goal of prospective ergonomics is to anticipate industry needs and provide reasonable and saleable solutions for preventing MSDs[108, 109]. This approach would include the development and proposal of innovative intervention approaches for reducing potential workplace MSDs[110]. The final chapter of this thesis provides a framework for a steering group to implement a targeted exercise intervention on an industry-wide scale amongst SA workers hired to work in the canola industry. This proposed intervention also serves as summary for the experimental chapters of the thesis, allowing for an exploration of the strengths, challenges, and proposed best practices for ergonomic interventions amongst SA workers.

The objective for following three chapters is to collectively demonstrate that work-related MSD issues in agriculture can be addressed using current best practices in ergonomics. The agricultural industry is largely untouched by ergonomics, and the fundamental purpose of this thesis is to demonstrate that this exclusion is unfounded. Ergonomic initiatives can and should exist, especially for SA workers, who are at the greatest risk in agriculture of suffering from a work-related MSD. These chapters establish that SA workers can be protected by identifying the tasks that could cause MSDs, developing and validating a practical exercise intervention as a solution for increasing musculoskeletal tissue tolerance, and providing a potential industry-wide solution for ergonomic intervention adoption.

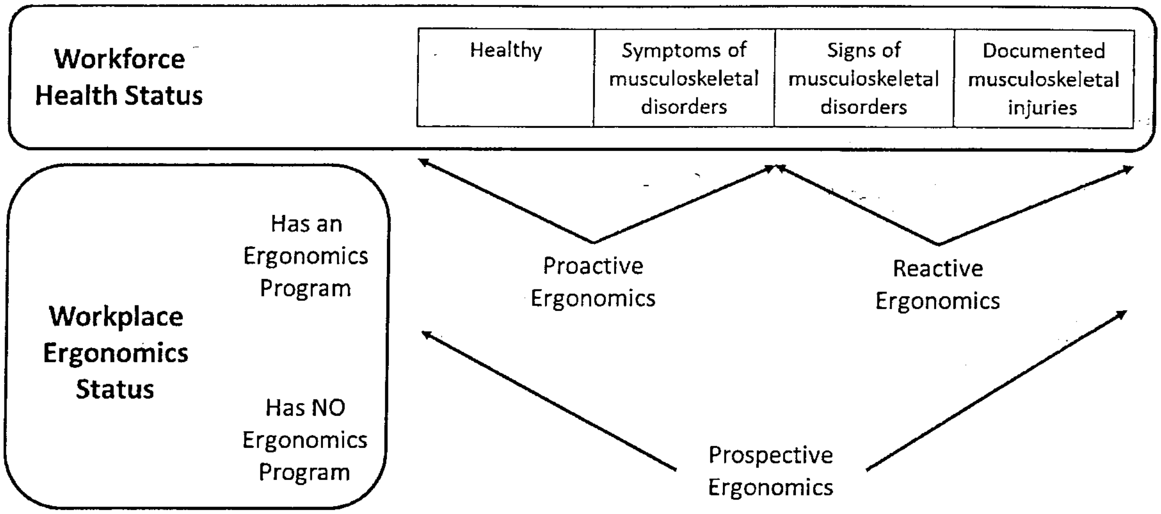


Figure 1.1. Scope of ergonomic practice with regard to the workforce and the workplace. Potential opportunities to deliver reactive, proactive, and prospective ergonomics to the workforce, based upon the workforce health status and the workplace ergonomics status. Arrows indicate the scope of practice for each alternative model of ergonomics. Boxes represent worker's physical condition.

Chapter 2 - The biomechanics of intermittent weed pulling are modified by contextual priming

2.1 Introduction

Physically demanding tasks in agriculture need ergonomic solutions to reduce the continued prevalence of MSDs amongst agricultural workers[17]. Research has indicated that there is considerable variation of biomechanical stressors on agricultural workers when considering various crop types[23, 35, 111]. Seasonal agricultural (SA) workers often labour in several different crop types and across a variety of intermittent physically demanding tasks during their cumulative yearly employment. Intermittent physically demanding tasks may be a contributing factor to the high prevalence of musculoskeletal disorders (MSDs) in agriculture. Workers that use whole body range of motion to perform intermittent tasks may have greater protection from MSDs, as tissue forces can be distrubuted throughout more of the body[112]. Ergonomic researchers often use a controlled laboratory setting to analyze physically demanding tasks and occupational behaviours, to quantify biomechanical stressors and potential risks for MSDs[112]. Laboratory modelling and analysis may be particularly useful in studies of agricultural work, given field analysis limitations due to work area size, rural location, and crop density.

A challenge associated with analyzing intermittent field tasks performed in a laboratory setting (such as the physically demanding duties of SA workers) is modelling the relevant and cumulative work components that may contribute to the risk of injury. An example of an agricultural task that could contribute to MSDs experienced by SA workers is manual weed removal. In commercial hybrid canola production, for example, manual weed removal requires SA workers to intermittently stoop and grasp weeds during extended periods (2+ hours) of field walking. While stooped work is a major contributing factor to low back MSDs, and a prevalent ergonomic hazard throughout the agricultural industry[22, 113], extended periods of standing or walking during work have the potential to moderate task-specific behaviour and soft tissue loading by altering range of motion in the lower extremities[114]. Research has established that worker technique changes in reaction to workplace design[115], yet previous hand harvesting and weed removal research has not identified how worker motion strategies and soft tissue loading may differ when immediate previous prolonged walking is considered as part of the task model[111, 116]. The interplay of work activities (and demands) of extended field walking and intermittent stooping to grasp weeds may modify the occupational behaviours and biomechanical stressors SA workers experience during manual weed removal in hybrid canola, leading to a commodity-specific risk of MSDs. Ergonomic interventions intended to limit the risk of potential MSDs induced by stoop and grasp tasks could become more specific if laboratory analysis is used to provide a more accurate determination of the associated musculoskeletal factors, including worker range of motion strategies.

The purpose of the present study was to examine whether the relevant weeding task precursor, specifically prolonged walking, would alter the biomechanics of weed pulling behaviour in a laboratory setting. The theory is that combining relevant tasks in an experimental task model can improve the understanding of work behaviours, and causes of work-related MSDs. Researchers hypothesized that participants would use a greater range of motion at the knees and the ankles for stooping to grasp a weed if the precursor prolonged walking task was included in the task model.

2.2 Methods

2.2.1 Preliminary Assessment

A preliminary field assessment was completed amongst SA workers experienced in manual weed removal in canola[117]. Main findings from the preliminary field assessment indicated that SA workers hired for the task of manual weed removal walked 16.8 km/day (+/- 2.4 km/day) and removed over 1000 weeds per shift with an average force of 117 N (+/- 60 N)[117]. These findings were used to simulate a weed removal task in a laboratory setting. Average force required for weed removal and average weed heights were used to prepare the simulated weed (Figure 2.1, 11.9 kg with a height of 0.5 m)[117].

2.2.2 Laboratory Analysis

Two experimental conditions were used in the laboratory for simulation of manual weed removal in a field setting. In the primed condition (P), participants walked 1600 m on indoor concrete at a self-selected pace prior to manually removing the simulated weed in 6 trials, simulating the interplay of physical demands (10% of an average field day of prolonged walking combined with intermittent weed pulling) that make-up the field task of manual weed removal. The not primed condition (NP) consisted of participants manually removing a simulated weed in a laboratory setting over 6 trials without the precursor prolonged walking. The P and NP conditions were compared to determine whether the ecologically valid precursor of prolonged walking prior to stooping to grasp affected the biomechanics of the stoop to grasp task.

2.2.3 Participants

The study had previously been approved by the Human Subject Research Ethics committee at the University of Lethbridge, in concordance with the Declaration of Helsinki. Participants were randomly assigned to either the P or NP condition and were given an informed consent and advised of the condition they would complete. Twenty-seven university students (16 female, mean age 21.3 years) completed the P trials and fourteen university students (7 female, mean age 21.6 years) completed the NP trials. Participants were not expected to have prior SA field working experience.

2.2.4 Protocol

Segment end point optical markers were placed on each participant prior to completing the manual weed removal task. Fourteen optical markers were placed on the participant, including: forehead (1), sternal notch (1), anterior aspect of the left and right pelvis (2), left and right wrist (2), left and right knee (2), left and right ankles (2), and left and right toes of shoes (2), as well as on the simulated weed (2). The manual weed removal task consisted of participants walking 3 m towards a simulated weed before pulling the weed and placing it on a platform immediately in front of the weed. The platform had a height of .1 m to simulate a minimum required vertical displacement for weed removal. Participants were informed that the simulated weed represented the average vertical force requirement for the weed removal task in canola crops, and they were instructed to remove the simulated weed as if they were working in a field. Participants were permitted to use either hand for manual weed removal and use any approach strategy for each of the six trials. At the end of each trial, researchers reset both the simulated weed and the participant to their starting positions.

2.2.5 Measurements

Participant postures were captured in 3 dimensions during the manual weed removal task using segment end point optical markers and calibrated motion capture (Peak Motus, Vicon Peak, Oxford UK, and Optotrak CERTUS, Northern Digital, Waterloo ON). Information gaps from optical markers were interpolated post hoc using Matlab. Minimum angular displacements for the hip, knee, and ankle were calculated for each participant over all trials. Participant angular displacement averages were calculated and grouped according to the NP or P condition. The hip angle at weed removal onset was calculated using segment end point optical markers from the sternum, hip, and knee of the leg closest to the simulated weed at the time of grasp onset. Knee angle was calculated using segment end point markers from the hip, knee, and ankle of the closest leg at weed removal onset. Ankle angle was calculated with segment end point markers from the knee, ankle, and toe of the closest leg at weed removal onset. Toe-weed proximity was calculated using the distance from the weed to the closest toe at weed grasp onset. Grasp onset was determined as the instant the weed began moving vertically away from the ground.

2.2.6 Statistical Analysis

After data cleaning for missing markers, twenty-three participants (13 female, mean age 22.1 years) data from P trials and eleven participants (4 female, mean age 21.6 years) data from NP trials remained for analysis. Statistical analysis of postural differences at weed grasp onset was conducted using SPSS version 19 with a statistical significance of $p < .05$. An independent groups t-test was used to determine the statistical differences between lower extremity angles of the hip, knee, and ankle of the leg closest to the simulated weed, as well as toe-weed proximity at grasp onset by comparing trial averages from P and NP participants.

2.3 Results

Comparison of P and NP participant trials using an independent groups t-test indicated a significant difference in angular displacement at the ankle ($t\ (32) = 5.08$, $p < .001$), indicating that P participant ankle angles (mean = 54.23°, SD = 18.27) were smaller than NP participant ankle angles (mean = 86.95°, SD = 15.93) at weed grasp onset. There was also a significant difference between P and NP participants for toe-weed proximity ($t\ (32) = 2.78$, $p = .008$), with than P participants using a greater toe-simulated weed distance (mean = .19 m, SD = .09) than NP participants (mean = .11 m, SD = .08) at weed grasp onset. There were no significant differences between P and NP for angular displacement of the hip or the knee. Figure 2.2 shows the lower extremity postural differences of NP and P participants at weed grasp onset.

2.4 Discussion

The purpose of this study was to examine whether prolonged walking as an ecologically-valid behavioural primer would change the biomechanics of weed pulling in a laboratory setting. Results indicated that the walking primer changed the biomechanics in at least two measured ways, the first being the magnitude of angular displacement at the ankle joint and the second being the toe-weed proximity at grasp onset. The hypothesis that participants would use greater range of motion in the lower extremities was confirmed for the ankle but not for flexion of the knees or the hips. Toe-target proximity differences between trial conditions are consistent with object lifting research conducted by Wickel and Reiser[118]. Increased ankle flexion suggests that the potential loading of the lower back in the P condition is less likely to cause an MSD than in the NP condition because more of the load is transferred through the lower extremities, thus reducing overall stress on the lower back.

The findings from the laboratory setting have two important applied implications for SA workers and their employers. The first implication is that manual weed removal, specifically for hybrid canola crops, does have a risk of stressing the lower back, which potentially could cause MSDs. This assertion is based both on the observed frequency of intermittent weed removal in the fields[117] and the observed minimum average hip angles in the laboratory of the NP and P conditions that indicate compressive force on the lumbar spine. The P participants are at a biomechanical advantage over the NP participants because the increased range of motion transfers the load throughout more of the body, lessening the overall load for the lower back[112]. An exercise intervention that targets the muscles of the lower back may be an effective pre-season training tool to increase SA worker musculoskeletal capacity to perform this physical task.

The second implication is that an in-field dynamic warm-up could be a useful daily component of SA field work, based on the finding that prolonged walking in the P condition modified grasp posture to a safer position. Warming-up at work to prevent MSDs is consistent with sports medicine research, where it has been found that activity-specific warm-ups can increase body temperature and prepare muscles for subsequent performance[119, 120].

This study has important implications for ergonomic researchers that use a laboratory setting to analyze occupational tasks. While it is often easier to analyze a task in the control of a laboratory setting, such analysis needs to include as much relevant context as practicable. The inclusion of prolonged pre-pull walking in this study was determined to influence the biomechanics of the task. Adequately re-creating the working tasks in a laboratory can enable researchers to more accurately examine work demand, and more effectively develop viable interventions[121].

2.5 Limitations

There were specific limitations with this study. The motion capture system used relied on six fixed position cameras to provide relative information on positioning of segment end point optical markers. Although the camera positions adequately collected data from the volume, the stoop to grasp task occasionally masked segment end point optical markers. This resulted in post data collection processing to interpolate some of the data gaps, which may have caused errors in data analysis. Gap interpolation was done with reasonable accuracy using current best practices in smoothing data, but some trials had to be excluded in the data analysis due to large data gaps. Further attempts to optimize camera positions and/or positioning of segment endpoint markers, or the inclusion of additional cameras into the experimental design, should reduce the quantity of gap interpolation.

2.6 Conclusion

The biomechanics of manual weed removal is affected by the inclusion of precursor walking, increasing participant range of motion for weed grasp onset and reducing the likelihood of experiencing a work-related MSD. Agricultural employers should encourage SA workers to perform appropriate warm-ups before physically demanding tasks are executed, as this may reduce the risk of MSDs by increasing the range of motion. Researchers that use a laboratory setting to analyze physically demanding occupational tasks need to sufficiently simulate physical demands workers experience.

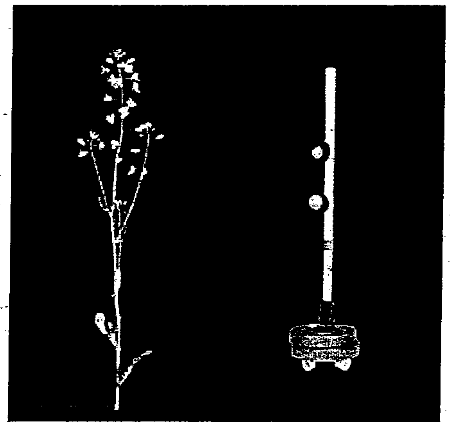
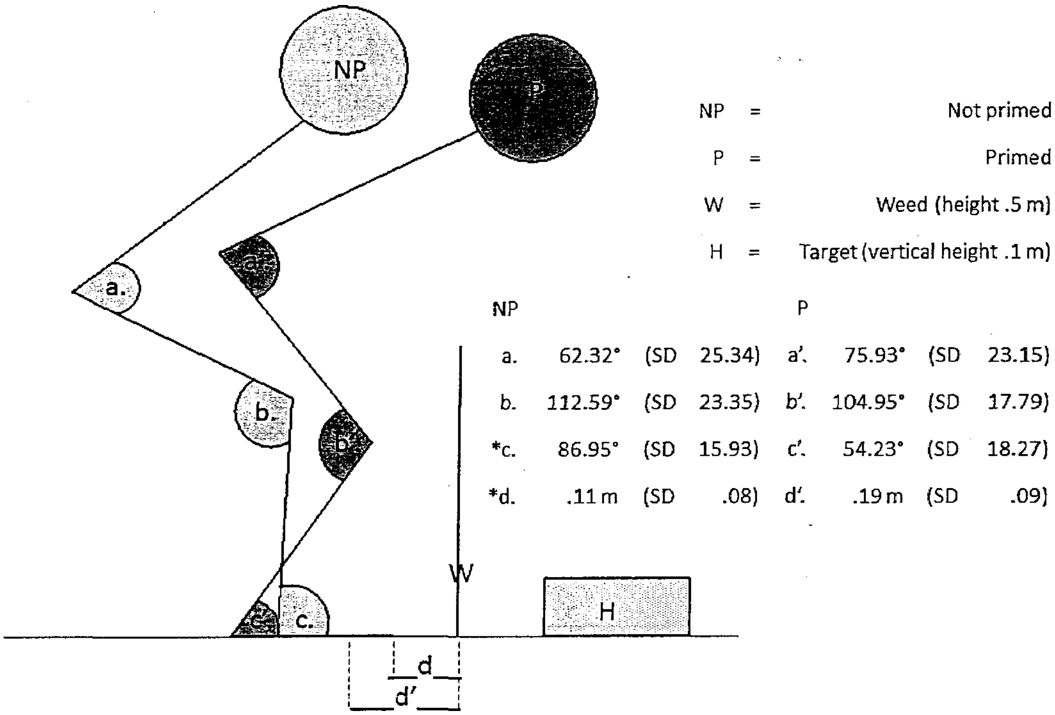


Figure 2.1. Canola weed (left) and simulated laboratory weed (right).
Force to remove average canola weed from the ground is 117 N (+/-60 N). Simulated weed weighs 11.9 kg to recreate ground removal force of 117 N (+/-60 N) of canola weed.



NP			P		
a.	62.32°	(SD 25.34)	a'.	75.93°	(SD 23.15)
b.	112.59°	(SD 23.35)	b'.	104.95°	(SD 17.79)
*c.	86.95°	(SD 15.93)	c'.	54.23°	(SD 18.27)
*d.	.11 m	(SD .08)	d'.	.19 m	(SD .09)

Figure 2.2. Comparison of lower extremity angles for NP and P participants at weed grasp onset.

Body segment diagrams based on anthropometrical average segment lengths. Measured angles represented are hip (a, a'), knee (b, b'), and ankle (c, c'), and toe-target distance (d, d'). Significant differences ($p < .05$) indicated by * on rows.

Chapter 3 - Increasing seasonal agricultural worker musculoskeletal tissue tolerance through a tailored preseason exercise intervention

3.1 Introduction

Physically demanding occupations that consistently load musculoskeletal tissue and decrease tissue tolerances have the potential to generate chronic work-related musculoskeletal disorders (MSDs). When chronic MSDs exist in the workplace, organizations can address the issue by either changing the task through engineering controls and/or administrative practices[22] or improving the musculoskeletal tissue tolerance of affected workers[122]. Workplace exercise interventions may be a feasible solution for increasing musculoskeletal tissue tolerances, thereby expanding the margin of safety between applied load and maximum permissible load to reduce the risk of MSDs[12, 13]. Along with potentially reducing the risk of chronic work-related MSDs, researchers continually demonstrate that exercise aids in the prevention of chronic diseases such as cardiovascular disease, diabetes mellitus, obesity, hypertension, osteoarthritis, and depression[9, 10]. Exercise interventions may also positively influence quality of life (QoL), as new exercisers report QoL improvements during the initial months of an exercise intervention[9]. Businesses that implement exercise interventions have reported lower absenteeism, increased productivity, reduced compensation claims, and decreased health care costs[8, 11].

The agricultural industry has been slow to recognize and adopt best practices for protecting workers from work-related MSDs, including exercise interventions[16]. Commercial agricultural operations regularly employ seasonal agricultural (SA) workers during labour-intensive months of production to meet crop-specific demands[15]. SA workers are subject to short periods of acclimatization, followed by long, physically intense workdays[16, 31] under employment contracts that may last for a few weeks or extend to several months of the year[16].

These employment parameters are similar to those of a professional athlete – both SA workers and athletes have physically demanding seasons separated by lower-intensity off-seasons. Unlike SA workers, however, athletes often prepare for their seasonal physical demands through pre-season exercise training, helping to acclimatize tissue tolerances to the cumulative musculoskeletal loads demanded by their profession[7].

Pre-season exercise training may have useful application for increasing musculoskeletal tissue tolerance amongst SA workers, provided that the intervention addresses resource and personal barriers to participation. The rural environment limits structured exercise activity, as physical resources such as exercise facilities and trainers are often unavailable[64]. Minimizing the need for exercising with fitness equipment might be a practical and low-cost solution for improving SA worker musculoskeletal tissue capacity[66]. Exercise interventions for SA workers need to function within the unique social characteristics of the workforce, which includes young inexperienced workers[16], migratory workers hired on temporary work visas[52], language and literacy issues associated with migration[15, 81], gender differences and inequalities[16], cultural norms including religious beliefs and family support[15, 82, 123], and previous exercise experience[124]. The barriers inherent to the SA workforce make it difficult to know if a workplace exercise intervention is a feasible solution for protecting SA workers from work-related MSDs.

The purpose of this study was to establish the effectiveness of an exercise intervention designed to increase musculoskeletal performance and work-related soft tissue injury capacity amongst SA workers. The intervention was modelled after pre-season athletic training and designed for completion by SA workers in a rural environment. Intervention effectiveness was measured objectively using indicators of physical fitness and subjectively by measuring quality of life (QoL), a measure that has been related to worker wellness[9]. It was hypothesized that a pre-season exercise intervention designed for SA workers would provide the benefit of improved musculoskeletal tissue capacity, potentially to reducing the likelihood of SA workers suffering from work-related MSDs while improving workplace wellness. An additional benefit of preseason exercise training may be to develop workplace wellness by improving participant QoL[9]. Empirical evidence of the physical and QoL benefits could help validate exercise interventions as a best practice in the agricultural workplace, making this one viable solution for increasing worker musculoskeletal tissue tolerance and preparing SA workers for seasonal occupational demands.

3.2 Methods

3.2.1 Participants

Fifty-three participants were recruited to participate in a progressive exercise intervention. The study was approved by the Human Subject Research Ethics committee at the University of Lethbridge, in concordance with the Declaration of Helsinki. Participants were volunteers consisting of ten seasonal agricultural (SA) workers (mean age 16.8 +/-1.27 years; 7 female), twenty five university students (US) (mean age 20.6 +/-2.1 years; 18 female), and eighteen full or part time employed adults (AW) (mean age 26.5 +/-6.76 years; 12 female). Participants that needed no additional screening following completion of a physical activity readiness questionnaire were included in the study. The SA workers lived in rural communities and were recruited through a human resources firm contracted to supply several localized agricultural operations with temporary labourers. The US participants were recruited from the kinesiology department of the University of Lethbridge. The AW participants were recruited from the faculty and staff of the University of Lethbridge. All participants were initially assessed as one group.

3.2.2 Intervention Development

Field assessments were conducted to determine the physical and cognitive demands of manual weed removal for commercial canola crops[117]. There were three components of the field assessments: a focus group consisting of a semi-structured interview between researchers and SA workers experienced with manual weed removal, field observations of physical demands identified using ergonomic checklists, and measurement of force requirements determined with an analog force gauge (NK-500, Chatillon, 8600 Somerset Drive Largo, Florida 33773 US) for manual weed removal[125]. Information from these risk identification and assessment activities was synthesized to characterize musculoskeletal requirements for canola rouging[117].

An exercise intervention was designed to acclimatize SA workers to the identified musculoskeletal requirements of manual weed removal in canola crops. Exercises for the intervention (outlined in Table 3.1) were selected based on the feasibility for safe completion in a rural environment with minimal exercise equipment and on non-company time. Each exercise and workout was selected by a certified personal trainer (CSEP-CPT) under the supervision of an exercise physiologist (CSEP-CEP). Participants were each given a paper copy of the intervention (Appendix A). This document contained the detailed exercises, including photographs and directions for increasing the difficulty, the complete week-by-week workout schedule, a log book, and the assessments used. The twelve week intervention consisted of eighteen total exercises, including two base movement exercises, four aerobic exercises, twelve strength exercises, and three flexibility exercises (Table 3.1), formed into progressive workouts increasing from a beginner to an expert degree of difficulty. Thirteen of the exercises also progressed through five levels of intensity. Exercises were grouped into 30-60 minute workout sessions consisting of 6-10 exercises per workout, totalling thirty three compulsory workouts and twelve optional workouts during the twelve weeks. There were 3-5 workouts prescribed during each week of the intervention.

3.2.3 Protocol

3.2.3.1 Orientation

Each participant was initially invited to one of several group orientation sessions, with each session lasting approximately one hour. Orientation sessions for US and AW were conducted in a laboratory setting on the University of Lethbridge campus. The orientation session for the SA workers was conducted in a rented community center in the area. The orientation sessions included participants signing an informed consent, completing a Physical Activity Readiness Questionnaire[126], and receiving instructions from the research team on the expectations and protocol involved in the twelve week exercise intervention. During the orientation session, all eighteen exercises with each degree of difficulty were demonstrated by the researcher. All participants were invited to practice each exercise during the orientation.

3.2.3.2 Pre-intervention measurements

At the conclusion of the orientation participants scheduled a baseline assessment, within one week of the orientation date. For the SA workers, their baseline assessments were scheduled on the same day as the orientation, to accommodate the participant and researcher availability in the rural community. All participants were statistically analyzed as one BASELINE recruitment group. Baseline assessments included measures of body composition, physical fitness, and QoL (Table 3.2). Measurements of body composition consisted of height (m), weight (kg), BMI (kg/m^2), and waist circumference (cm). Physical fitness measurements consisted of a validated 90° wall sit measurement[127] used to assess leg strength (seconds/kg), a composite musculoskeletal fitness score[128] comprised of grip strength (kg), partial curl-ups, push ups, sit and reach (cm), and timed back extensor endurance test (s), CSEP measurements for composite back fitness[128] consisting of The Healthy Physical Activity Participation Questionnaire[128] waist circumference, sit and reach (cm), partial curl-ups, and timed back extension (s). Physical fitness measurements also included the Rockport 1-mile walk test[129] as a submaximal assessment of maximal aerobic power (VO_2max ml/kg/min). Quality of life (QoL) was measured using the World Health Organization WHOQOL-BREF assessment[130], which uses additive scoring across four domains: QoL-physical, QoL-psychological, QoL-social, and QoL-environment.

3.2.3.3 Intervention

After baselines were established, participants received a physical copy of the exercise intervention (Appendix A). Participants had the latitude to select the days and times of the week that they would exercise and were encouraged to complete every compulsory workout and as many optional workouts as possible. Workout attendance was self-reported in each participant's paper copy of the intervention. Participants were encouraged to contact the principal investigator at any time during the intervention for any assistance with questions related to the intervention.

3.2.3.4 Quality assessment

Participants were invited to complete an intervention quality assessment during week six of the intervention. Of the initial participants, three female SA workers, twelve US participants (8 female) and eight AW participants (5 female) came to the mid-intervention quality assessment. The quality assessment required each participant to demonstrate three randomly selected exercises from the intervention. Participants were also provided an opportunity to receive direction from the principal investigator with respect to any concerns they had with intervention participation. The quality assessment was only used as an opportunity for researchers to council with each participant.

3.2.3.5 Post-intervention measurements

At the conclusion of the twelve week intervention, participants completed a post-intervention assessment that was identical to the baseline measurements previously described. Researchers attempted to schedule post-intervention assessments as closely as possible to the same time of day and day of the week that each participant completed their baseline assessments, to maximize test-retest reliability[131]. Participants returned their paper copy of the intervention containing their self-reported attendance. There was no follow-up with participants that did not attend their post-intervention assessment.

3.2.4 Statistical Analysis

All statistical analyses were conducted using SPSS 19 with weak statistical significance of $.05 < p < .1$ and statistical significance of $p < .05$. The primary justification for a non-conventional statistical significance was to identify promising results from the dataset. Figure 3.1 shows the measurements of participant comparisons for statistical analysis. Descriptive statistics were used to determine skewness amongst all participants as one recruitment group.

Independent groups t-tests were conducted to identify any differences between participants that completed the pre-intervention only (BA) assessment (n = 27, 20 female) with participants that completed both the pre- and the post-intervention (PP) assessment (n = 26, 17 female) to analyze group differences.

A between subjects ANOVA compared INTERVENTION differences amongst all participants that completed both the baseline and the post-intervention assessments. A 70% intervention completion threshold led to two sub-groups that were below completion threshold (BT, n = 10, 7 female) and above threshold (AT, n = 16, 10 female) respectively. This completion threshold was determined because 70% completion guaranteed 8 weeks of participation, which has been identified as a potential threshold for minimum fitness improvements[132]. The between-subjects variable was INTERVENTION group, and within-subjects variable was TIME. Paired samples t-tests were used evaluate INTERVENTION dose-response effect sizes for all participants who completed 30%, 50%, and 70% of the prescribed workouts.

3.3 Results

3.3.1 Recruitment

Fifty three participants (10 SA, 25 US, 18 AW) completed baseline assessments, establishing BASELINE recruitment normality. Descriptive mean (SD) BASELINE assessments for age, body composition, physical fitness and QoL are provided in Table 3.3. Positive skewness observed for age (g = 1.60), waist circumference (g = 1.21), and leg strength (g = 1.63) was not corrected because the sample size would have limited the interpretation on transformed variables. All other baseline measurements were within acceptable measures of normality.

3.3.2 Participation Assessment

Twenty-six of the fifty three participants returned for the post-intervention assessment, including one female SA worker, eighteen US participants (12 female), and eight AW participants (5 female). The returning participants (PP) were grouped on BASELINE assessments and compared with baseline only (BA) participants, and these groups' descriptive means (SD) are shown in Table 3.4. Participation comparison using an independent groups t-test indicated significant age difference (t (51) = -2.309, p = .025 (2-tailed)), signifying that PP were older than BA. Participation QoL comparisons using an independent groups t-test showed PP had a significantly lower baseline QoL-environment score than BA (t (51) = 2.459, p = .017 (2-tailed)). There were no other significant differences for BASELINE participation.

3.3.3 Threshold Comparison

Mean (SD) of BT and AT groups comparing baseline and post-INTERVENTION assessments are shown in Table 3.5. Body composition comparisons showed a significant TIME effect for waist circumference for all participants (F (1, 24) = 4.54, p = .043, partial η^2 = .16), regardless of percent of intervention completed. Significant physical improvements across time were observed for composite musculoskeletal fitness (F (1, 24) = 5.45, p = .028, partial η^2 = .185), and composite back fitness (F (1, 24) = 6.19, p = .020, partial η^2 = .205), as well as a weak significant TIME improvement in leg strength (F (1, 24) = 3.03, p = .094, partial η^2 = .112). Domain changes for QoL indicated a significant TIME QoL-environment improvement (F (1, 24) = 11.15, p = .003, partial η^2 = .317) and a significant TIME x threshold change for QoL-psychological (F (1, 24) = 4.501, p = .044, partial η^2 = .158) such that AT scores increased while BT scores decreased. Weak significant TIME improvements for QoL-physical (F (1, 24) = 2.918, p = .10, partial η^2 = .108) and threshold improvements for QoL-environment physical (F (1, 24) = 3.217, p = .085, partial η^2 = .118) were also observed.

3.3.4 Intervention completion

Mean differences and SD for INTERVENTION completion of > 30%, > 50%, and > 70% are shown in Table 3.6, with the greatest effect sizes highlighted for all significant measurements. Paired sample t-tests for all participants who completed > 30% of the intervention showed significant dose-responses of physical fitness improvements for composite musculoskeletal fitness (t (22) = 2.60, p = .016 (2-tailed), d = .54) and for composite back fitness (t (22) = 2.43, p = .023 (2-tailed), d = .51), as well as significant QoL domain improvements for QoL-environment (t (22) = 3.97, p = .001 (2-tailed), d = .83). There was also a weak significant decrease in waist circumference (t (22) = -1.93, p = .067 (2-tailed), d = .40), a weak significant increase in leg strength (t (22) = 1.76, p = .093 (2-tailed), d = .36), and a weak significant increase in QoL-physical (t (22) = 1.95, p = .064 (2-tailed), d = .41).

A paired sample t-test for INTERVENTION completion > 50% indicated that significant improvements observed at INTERVENTION completion > 30% were maintained for composite musculoskeletal fitness (t (20) = 2.92, p = .008, d = .64), composite back fitness (t (20) = 2.35, p = .029. d = .51), and for QoL-environment (t (20) = 3.80, p = .001, d = .83). Additionally, leg strength improvements moved from weak significant improvements at INTERVENTION completion > 30% to strong significant improvements at INTERVENTION completion > 50% (t (20) = 4.29, p <.001, d = .94). Weak significant changes at INTERVENTION dose-response > 30% were not maintained at > 50% for waist circumference (t (20) = -1.71, p = .102, d = .37) or for QoL-physical (t (20) = 1.51, p = .146, d = .33). Significant improvements for participants with INTERVENTION completion > 70% were maintained for leg strength (t (15) = 3.80, p = .002, d = .95), composite musculoskeletal fitness (t (15) = 2.26, p = .039, d = .56), composite back fitness (t (15) = 2.14, p = .049, d = .53), and QoL-environment (t (15) = 3.47, p = .003, d = .86). At INTERVENTION completion > 70%, QoL-psychological now also showed significant improvement from baseline to post-intervention (t (15) = 2.33, p = .034, d = .58).

3.4 Discussion

This study evaluated the effectiveness of an exercise intervention designed to increase musculoskeletal fitness amongst SA workers in a rural environment. Results from the study suggest that employers could use this preseason exercise intervention to provide physical benefits necessary for increasing SA worker musculoskeletal tissue capacity and increase workplace wellness through QoL improvements. SA workers that participate in an appropriate exercise intervention should have a goal of completing as much of the intervention as possible to improve both personal physical fitness (thereby reducing the risk of work-related MSDs by increasing musculoskeletal tissue capacity) and QoL (thus having greater overall wellness). Implementing a pre-season exercise intervention could become a viable best practice solution for preparing SA workers for the physical occupational demands while improving perceptions of working conditions.

Three of the pre-intervention measurements (age, waist circumference, and leg strength) were skewed. Evidence from the intervention development focus group[125] combined with information about at risk agricultural workers[16] suggests that many SA workers are of minimum working age, putting slightly older workers in an age minority and creating a natural occupational age skewness. A skewed younger population may also have driven the skewness for waist circumference, as aging has been correlated with increased waist circumference amongst working adults[133]. The leg strength skewness may be a product of the sample size, and this skewness could dissipate if sample size was increased. The normalcy of the non-skewed measurements provides a good indication that participants were an adequate representation of the population that could potentially be hired as SA workers for manual weed removal.

Although each participant initially committed to complete the entire 12 week exercise intervention, overall attrition rate was 51%. This study did not specifically address reasons for attrition from baseline to post-intervention, but attrition is a common problem of exercise intervention studies[12; 13]. Studies have identified age, previous exercise history, socioeconomic status (including differences amongst rural and urban referents), and BMI as early indicators for potential exercise intervention dropout[124, 134]. This intervention attempted to encourage participation in a rural setting by minimizing both required equipment and need for sustained support. In an organizational setting there may need to be a supportive network of employer representatives, SA worker representatives, and industrial health specialists collaborating specifically to help participants overcome the barriers that may reduce intervention adherence, hopefully leading to measurable quality improvements[48].

BASELINE comparisons indicated age of PP participants was slightly older than BA participants, which is important because many SA workers are adolescents. Linker et al. (2005) found that the most effective form of training amongst young workers was in-person[75], a strategy that was only a component of the current intervention orientation and assessments. Because the completion age difference was only a few years, it may be useful for SA employers to have direct and frequent contact with young SA workers through trainers or supervisors, both to improve intervention adherence rates and to safeguard against of work-related MSDs.

INTERVENTION threshold comparison of BT and AT showed TIME improvements but no INTERVENTION x TIME differences. The completion threshold of 70% did not differentiate the varied completion levels of those in the BT group that completed some of the intervention. The set threshold of > 70% completion (or approximately 8 weeks) was used because a previous study had identified this time frame as a minimum threshold for fitness gains[132]. Contrary to the study conducted by Kell and Asmundson (2009)[132], this study showed measureable physical fitness and QoL benefits at minimum completion levels > 30% and > 50%. While early pre-season recruiting of SA workers may be difficult, SA employers should be encouraged that even lower doses of the preseason exercise intervention might increase worker musculoskeletal tissue capacity and improve QoL. INTERVENTION response showed that the greatest effect sizes were observed when > 70% of the intervention was completed, indicating that SA workers who are able to start a preseason exercise intervention earlier, and adhere to said program, could receive the greatest seasonal benefits. This lends support to the theory that routine exercise, or exercise that is incorporated into weekly living, enhances musculoskeletal fitness and improves overall wellness status[10]. The important implication for SA workers and their employers is that there are feasible solutions to protect from work-related MSDs by increasing musculoskeletal tissue capacity during pre-season.

3.5 Limitations

This study was not without limitations. Prescribed workouts within the intervention were not supervised and participants may have unknowingly performed the exercises incorrectly or over-reported their participation. Possible errors in exercise movement, combined with self-reported attendance, are signals that the observed effect size may be smaller than the potential gains possible through supervised completion of the intervention. Clinical research has demonstrated greater physical improvements for supervised exercise in comparison with unsupervised exercise[135].

This intervention did not restrict participants' physical activity to only the prescribed workouts. Although each participant was encouraged to record any physical activity other than the exercises, many participants did not indicate they adequately tracked their physical activity, which was especially true of participants with lower completion levels. It is a probability that any excess physical activity could have enhanced the post-intervention results, but it is more likely that the intervention was the main contributing factor to the positive results, given the increased effect size for INTERVENTION completion. Scoring components of composite musculoskeletal fitness, composite back fitness and each QoL domain had a maximum attainable score, creating a potential ceiling for effect size. These measurements were selected for ease of administration within the constraints of a rural setting.

3.6 Conclusion

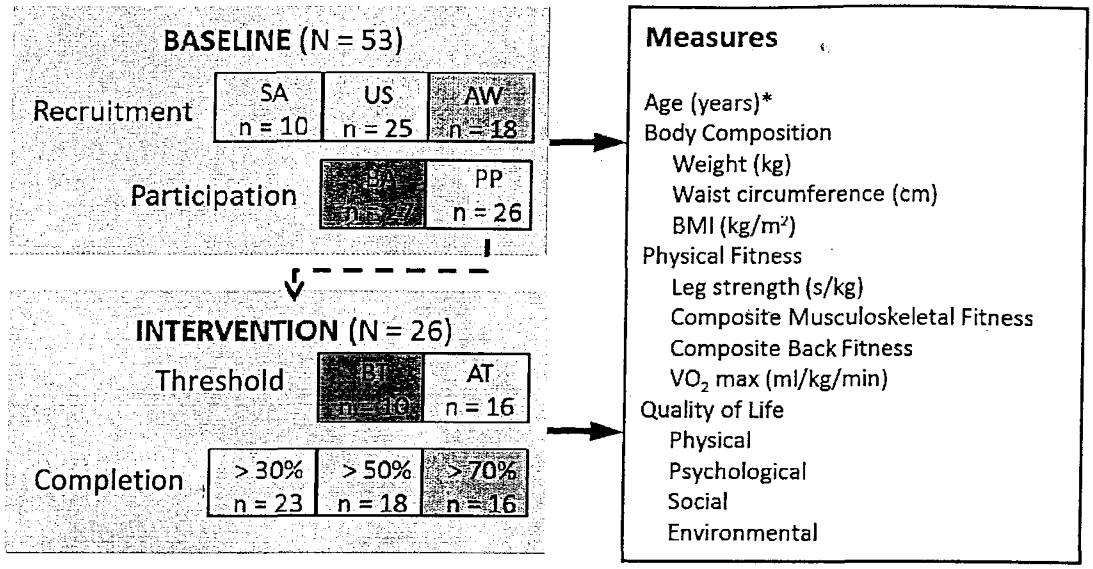
Pre-season exercise interventions targeted to the occupational demands in agriculture could be a feasible solution for preparing SA workers for their occupational physical demands. A tailored pre-season exercise intervention can improve physical fitness and QoL. Although minimal exercise doses will improve physical fitness, SA workers should be provided every opportunity to complete the entire pre-season intervention with frequent contact from a trainer. Minimal equipment exercise interventions are beneficial for ease of completion within the barriers of a rural environment which makes this a viable solution for increasing SA worker musculoskeletal tissue capacity. By implementing best practices in pre-season exercise training, agricultural employers could become leaders in protecting their workers from work-related MSDs, increasing musculoskeletal tissue capacity affected by chronic occupational loading.

Table 3.1. Exercises included in the intervention, grouped by category and number of times prescribed.

	Exercises	Compulsory (of 33)	Optional (of 12)
Basic Movement	Warm-up	33	12
	Cool down	33	12
Aerobic	Distance Running	6	2
	Pivot	12	1
	Stairs	12	2
	Walking/Jogging	6	4
Strength	Bird Dog	11	4
	Burpies	11	2
	Curl-Up	15	7
	Leg Raises	11	2
	Lunges	12	2
	Plank	14	5
	Roguer	14	4
	Side-Plank	13	4
	Squats	18	6
Flexibility	Groin flexibility	15	5
	Thigh Flexibility	12	4
	Trunk Flexibility	11	6

Table 3.2. Compilation of all measurements used to measure participant body composition, physical fitness, and quality of life.

		Measurement
Body Composition		
		Height (m)
		Weight (kg)
		BMI (kg/m^2)
		Waist Circumference (cm)
Physical Fitness		
		Leg Strength (s/kg)
	Composite Musculoskeletal Fitness	
		Grip Strength (kg)
		Partial curl-ups (# up to 25)
		Push-ups (#)
		Sit and Reach (cm)
		Timed Back Extensor (s)
	Composite Back Fitness	
		HPAP Questionnaire
		Waist Circumference (cm)
		Sit and Reach (cm)
		Partial curl-ups (# up to 25)
		Timed Back Extensor (s)
		VO_2max (ml/kg/min)
Quality of Life		
		Physical
		Psychological
		Social
		Environmental



*Indicates comparisons made for only for BASELINE.

Legend
SA = seasonal agricultural workers
US = university students
AW = employed adults
BA = pre-intervention only assessment
PP = pre- and post-intervention assessment
BT = below completion threshold
AT = above completion threshold

Figure 3.1. Flowchart of statistical comparisons made between participants.
Baseline measurements were grouped based on recruitment and intervention participation. Intervention measurements for those who completed pre- and post-intervention assessments were based on completion threshold and on percentage of intervention completion.

Table 3.5. INTERVENTION groups comparison of mean (SD) from baseline to post-intervention.

	BT (n=10)		**AT** (n=16)	
	Baseline	Post	Baseline	Post
Body Composition				
Weight (kg)	70.45 (9.66)	70.86 (10.14)	72.76 (16.46)	73.36 (16.09)
Waist Circumference (cm)	81.80 (7.73)	80.35 (8.35)	79.81 (11.31)	78.72 (10.13)
BMI (kg/m^2)	24.37 (3.56)	24.59 (4.03)	25.18 (4.07)	25.12 (3.92)
Physical Fitness				
Leg Strength (s/kg)	1.49 (.92)	1.52 (.65)	1.19 (.62)	1.63 (.95)
Composite Musculoskeletal Fitness	18.10 (5.86)	19.00 (4.32)	16.06 (5.58)	17.88 (5.81)
Composite Back Fitness	20.30 (5.85)	22.10 (5.42)	19.75 (5.57)	22.38 (5.31)
VO_2max (ml/kg/min)	48.76 (8.30)	46.83 (8.48)	48.66 (7.39)	50.05 (8.46)
Quality of Life				
Physical	22.70 (2.16)	23.70 (2.83)	23.81 (2.13)	24.56 (1.82)
Psychological	22.60 (2.22)	22.00 (2.53)	21.31 (2.44)	22.50 (2.07)
Social	11.90 (2.96)	11.40 (2.27)	11.50 (2.03)	12.12 (2.19)
Environmental	33.60 (3.59)	34.40 (3.41)	30.75 (2.62)	32.81 (3.49)

Legend
BT = below 70% completion threshold
AT = above 70% completion threshold

Table 3.6. Mean difference (SD) for INTERVENTION completion. Reported as post-intervention assessment - baseline assessment, * indicates p = .05, † indicates .05 < p < .1, ‡ indicates greatest significant effect size (d). Negative values were desirable for Body Composition. Positive values were anticipated for Physical Fitness and Quality of Life.

	> 30% (n = 23)	**> 50%** (n = 21)	**> 70%** (n = 16)
Body Composition			
Weight (kg)	.23 (2.01)	.21 (2.11)	.61 (1.90)
Waist Circumference (cm)	-1.22 (3.03)†‡	-1.12 (2.99)	-1.09 (3.33)
BMI (kg/m^2)	-.15 (.81)	-.15 (.85)	-.06 (.88)
Physical Fitness			
Leg Strength (s/kg)	.26 (.71)†	.41 (.44)*	.44 (.46)*‡
Composite Musculoskeletal Fitness	1.57 (2.89)*	1.81 (2.84)*‡	1.81 (3.21)*
Composite Back Fitness	2.26 (4.45)*	2.38 (4.64)*	2.63 (4.91)*‡
VO_2max (ml/kg/min)	.48 (5.68)	.57 (5.49)	1.40 (5.30)
Quality of Life			
Physical	1.04 (2.57)†‡	.86 (2.59)	.75 (2.70)
Psychological	.74 (2.22)	.67 (2.31)	1.19 (2.04)*‡
Social	.43 (1.95)	.62 (1.88)	.63 (1.96)
Environmental	1.78 (2.15)*	1.86 (2.24)*	2.06 (2.38)*‡

Chapter 4 – Prospective ergonomics for agriculture: creating stakeholder involvement to sustain feasible interventions

4.1 Introduction

The continued need for physical labour in agriculture presents an industry-wide challenge of protecting workers from musculoskeletal disorders (MSDs), the most common of all non-fatal farm injuries[18, 19]. This need is exacerbated by the dearth of MSD interventions in agriculture. Chapter 1 of this thesis detailed several factors that continue to be barriers to establishing best practices in MSD health and safety in agriculture. Prospective ergonomics involves external specialists developing feasible and marketable strategies for increasing safe work practices by addressing barriers, such as the lack of collaboration, that exist within an industry[109].

The lack of collaboration in agriculture may best be addressed in any ergonomics program through participation from relevant agricultural stakeholders, creating the system whereby sound interventions might become sustainable industry-wide solutions for reducing workplace MSDs[48, 67]. Key stakeholders in seasonal agricultural work should include seasonal agricultural (SA) workers, their employers, and intervention specialists. Kirkhorn et al. (2010) have noted that while there is no "one size fits all" solution for collaboration in agriculture, commodity groups can have a substantial influence on the development, implementation, and evaluation of ergonomic interventions designed for their stakeholders[22]. Although SA workers and their employers may have a general desire to reduce workplace MSDs, lack of employee-employer collaboration limits the capability for reducing work-related MSDs[22]. Workplace interventions may therefore be best initiated under direction from specialists familiar with designing, testing, and implementing workplace health and wellness practices[109].

The current organizational framework of the Canadian canola industry (Figure 4.1 (a.)) limits the potential for a successful ergonomics program to be implemented and sustained amongst the stakeholders. In the existing framework, even motivated individual stakeholders might have only limited access to group knowledge or specialist resources for understanding musculoskeletal demands at work and improving workplace health and safety. The Canola Council of Canada (CCC) is a nationwide commodity group with a mission to advance the growth and outlook of the canola industry[51], but they do not organize or support a steering group that targets work-related MSDs. The pre-season exercise intervention (PSE) developed, tested, and reported in Chapter 3 is an example of programming that is limited by the lack of collaboration amongst stakeholders, leading to delays, failures, or inconsistencies in making this type of knowledge accessible and important for SA workers. A more thoughtful ergonomics steering process than currently exists within the canola industry is needed as part of an ergonomics program so that interventions targeting work-related MSDs, including the PSE in this thesis, can be integrated into the best work practices of agricultural operations.

The primary purpose of this chapter is to summarize and extend findings from the three previous research chapters, while prospectively proposing an ergonomics program that the Canadian canola industry could use to initiate, then sustain, an evidence-based proactive intervention targeting work-related MSDs amongst SA workers. This prospective ergonomics proposal suggests that the canola industry proactively use evidence-based PSE to improve worker health and wellness, with the organizational goals of decreasing absenteeism, improving productivity, and increasing workforce sustainability on an industry-wide scale. This chapter will describe the strengths and limitations for participatory ergonomics within the Canadian canola industry. Considerations are given for a proposed steering group to resolve limitations so that an intervention could become a sustainable industry resource.

4.2 Strengths

The PSE developed and validated in Chapter 3 was specifically designed to address the musculoskeletal demands of SA workers (Chapter 2), while being conscious of broader agricultural industry factors identified in the literature review of Chapter 1. The design and intent of the PSE developed in this thesis sprang from the seasonal timeframe of agriculture, concentrating on the concept of SA workers as agricultural industry athletes. Given these concepts, the model was to prepare these athletes for their physically demanding season during their less demanding pre-season. SA workers that experience a long duration off-season may experience a recovery from their work-related cumulative loading effect, but the length of the off-season could lead to de-conditioned workers. A PSE could be introduced that would sufficient recovery but prevent deconditioning, and even increase soft tissue tolerance with progressive training scheduled to prepare SA workers for their season.

The PSE incorporated many of the best practices identified through the case studies in Chapter 1, and addressed several identified intervention criteria, including feasible completion within a rural environment, zero need for exercise equipment or experience, and progressive training potential with small time commitment. Just as the workers in Case Study #1-Dora Evelia influenced the intervention delivery method[85], this PSE was designed based upon SA worker observations from the focus group highlighted in Chapter 2. Testing the PSE in Chapter 3 included participant pre-intervention training from a qualified exercise specialist, founded on similar strategies used in Case Study #2-Move to Improve[83] and Case Study #3-Prevention First[9].

The cultural and familial bonds that Chapter 1 highlighted as a strong component of SA work could be useful for completing team-based activities such as participatory ergonomics development, steering group duties, and , most significantly, PSE program participation. These bonds could be a strong positive influence – family members and religious connections might more easily support and encourage each other, and they share the accessibility necessary to directly monitor exercise performance and adherence. The nature of these bonds is similar to that of a sports team, a concept that was identified during the focus group interview (Chapter 2). This team structure is naturally conducive to the industrial athlete analogy employed in Chapter 3, and could be highly useful in theming the PSE program materials, delivery, and rewards in any proposed industry-wide ergonomics intervention. The PSE developed for Chapter 3 (Appendix A) was designed to simulate playbooks that are often used in team sports such as football.

The exercises of the intervention were selected to target the occupational loading involved with intermittent manual weed removal, identified in Chapter 2. The selection of the exercises was informed by evidence from an SA worker focus group and field evaluations[117, 125]. Exercises selected for the PSE were specific to the tasks required in manual weed removal and limited any equipment requirements so that the intervention could be completed in any rural environment. The workouts were built to progressively load SA worker soft tissues as a pre-season build up for in-season physical demands. The exercise intervention (Appendix A) was written in plain language and saturated with visuals that the researchers included to address low literacy and limited education issues identified in the literature review of Chapter 1. The PSE was structured with a flexible schedule to encourage participation from amongst SA workers with strong cultural or religious beliefs. Amongst the feasibility test groups of Chapter 3, the prepared PSE resulted in measurable increases in physical fitness and quality of life.

Several characteristics specific to canola farming may also be strengths for implementing and sustaining a proactive participatory ergonomics program. In comparison with other agricultural commodities, canola is a relatively new industry that is accustomed to rapidly evolving industry advancements[51]. An industry-wide tradition for innovation and change may increase the likelihood that canola stakeholders could adopt industry-wide participatory ergonomics and PSE, as another example of thoughtful, progressive change. The CCC could use their network and influence to increase the rate of PSE interest and acceptance amongst its stakeholders, which currently consists of canola growers, suppliers, exporters, processors, and manufacturers[51]. Many of these stakeholders employ SA workers. The CCC uses several means for disseminating knowledge to their stakeholders, including annual national and regional conferences, publically-available internet resources, and long-standing industry relations, which collectively could increase the dissemination of a unified message amongst stakeholders. The federal government provides the CCC with financial assistance through Agriculture and Agri-Food Canada, enabling industry-specific research plus stakeholder access to publications, printed materials, and electronic media that could all be used to help make an intervention feasible for the industry. Industry-wide support of an intervention such as PSE through the CCC could ensure sustainability, as the financial costs of researching, testing, and initiating the intervention could be shared amongst the stakeholders that already support the CCC[50].

4.3 Limitations

The attempts to structure PSE as a sustainable ergonomic practice in the canola industry were limited in part by the current lack of collaboration within the canola industry (Figure 4.1(a.)). Highly infrequent communication, even at internal and local levels, limited regular contact with SA workers, either as individuals or as groups, during their pre-season. Chapter 3 identified the limited support system as a potential reason for intervention dropout. Recruiting

SA workers as participants in the development of PSE was constrained by the fragmented knowledge transfer network of the canola industry during non-production months.

Implementing PSE industry-wide as a solution for protecting SA workers from MSDs is also constrained by the lack ergonomic programming in the canola industry. As Chapter 1 identified, many agricultural operations do not have systems for recognizing, reporting, treating, and reducing chronic MSDs[15, 16, 22], and in most Canadian provinces the lack of legislation minimizes interest in addressing work-related MSDs [55]. Where agricultural ergonomic programs do exist, the results of Chapter 2 suggest that agricultural field assessments alone may be inadequate due to the remote locations and conditions of the fields, and that evaluations in laboratory settings need to validly model the work tasks.

Several SA worker characteristics that were identified in Chapter 1 may have influenced the limited participation of actual SA workers recruited for Chapter 3's feasibility testing of PSE, despite conscious efforts at mitigation. All of the contacted SA workers were rural youth with low literacy levels, and the majority of these SA workers were also female. These factors may have generated a percieved power dynamic that limited both interest in and completion of the intervention, given that the researchers that contacted these workers were male university researchers. Researchers attempted to overcome this challenge by recuiting through a local faith community center and through a human resource firm that had established contacts with SA workers in the region. Further recruiting by acknowledged leaders within the worker group was compromised by internal limitations of contact information and technology.

Initiating a PSE amongst SA workers becomes more challenging with the hiring model of seasonal agricultural work. When an employer uses a human resource firm to hire SA workers, there may be confusion as to who the actual employer is, both from the workers' perspective and from the employers'. This confusion could lead to employers, human resource firms, and SA workers deflecting and/or neglecting responsibility when an MSD occurs. These workers are often hired only days before the seasonal work is scheduled to begin, which may contribute to workers having a mental disconnect with their employers and an unfamiliarity with health and safety procedures. This model also facilitates an annual 'labour crisis,' as experienced workers preferentially select part- or full-time work in year round jobs when available. Seasonal hiring challenges have led to the continued increase in the hiring of migrant workers who often do not arrive in the area until the day they are to start work[22]. Resources for PSE need to extend to migrant workers before they ever arrive for work so that they can receive the training benefit. As the findings of Chapter 3 indicated, the best physical improvements for PSE occured when a participant was engaged in the intervention for a longer time period, suggesting that local and migrant SA workers should to be hired for several weeks (at least as part-time employees in-training), not days, before the field work starts.

The CCC has reasonable outlets to provide its stakeholders with information on industry leading practices, but currently does not represent all stakeholders within the canola industry, including some employers involved with canola. Two stakeholder groups not currently represented in the CCC are human resource firms contracted to hire SA workers, and the SA workers themselves. Human resource firms only have a vested interest in the canola industry when seeking contracts or trying to fulfill labour commitments. Agricultural laborers in Canada generally have no formal union or stakeholder representation to provide an avenue for collaboration. Formal organization of SA workers is limited by an employment time frame that ranges from only a few weeks to a few months of the year[16]. Both human resource firms and SA workers might have only a limited interest in the CCC, given the finite annual time frame that these stakeholders are involved in the work in canola fields. Regardless of the time commitment, contracted human resource firms and SA workers are essential stakeholders whose active involvement in ergonomics programming could collectively reduce the risk of MSDs within the canola industry.

Intervention specialists may not be directly connected to stakeholders in the canola industry, as was the case with thesis. The limitation of this prospective ergonomic approach is that specialists might develop an intervention that prevents or reduces workplace MSDs without a contract from stakeholders in the industry[109]. The hope of an intervention specialist external to the industry is that their developed intervention might be adopted within the industry. The reality of prospective ergonomics is that the intervention may never reach the intended users because the framework for knowledge transfer does not exist in the targeted industry, or the appetite for the proposed work doesn't exist amongst decision makers.

4.4 Resolving Limitations through Participatory Ergonomics: A Prospective Proposal

Stakeholders in the canola industry should look at successful strategies from other industries to build a collaborative knowledge transfer network to address work-related MSDs. Giannakis (2008) analyzed successful knowledge transfer as it exists in non-agricultural professions (financial services, pharmaceutical, telecommunications, and airport authority) and suggested three elements for a conceptual model of knowledge transfer: understanding the elements and processes of stakeholder interaction, understanding the positions of involved stakeholders, and the power-dependence relationships between the employers and their workers[136]. Within this conceptual model, the stakeholders are actively involved in evidence gathering, generating intervention alternatives, intervention selection and best practice implementation. The findings of Giannakis' (2008) study indicated that industries using this framework had established effective knowledge transfer networks because the roles and interactions of the stakeholders were well defined, enabling stakeholder confidence and flexibility for within-industry innovation[136]. The canola industry could use this framework as the basis for establishing the stakeholder roles necessary for an intervention to succeed within the industry.

A steering group comprised of representation from all industry stakeholders could help address the current work-related MSD issues in the canola industry. Case Study #2-Move to Improve used a steering group to implement and provide sustained support for their intervention, which was successful for increasing by 20% the number of participants that achieved minimum levels of physical activity in twelve weeks[83]. A defined steering group role for human resource firms, SA worker representation, and intervention specialists with the CCC and canola employers could enable a more proactive process in planning and conducting an intervention that could reduce the risk of work-related MSDs, including adopting PSE for SA workers. Transferring knowledge of intervention effectiveness to industry stakeholders through a steering group is one possible method for encouraging adoption on an industry-wide scale. A steering group could use their stakeholder representation to facilitate knowledge transfer to the intervention users, providing a clear and uniform message of how the industry is reducing and preventing work-related MSDs.

4.5 Intervention Initiation

A stakeholder-led steering group within the canola industry could have specific contributions for initiating a new intervention (Figure 4.1 (b.)). Intervention initiation needs a supportive framework that consists of active and visible management roles, a defined budget, a clear timeframe (including when an intervention will begin), resources and knowledge from specialists, and the worker participation required to ensure that the intervention can become successful.

Of all the identified shareholders, the CCC is in the best position to facilitate a steering group for intervention initiation, and to manage the establishment of an intervention within the canola industry. The CCC has the necessary resources in place to direct the knowledge transfer between all other canola industry stakeholders, including federal funding and accessible media[51]. Having the CCC support stakeholder involvement in the establishment of a steering group could enable faster adoption of feasible solutions for reducing MSDs, because the CCC already collaborates with several canola employers nationwide, and possesses communication strategies and resources to deliver a consistent message to the industry.

Active employer involvement on and with the steering group is vital for intervention initiation. Employer representation, acting on behalf of their organization, provides the authority on whether or not an intervention will become a resource for their employees. Employer representation in an industry-wide steering group could facilitate the necessary intervention coordination involved with other occupational tasks and priorities, as was demonstrated in Case Study #2 – Move to Improve[83]. Interventions are most likely to be successful when employers are actively involved, as direct decision makers and supporters of the changes asked of workers[68].

Human resource firm(s) representation and participation with steering group decisions on ergonomic intervention programs could improve contract negotiation decisions and hiring incentive programs. Human resource firms may be viewed by SA workers as their principle employer (as expressed in Chapter 2 focus group) and may hire the same SA workers for multiple employers. This creates an interesting duality, in that multiple employers may have an interest in maintaining the same healthy workforce because of their contracts with human resource firms, despite those same employers being competitors in the market of products produced by that workforce[59]. Human resource firm input into a steering group could be useful during intervention initiation to encourage both employers and SA workers to actively support work initiatives that could improve working conditions, and could provide perspective related to the needs of the workforces. This group would also be responsible for managing and reimbursing preseason work.

While it may not be practical to organize SA workers using a traditional union model, developing a network amongst SA workers is realistic and important step for initiating an ergonomics process amongst the workforce. Many SA workers return year after year to the same employment with the same crew[61], and some of these SA workers could represent their co-workers as an integral component of a steering group. Suitable SA worker representation could come about if the CCC, along with employer, human resource firm, and co-worker assistance, identified potential leaders amongst returning SA workers and gave them ergonomics education, 'train the trainer' experience, and intervention-specific responsibilities. SA worker representation and networking could have an added industry-wide advantage of increasing workforce stability while decreasing seasonal recruitment costs and staffing shortfalls.

Specialists need to be highly involved with the steering group during the initiation phases of an intervention. The resource experts should be intervention specialists, having done the leg work with employers, human resource firms, and SA workers, to develop and test a proposed intervention. This specialist directed approach was used as a major component in developing the PSE for this thesis, based upon the analyzed musculoskeletal demands of weed pulling. The specialist role in with the steering group during the initiation phase should be to educate the stakeholder representatives to the point that they become the primary intervention resource for their respective stakeholder groups. Intervention initiation may be best accomplished as each of these stakeholders commit to a steering group tasked with protecting workers from work-related MSDs[22].

4.6 Intervention Sustainability

Stakeholder representative roles in an intervention may become more defined when an intervention transfers from initiation phases to a sustained resource, as shown in Figure 4.1(c.). Continuous involvement of the CCC with and on the steering group would be necessary for an intervention to remain sustainable. The CCC representatives could become the resource for accessing intervention materials and keeping industry-wide statistics on the effectiveness of reducing work-related MSDs. The CCC's proposed role of directing knowledge transfer to stakeholder representatives would need to continue for a sustainable intervention.

Employers engaging in an intervention, suggested by the steering group, need to continually demonstrate that they are concerned for their employees' well-being by participating in proactive steps that provide SA workers with time and compensation for sustained intervention use. Workers that do not perceive employer intervention support may be less likely to engage with or continue in an intervention when it is offered[101, 137]. Employers may need to engage the steering group when operations change, so that the steering group can assist the employers with necessary adjustments to an ongoing intervention.

Human resource firms, like employers, would need a continued steering group presence as an intervention becomes sustainable, for two reasons. The first reason for continued involvement would be to ensure that their employer contract obligations are fulfilled. The second and more important reason is because SA workers may view the human resource firms as their primary employer. Employers and human resource firms should be giving the SA workers the same intervention messages under direction from the steering group.

SA worker representatives on the steering group could be trained to become worker 'coaches' that help their peers complete PSE in preparation for their seasonal demands. These SA worker 'coaches' should be one of the first resources fellow SA workers turn to for intervention direction and support. For exercise interventions such as this PSE, these SA worker 'coaches' should be trained to identify the correct way of completing the exercises, provide encouragement, and identify where modifications may be required. When intervention questions arise, SA worker representatives should work with the steering group to provide solutions. An MSD reducing intervention can be sustainable when SA worker representatives are capable of helping their peers successfully complete the intervention with minimal assistance from the steering group.

Involving a broad range of stakeholders in an intervention steering group could enable SA worker protection from occupational MSDs. The final piece of a sustainable intervention is for the steering group to direct an intervention without the constant assistance from the specialists[136]. The objective for an intervention specialist should be to create a sustainable intervention that stakeholders can access, interpret, adopt, and maintain through an internal process, after the specialist has transitioned to a supportive and advisory role[136]. Active stakeholder representation within a steering group could facilitate the collaboration and intervention knowledge transfer needed for implementation and ongoing sustainability. Limitations that prevent this PSE (and other targeted agricultural industry interventions) from becoming an essential musculoskeletal preparation for SA workers preparing to start their season within the canola industry could also be addressed, through a steering group tasked with industry-wide protection against MSDs, in a consensual and multi-stakeholder fashion.

4.7 Conclusion

The research presented throughout this thesis provides both case and means for protecting SA workers from MSDs. There are several challenges to the success of any intervention in agriculture, especially for an intervention targeting SA workers. Assembling a multi-stakeholder commodity-specific steering group could be an effective strategy for implementing and sustaining a targeted intervention. Pre-season exercise intervention is one strategy that commodity stakeholders in the canola industry could use to reduce the risk of MSDs associated with intermittent soft tissue loading. Although the pre-season exercise intervention was specifically developed with a focus on the manual weed removal task in canola fields, multiple agricultural commodities could benefit from the findings presented throughout this thesis, adding it to their resources as a means of protecting SA workers from MSDs. Hand harvesting for ground crops (cucumbers, melons, strawberries, etc.) or bush and vine crops (peppers, tomatoes, grapes, etc.) has similar work task demands and chronic loading of the musculoskeletal systems of their SA workers[111]. Commodity groups in agriculture could either adopt or adapt preseason exercise interventions for their SA workers in parallel with other current best practices in ergonomic risk control (job rotation, work-rest cycling, changes to hand tools), and use these findings to generate an intervention strategy tailored to the needs of their industry.

Preventing work-related MSDs amongst SA workers is a vital issue that all agricultural stakeholders need to address. Protecting SA workers from MSDs is important, as the occupational tasks that SA workers perform are essential and these workers deserve every effort to have a healthy and injury-free workplace. When agricultural industry stakeholders collaborate to protect their workers from injury, the delivery of an intervention may become feasible, the importance of establishing current best ergonomic practices in agriculture could become more visible, and there will be a cooperative effort to address the plague of MSDs. Collaboration and involvement of key stakeholders, a resolve to remove outdated practices, and a determination to use current best practices for reducing and preventing work-related MSDs are absolute necessities for the agricultural industry. Agricultural industry stakeholders need to protect SA workers and all workers from work-related MSDs, and feasible ergonomic interventions exist that can be the sustainable resolutions urgently needed in agriculture.

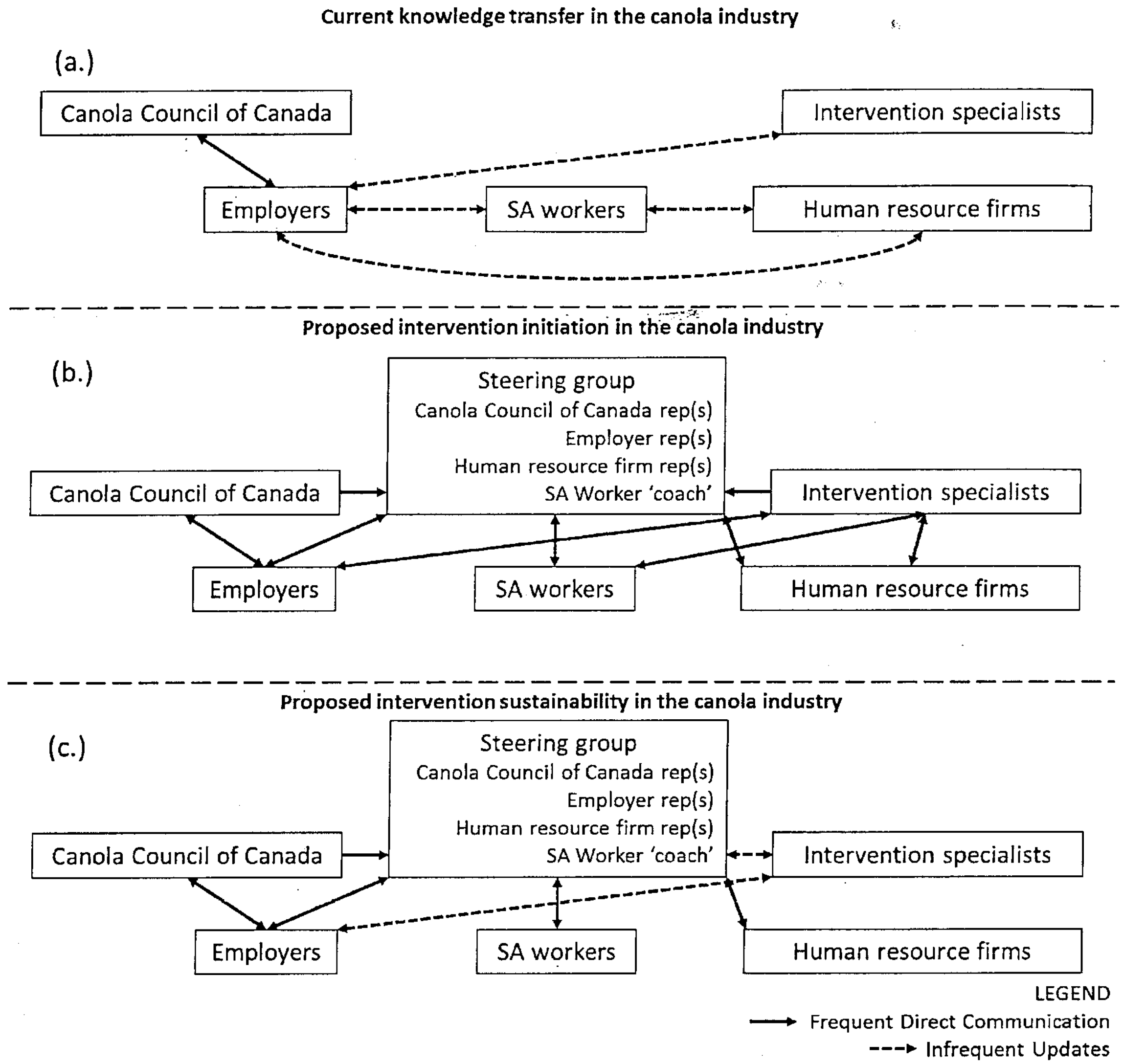


Figure 4.1. Current and proposed intervention collaboration strategy for the Canadian Canola industry.

Knowledge transfer as it exists in the Canadian canola industry currently (a.) as well as proposed solution for initiating an intervention through a steering group (b.) and sustaining a canola industry intervention (c.). Arrows indicate direction of knowledge transfer. Lines indicate frequency of communication involvement, with solid indicating frequent and dotted indicating infrequent (a.) or as required for ongoing sustainability (c.).

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University of Lethbridge

The Playbook

Canola Rouging Exercise Prescription

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12 week pre-season exercise program designed specifically for Canola Rougers. Details of each exercise, daily workout, and weekly prescriptions.

Instructions

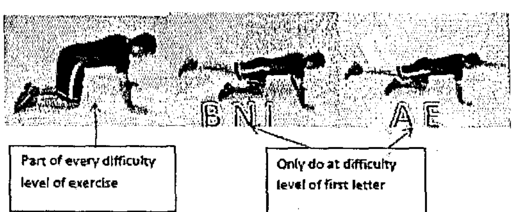
There are several tools in the Playbook, including, exercises (18), an overall program layout (1), weekly exercise program (12), images (4 pages), consent forms (1), PAR-Q+ (1), quality of life assessments (2), and fitness assessments (2). This section will provide information and ideas on how to use each tool. You will have the freedom to choose your time of day for exercising, whether to exercise as a group or by yourself, and how hard you are going to push yourself.

Exercises

Each exercise consists of images, a written description, and how frequently they are in the program. Some of the exercises also contain 5 degrees of difficulty; Beginner, Novice, Intermediate, Advanced, and Expert. The images either have the letters B, N, I, A, E, to correspond with the difficulty level, or no letters, indicating this should be done at all levels. Each exercise with multiple degrees of difficulty will have the recommended intensity level for each time you are to complete that exercise. Repetitions and estimated time per set are included as part of the difficulty level. You have the freedom to increase or decrease the difficulty level for each workout. Try to only deviate up or down one level from the recommended difficulty.

Difficulty	Description	Repetitions	Time
Beginner	Place your hands at your sides so your fingers are touching your hamstring.	5-7	30 secs
Novice	Place your hands at your sides so your fingers are touching your hamstring. Try to lift a little higher off the ground.	7-10	40 secs
Intermediate	Place your hands beside your ears. Do not pull on your neck.	7-10	40 secs
Advanced	Cross your hands across your chest.	7-10	40 secs
Expert	Cross your hands across your chest.	10-15	1 min

Example of a level of difficulty for an exercise.



Example images with multiple levels of difficulty.

Overall Program Layout

This tool gives you an overall view of how the program is supposed to progress. Following this guideline should prepare you in a healthy way for the start of your working season. This tool helps you to see how difficult future workouts will be, as well as help you reflect on how much you have improved. This section also has a blank calendar on pg. 24 so you can schedule each exercise for the 12 week program. The following calendars can be used as examples to follow for your program.

Week	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1		Day 1		Day 2		Day 3	
2		Day 1		Day 2		Day 3	
3		Day 1		Day 2		Day 3*	
4		Day 1		Day 2		Day 3	Day 4*
5		Day 1		Day 2		Day 3	Day 4*
6		Day 1		Day 2		Day 3	Day 4*
7		Day 1		Day 2		Day 3*	
8		Day 1	Day 2		Day 3*	Day 4	Day 5*
9		Day 1	Day 2		Day 3*	Day 4	Day 5*
10		Day 1	Day 2*		Day 3	Day 4*	Day 5
11		Day 1		Day 2		Day 3	
12		Day 1		Day 2		Day 3*	

Example Calendar 1. Days listed with * can be optional workouts.

Week	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1		Day 1			Day 2		Day 3
2			Day 1		Day 2	Day 3	
3		Day 1			Day 2		Day 3*
4		Day 1		Day 2		Day 3	Day 4*
5			Day 1	Day 2		Day 3	Day 4*
6		Day 1		Day 2		Day 3	Day 4*
7			Day 1		Day 2		Day 3*
8		Day 1	Day 2	Day 3*	Day 4	Day 5*	
9			Day 1	Day 2	Day 3*	Day 4	Day 5*
10		Day 1	Day 2*	Day 3		Day 4*	Day 5
11			Day 1		Day 2		Day 3
12		Day 1		Day 2		Day 3*	

Example Calendar 3. Days listed with * can be optional workouts.

Weekly Exercise Program

This is your go-to tool for the day-to day aspect of this program. This tells you all of the exercises for every week, with a different week on every page. Each week is broken down by day with specific exercises for each day. Feel free to take the weeks exercises out of the book and place them in front of where you will be exercising.

Some weeks have as few as 3 exercise days and some have as many as 5. Use the calendar on pg. 24 to plan your workouts. Each exercise lists the recommended difficulty (where applicable), the number of repetitions per set, the number of sets, and the estimated time to complete each set. Optional exercise days are marks with an (*).

There is space provided by each exercise on each day to mark whether or not you completed that portion of the workout. There a notes section on the bottom and back of each page for you to write notes for yourself or your head coach. You are encouraged to write how the workout made you feel, anything you found difficult with the workout, any changes you made to the workout, and goals you might have for each day. Keep track of your other physical activity using the weekly activity tracker on the notes page to such just how active you really are getting.

Indicates optional day

Check here if workout was completed

Day 4*	Exercise	Difficulty	Repetitions	Sets	Time/Set
✔	Warm up	-	1	1	3-5 min
	Walking/Jogging	Advanced	1	2	10 min
	Rouger	Expert	10-15	3	1 min
	Planks	Advanced	1	3	40 secs
	Trunk Flexibility	-	1	3	45 secs
	Side Plank	Advanced	1	3	1 min
	Squats	Intermediate	5	3	1 min
	Cool-down	-	1	1	2-3 min

Images

The images in the Playbook can be used as a quick reference to remind you how to perform each exercise.

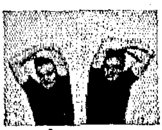
Fitness Assessments

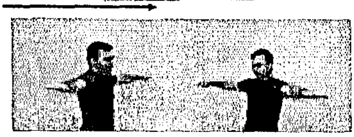
The fitness assessments in this book are designed to be completed by a qualified personal trainer. The assessments are to be done before Week 1 and after Week 12. Your personal trainer will interpret your results so that you can understand your improvements. This tool will give you an indication of your progression from the start to the finish of your exercise program. In the absence of a personal trainer, some of these measurements may still be done as a personal assessment. Measurements indicated with an (*) should only be conducted by a certified personal trainer.

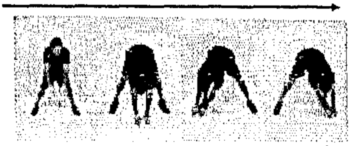
Warm up	
	Slow jogging to get the heart rate up for 3-5 minutes. Should be able to talk easily throughout this exercise. The basic idea is to get your muscles feeling warm and ready for physical activity.
	**Variations** Repeatedly jogging up and down stairs at a pace that you could talk easily
	Jumping jacks at a slow pace (20-25 per minute)

*This exercise is the first minutes of every workout, every day. There are no increases on difficulty, but try to increase the amount of stretch that is done as the program progresses.

Cool down







Head to toe flexibility final 2-3 minutes of workout. Dynamic flexibility routine moving though each motion and holding point of greatest stretch for 5-7 seconds.

Neck- While standing, slowly tilt right ear toward right shoulder then repeat on the left side. Then shoulder check over each shoulder. 5 Repetitions.

Arms- Stand with arms making a "T" position, make small circles with both arms and gradually make bigger and bigger circles in a forward direction until the circles are at maximum. Then reverse the direction with big circles and gradually make them smaller and smaller.

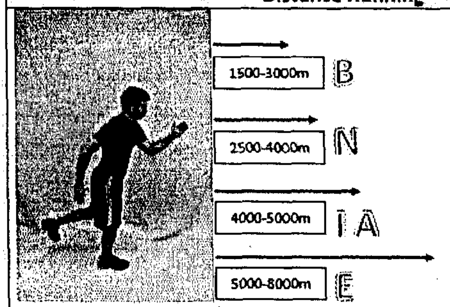
Put both arms above the head. Grab your right elbow with your right hand and gently pull right arm toward the head and hold. Repeat with the left arm. 2 Repetitions.

Back- From the standing "T" position, turn your upper body to the right 90° and hold while keeping your feet planted on the floor. Repeat on the left side. 5 Repetitions.

Legs- Move feet twice shoulder width apart. Using both hands slowly bend down and touch the floor as close to the right foot as possible. Then, while still touching the floor slowly move to the left foot. 5 Repetitions.

*This exercise is the final minutes of every workout, every day. There are no increases on difficulty, but try to increase the amount of stretch that is done as the program progresses.

Distance Running



Continuous movement through distances greater than 1500m. Should be able to carry on a conversation at Beginner and Novice difficulty. It should be difficult to talk for long periods of time for Intermediate, Advanced, and Expert. Focus on completing the distances in the prescribed time.

Difficulty	Description	Repetitions	Time
Beginner	1500-3000m, can talk with some effort	1	20 min
Novice	2500-4000m, can talk with some effort	1	25 min
Intermediate	4000-5000m, talking may be limited	1	30 min
Advanced	5000m, attempting to beat a previous time, talking will be limited	1	<30 min
Expert	5000m-8000m, as fast as possible, talking will be very limited	1	50 min

Week	Day	Difficulty
2	2	Beginner
4	1	Beginner
4	4	Novice
5	3	Intermediate

Week	Day	Difficulty
8	1	Advanced
8	3	Advanced
9	4	Expert
12	2	Advanced

Pivot

Run 20 m, stop and touch the ground, run back to the starting point, stop and touch the ground. When turning, always face the same direction (wall) to train both bi-laterally. Focus on completing this exercise in the prescribed time.

Difficulty	Description	Repetitions	Time
Beginner	Walking pace, can easily talk and answer questions	10	3 mins 45 secs
Novice	Jogging pace, can talk with some effort	10	3 mins 10 secs
Intermediate	Distance pace, talking may be limited	10	2 mins 20 secs
Advanced	Distance pace, talking may be limited	15	3 mins 30 secs
Expert	Full-on sprinting pace, talking will be very difficult	10	>2 mins

Week	Day	Difficulty
1	3	Beginner
2	3	Beginner
3	2	Novice
4	2	Novice
6	1	Novice
6	3	Intermediate

Week	Day	Difficulty
7	2	Advanced
8	2	Advanced
8	5	Advanced
10	1	Advanced
10	5	Advanced
11	2	Expert

Stairs

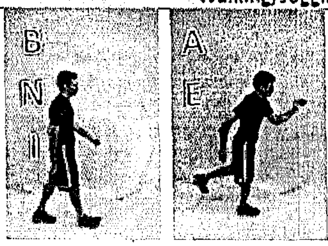
Repeatedly going up and down a set of stairs, at a set pace. Focus on completing the exercise in the prescribed time.

Difficulty	Description	Repetitions	Time
Beginner	Going up and down stairs at a walking pace, talking will be easy	1	10
Novice	Going up and down stairs at a walking pace, talking will be easy	1	15
Intermediate	Going up and down stairs at a jogging pace. Can talk with some effort	1	10
Advanced	Going up and down stairs, missing every other stair, at a jogging pace. Can talk with some effort	1	10
Expert	Going up and down stairs, missing every other stair, at a jogging pace. Talk with some effort.	1	15

Week	Day	Difficulty
1	2	Beginner
2	1	Novice
3	1	Novice
4	3	Novice
5	2	Intermediate
6	2	Intermediate
7	1	Advanced

Week	Day	Difficulty
8	4	Advanced
9	2	Advanced
9	5	Advanced
10	3	Expert
11	1	Expert
12	1	Advanced
12	3	Advanced

Walking/Jogging



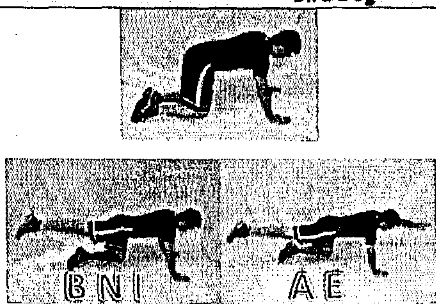
Travelling from one place to another at a pace that requires little to some effort. Use arms for stability. Should be able to talk easily or with some effort. Focus on the time to complete this exercise.

Difficulty	Description	Repetitions	Time
Beginner	Walking pace where one foot is always touching the ground, can easily talk.	1	10 min
Novice	Walking pace where one foot is always touching the ground, can easily talk.	1	15 min
Intermediate	Brisk walking faster pace than Beginner and Novice, can easily talk.	1	20 min
Advanced	Jogging at a pace where feet start touch the ground less than when walking, can talk with some difficulty.	1	10 min
Expert	Jogging at a pace where feet start touch the ground less than when walking, can talk with some difficulty.	1	15 min

Week	Day	Difficulty
1	1	Beginner
3	3	Novice
5	4	Novice
6	4	Intermediate
7	3	Intermediate

Week	Day	Difficulty
9	1	Expert
9	3	Expert
10	2	Expert
10	4	Expert
11	3	Advanced

Bird Dog

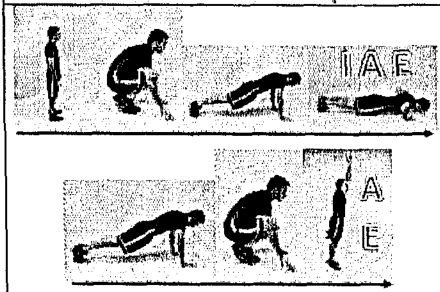


Hands shoulder width apart, elbows extended on the floor. Start with both knees on the floor and the back in a neutral position. Lift and extend one leg off the ground so that it forms a straight line with the back. Hold, and then repeat on the other leg. Focus on the number of repetitions for each set

Difficulty	Description	Repetitions	Time
Beginner	Hold each leg at full extension for 5-10 seconds.	2	40 secs
Novice	Hold each leg at full extension for 5-10 seconds.	5	1 min 45 secs
Intermediate	Hold each leg at full extension for 5-10 seconds.	10	3 min 30 secs
Advanced	While the leg is extended, lift the opposite hand parallel to the floor and hold for 5-10 seconds.	5	1 min 45 secs
Expert	While the leg is extended, lift the opposite hand parallel to the floor and hold for 5-10 seconds.	10	3 min 30 secs

Week	Day	Difficulty
1	2	Beginner
2	2	Beginner
3	1	Novice
3	3	Beginner
4	1	Novice
4	4	Novice
6	1	Intermediate
7	1	Advanced

Week	Day	Difficulty
7	3	Intermediate
8	1	Advanced
8	3	Advanced
9	4	Intermediate
10	1	Expert
11	1	Expert
12	2	Advanced

Burpies	
	Start in a standing position, feet shoulder width apart. Drop so that your hands touch the ground slightly more than shoulder width apart. Kick your feet out to a push up position. Kick your feet back to the starting position. Focus on the number of repetitions for each set.

Difficulty	Description	Repetitions	Time
Beginner	Stand quickly back to the starting position.	3-5	20 secs
Novice	Jump straight up to return to the starting position.	3-5	20 secs
Intermediate	Do a full push-up when the feet are kicked out. Stand quickly back to the starting position.	3-5	25 secs
Advanced	Do a full push-up when the feet are kicked out. Jump straight up to return to the starting position.	3-5	30 secs
Expert	Do a full push-up when the feet are kicked out. Jump straight up to return to the starting position.	5-10	1 min 15 secs

Week	Day	Difficulty
1	1	Beginner
2	1	Beginner
3	2	Novice
4	3	Novice
5	1	Intermediate
5	4	Intermediate
6	3	Intermediate

Week	Day	Difficulty
7	2	Advanced
8	4	Expert
9	1	Expert
9	3	Expert
10	5	Expert
11	2	Expert

Curl-up

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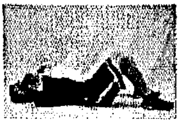

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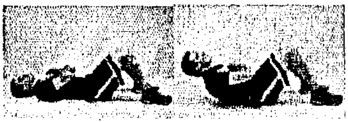


Lying on your back, place your feet flat on the floor, so that your knees form roughly a 90° angle. While keeping your feet flat on the floor, curl your upper body up toward the roof, so that your abdominals are activated. Hold for 3 seconds. Don't try to sit all the way up, curl to the dotted line shown in the picture. Focus on the number of repetitions for each set

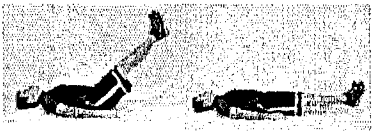
Difficulty	Description	Repetitions	Time
Beginner	Place your hands at your sides so your fingers are touching your hamstring.	5-7	30 secs
Novice	Place your hands at your sides so your fingers are touching your hamstring. Try to lift a little higher off the ground.	7-10	40 secs
Intermediate	Place your hands beside your ears. Do not pull on your neck.	7-10	40 secs
Advanced	Cross your hands across your chest.	7-10	40 secs
Expert	Cross your hands across your chest.	10-15	1 min

Week	Day	Difficulty
1	1	Beginner
2	3	Beginner
3	1	Novice
3	3	Beginner
4	1	Novice
4	2	Intermediate
4	4	Novice
5	1	Novice

Week	Day	Difficulty
5	4	Novice
6	1	Intermediate
7	1	Advanced
7	3	Intermediate
8	1	Advanced
8	2	Advanced
8	3	Advanced

Week	Day	Difficulty
8	5	Advanced
9	1	Advanced
9	3	Advanced
10	1	Advanced
11	1	Expert
11	3	Intermediate
12	2	Advanced

Leg Raises



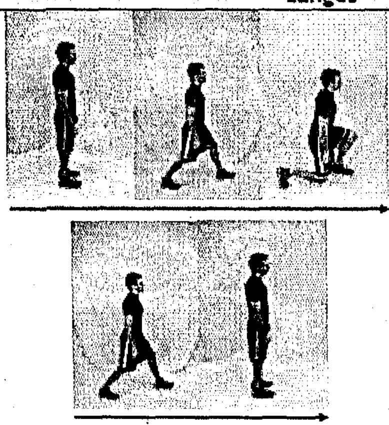
Lying on your back, lift your legs 6-10 cm off the ground. Hold. Then, while keeping your back and your head flush to the ground, lift your legs 45° off the ground. Hold. Lower back to 6-10 cm off the ground. Focus on the number of repetitions for each set.

Difficulty	Description	Repetitions	Time
Beginner	Hold at the top and at the bottom for 1-3 seconds. Move Slowly through the range of motion.	5	30 secs
Novice	Hold at the top and at the bottom for 1-3 seconds.	10	1 min
Intermediate	Hold at the top and at the bottom for 3-5 seconds.	5	1 min
Advanced	Hold at the top and at the bottom for 3-5 seconds.	10	2 min
Expert	Hold at the top and at the bottom for 5-10 seconds.	10	3 min 30 secs

Week	Day	Difficulty
1	3	Beginner
2	2	Beginner
3	1	Beginner
4	3	Intermediate
5	1	Novice
5	4	Intermediate
6	3	Novice

Week	Day	Difficulty
7	1	Advanced
8	4	Expert
9	1	Advanced
9	3	Advanced
10	5	Expert
11	1	Expert

Lunges



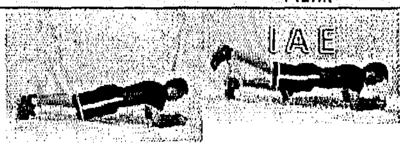
Stand with feet approximately shoulder width apart. Step forward with one foot larger than a normal stride. Lower your back knee so that it almost touches the ground and hold. Rise back up and return to the starting position. Then repeat with the other leg. Maintain a neutral back position throughout the movement. Focus on the number of repetitions for each set.

Difficulty	Description	Repetitions	Time
Beginner	Hold in the lowest position for 1-3 seconds.	10	1 min
Novice	Hold in the lowest position for 3-5 seconds.	10	2 min
Intermediate	Hold in the lowest position for 3-5 seconds.	15	3 min
Advanced	Hold in the lowest position for 5-10 seconds.	10	3 min 30 secs
Expert	Hold in the lowest position for 5-10 seconds.	15	4 min

Week	Day	Difficulty
1	1	Beginner
1	3	Novice
2	3	Novice
3	2	Novice
4	3	Intermediate
5	1	Intermediate
5	4	Intermediate

Week	Day	Difficulty
6	3	Intermediate
7	2	Advanced
8	4	Expert
9	1	Advanced
9	3	Advanced
10	5	Advanced
11	2	Expert

Plank



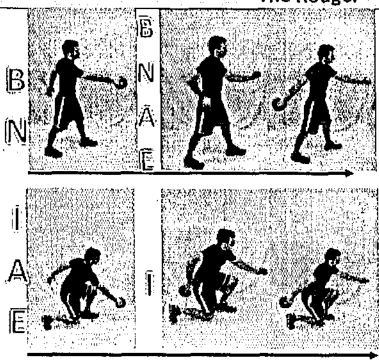
Start with your forearms and your toes on the floor. Keep your body straight from your head to your toes. Your head should be looking at the floor. Focus on the time for each repetition.

Difficulty	Description	Repetitions	Time
Beginner	10-15 second hold	1	15 secs
Novice	20-30 second hold	1	30 secs
Intermediate	10 second hold with toes on floor, 10 second hold while lifting one leg 15 cm off floor, 10 second hold while lifting other leg 15 cm off floor	1	30 secs
Advanced	10 second hold with toes on floor, 10 second hold while lifting one leg 15 cm off floor, 10 second hold while lifting other leg 15 cm off floor, 10 second hold back in starting position	1	40 secs
Expert	15 second hold with toes on floor, 15 second hold while lifting one leg 15 cm off floor, 15 second hold while lifting other leg 15 cm off floor, 15 second hold back in starting position	1	1 min

Week	Day	Difficulty
1	1	Beginner
1	3	Beginner
2	1	Beginner
3	2	Novice
4	2	Novice
5	2	Novice
6	2	Intermediate
6	4	Intermediate
7	2	Advanced
8	2	Advanced

Week	Day	Difficulty
8	5	Advanced
9	2	Intermediate
9	5	Intermediate
10	2	Expert
10	3	Expert
10	4	Expert
11	2	Expert
12	1	Advanced
12	3	Advanced

The Rouger



Hold a light resistance (2-5kg) in one hand. Place your feet in a lunge position, with the forward foot opposite the weighted hand. Extend the weighted arm in front of you. Pull the weight to your side as if you are opening a door, Continue moving the weight behind you by extending your elbow, then return to the forward position. Maintain a neutral spine throughout the movement and avoid twisting if possible. This should be a continuous movement, not a speed movement. Swing unweighted hand opposite weighted hand for balance. Focus on repetitions.

Difficulty	Description	Repetitions	Time
Beginner	Use a chair opposite your weighted hand if needed for balance.	5-10	40 secs
Novice	Swing unweighted hand opposite weighted hand for balance.	10-15	1 min
Intermediate	Perform while in the knees bent (lowest) lunge position.	5-10	40 secs
Advanced	When the weight is forward the knees are bent. Stand up as the weight is pulled towards and behind the body.	5-10	45 secs
Expert	When the weight is forward the knees are bent. Stand up as the weight is pulled towards and behind the body.	10-15	1 min

Week	Day	Difficulty
1	3	Beginner
3	1	Beginner
4	2	Intermediate
5	2	Intermediate
6	1	Intermediate
6	2	Intermediate

Week	Day	Difficulty
6	4	Advanced
7	1	Advanced
8	2	Expert
9	2	Expert
9	5	Expert
10	1	Expert

Week	Day	Difficulty
10	2	Expert
10	3	Expert
10	4	Expert
11	1	Expert
12	1	Expert
12	3	Expert

Side Plank

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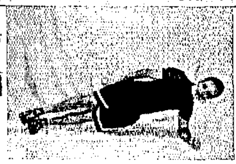

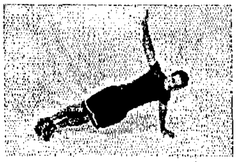

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From the plank position, roll onto one side and remove one forearm from the ground. Maintain a straight line from your shoulders to your feet, preventing your hips from dipping. Hold on one side, then rotate to the other side. Focus on the time to complete each repetition.

Difficulty	Description	Repetitions	Time
Beginner	10-15 second hold/side, free arm resting on your side	1	30 secs
Novice	20-30 second hold/side, free arm resting on your side	1	1 min
Intermediate	20-30 second hold/side, free arm 90° abducted from body vertically	1	1 min
Advanced	Lift further off the mat by supporting yourself only with your hand 20-30 second hold/side, free arm resting on your side	1	1 min
Expert	Lift further off the mat by supporting yourself only with your hand 20-30 second hold/side, free arm 90° abducted from body vertically	1	1 min

Week	Day	Difficulty
1	2	Beginner
2	1	Beginner
3	2	Novice
4	3	Novice
5	2	Novice
6	2	Intermediate
6	4	Intermediate
7	2	Advanced
8	4	Advanced

Week	Day	Difficulty
9	2	Intermediate
9	5	Intermediate
10	2	Expert
10	3	Expert
10	4	Expert
11	2	Expert
12	1	Advanced
12	3	Advanced

Squats	
B N I  A E 	Start with your feet shoulder width apart, arms outstretched in front of you. Lower yourself by bending your knees. Maintain a neutral spine and drop until your knees are bent less than 90°. Hold, and then return to starting position. Focus on repetitions.

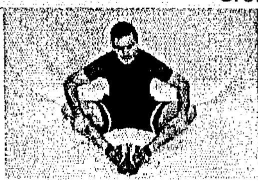
Difficulty	Description	Repetitions	Time
Beginner	Hold each squat for 3-5 seconds.	5	30 secs
Novice	Hold each squat for 3-5 seconds.	10	1 min
Intermediate	Hold each squat for 5-10 seconds.	5	1 min
Advanced	Lift one foot off the ground for each squat. Do not bend down as far with this movement. Hold for 3-5 seconds. Alternate feet.	6	30 secs
Expert	Lift one foot off the ground for each squat. Do not bend down as far with this movement. Hold for 3-5 seconds. Alternate feet.	10	1 min

Week	Day	Difficulty
1	2	Beginner
2	3	Beginner
3	2	Novice
5	1	Novice
5	2	Novice
5	4	Intermediate
6	1	Novice
6	2	Intermediate

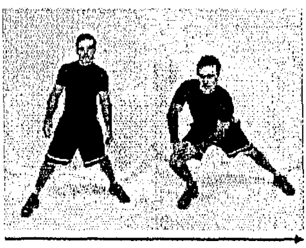
Week	Day	Difficulty
6	3	Intermediate
6	4	Novice
7	2	Advanced
8	2	Advanced
8	5	Advanced
9	1	Advanced
9	2	Expert
9	5	Expert

Week	Day	Difficulty
10	1	Expert
10	2	Expert
10	3	Expert
10	4	Expert
10	5	Expert
11	2	Expert
12	1	Expert
12	3	Expert

Groin Flexibility



From a sitting position on the ground, place soles of feet together. Place hands on inside of knees and push downward slowly. Hold at point of greatest stretch for 20 seconds.



Stand with feet greater than shoulder-width apart. Flex one knee and hip, lowering the body slowly closer to the floor. Hold at point of greatest stretch for 15 seconds. Repeat on both sides

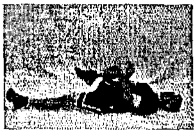
*This exercise does not have an increase in difficulty, but try to increase the amount of stretch performed as the program progresses.

Week	Day
1	1
2	2
2	3
3	3
4	1
4	4
5	1
5	3
5	4
6	1

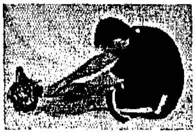
Week	Day
7	3
8	1
8	3
8	4
9	1
9	3
9	4
10	1
11	3
12	2

Thigh Flexibility

From a standing position, raise one foot toward the hips and grasp ankle. Pull leg upward toward buttocks. Repeat on each side. Move through the motion slowly and hold for 5 seconds at the point of greatest stretch.



Lying on your back, grasp the knee and pull knee toward chest, then flex head to knee. Repeat on each side. Move through the motion slowly and hold for 5 seconds at the point of greatest stretch.



From a long-sitting position, grasp the ankles and slowly flex the trunk toward the legs. Hold for 10 seconds at the point of greatest stretch

*This exercise does not have an increase in difficulty, but try to increase the amount of stretch performed as the program progresses.

Week	Day
1	3
2	2
3	3
4	1
4	4
5	3
6	3
7	3

Week	Day
8	1
8	3
9	1
9	4
10	5
11	3
12	2

Trunk Flexibility

Stand with feet shoulder width apart. Clasp hands together overhead with arms straight. Laterally flex trunk to the side approximately 20* and hold for 10 seconds. Repeat on both sides

Sit cross-legged. Rotate trunk to the right. Place hands on right side of the thigh and pull, holding for 10 seconds. Repeat on the opposite side.

*This exercise does not have an increase in difficulty, but try to increase the amount of stretch performed as the program progresses.

Week	Day
1	2
2	1
3	3
4	2
5	2
6	2
7	3
8	2
8	5

Week	Day
9	2
9	5
10	2
10	3
10	4
11	3
12	1
12	3

Weekly Exercise Program

Outline

Week	Focus	Intensity	Duration (mins)		Frequency (per week)	
			Min	Max	Min	Max
Week 1	Exercise Familiarization	Beginner	40	50	3	3
Week 2	Exercise Familiarization	Beginner	40	50	3	3
Week 3	Progression	Novice	35	45	2	3
Week 4	Stabilization	Novice	35	45	3	4
Week 5	Progression	Intermediate	35	45	3	4
Week 6	Stabilization	Intermediate	40	50	3	4
Week 7	Progression	Advanced	35	45	2	3
Week 8	Stabilization	Advanced	45	60	3	5
Week 9	Stabilization	Advanced	45	60	3	5
Week 10	Progression	Expert	45	60	3	5
Week 11	Peak	Expert	40	50	3	3
Week 12	Maintenance	Advanced	40	50	2	3
		Totals	1315	2330	33	45

Calendar

Week	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							

Your calendar for workouts. Schedule your weekly exercise routine here. See pg. 4 for suggestions.

Week	Focus	Difficulty	Duration	Frequency	
1	Exercise familiarization	Beginner	30-40 mins	3x	
Day 1	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Walking/Jogging	Beginner	1	1	10 min
	Planks	Beginner	1	2	15 secs
	Lunges	Beginner	10	2	1 min
	Curl-Up	Beginner	5-7	2	30 secs
	Groin Flexibility	-	1	2	1 min
	Burpies	Beginner	3-5	2	20 secs
	Cool-down	-	1	1	2-3 min
Day 2	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Stairs	Beginner	1	1	10 min
	Squats	Beginner	5	3	30 secs
	Side Plank	Beginner	1	2	30 secs
	Trunk Flexibility	-	1	2	45 secs
	Bird Dog	Beginner	2	2	40 secs
	Cool-down	-	1	1	2-3 min
Day 3	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Pivot	Beginner	10	1	3 mins 45 secs
	Leg Raises	Beginner	5	2	30 secs
	Lunges	Novice	10	2	2 min
	Planks	Beginner	1	2	15 secs
	Thigh Flexibility	-	1	2	1 min
	Rouger	Beginner	5-10	2	40 secs
	Cool-down	-	1	1	2-3 min

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Activity Tracker – Week 1

Day	Activity	Time	Difficulty
Sunday			
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			

Record any other physical activity you participated in during week 1 here. Estimate the difficulty level by using Beginner, Novice, Intermediate, Advanced, Expert. Other activity would include playing or practicing for sports, exercise, walking for more than 10 minutes at a time, and much more.

Week	Focus	Difficulty	Duration	Frequency	
2	Exercise familiarization	Novice	30-40 mins	3x	
Day 1	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Stairs	Novice	1	1	15 min
	Planks	Beginner	1	2	15 secs
	Side Plank	Beginner	1	2	30 secs
	Trunk Flexibility	-	1	2	45 secs
	Burpies	Beginner	3-5	2	20 secs
	Cool-down	-	1	1	2-3 min
Day 2	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Distance Running	Beginner	1	1	20 min
	Bird Dog	Beginner	2	2	40 secs
	Leg Raises	Beginner	5	2	30 secs
	Groin Flexibility	-	1	2	1 min
	Thigh Flexibility	-	1	2	1 min
	Cool-down	-	1	1	2-3 min
Day 3	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Pivot	Beginner	10	2	3 mins 45 secs
	Groin Flexibility	-	1	2	1 min
	Squats	Beginner	5	3	30 secs
	Curl-Up	Beginner	5-7	2	30 secs
	Lunges	Novice	10	2	2 min
	Cool-down	-	1	1	2-3 min

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Activity Tracker – Week 2

Day	Activity	Time	Difficulty
Sunday			
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			

Record any other physical activity you participated in during week 2 here. Estimate the difficulty level by using Beginner, Novice, Intermediate, Advanced, Expert. Other activity would include playing or practicing for sports, exercise, walking for more than 10 minutes at a time, and much more.

Week	Focus	Difficulty	Duration	Frequency	
3	Progression	Novice	35-45 min	2-3x	
Day 1	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Stairs	Novice	1	1	15 min
	Rouger	Beginner	5-10	3	40 secs
	Curl-Up	Novice	7-10	3	40 secs
	Bird Dog	Novice	5	3	1 min 45 secs
	Leg Raises	Beginner	5	3	30 secs
	Cool-down	-	1	1	2-3 min
Day 2	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Pivot	Novice	10	2	3 mins 10 secs
	Squats	Novice	10	3	1 min
	Burpies	Novice	3-5	3	20 secs
	Planks	Novice	1	3	30 secs
	Side Plank	Novice	1	3	1 min
	Lunges	Novice	10	3	2 min
	Cool-down	-	1	1	2-3 min
Day 3	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Walking/Jogging	Novice	1	1	15 min
	Bird Dog	Beginner	2	2	40 secs
	Groin Flexibility	-	1	2	1 min
	Trunk Flexibility	-	1	2	45 secs
	Curl-Up	Beginner	5-7	2	30 secs
	Thigh Flexibility	-	1	2	1 min
	Cool-down	-	1	1	2-3 min

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Activity Tracker – Week 3

Day	Activity	Time	Difficulty
Sunday			
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			

Record any other physical activity you participated in during week 3 here. Estimate the difficulty level by using Beginner, Novice, Intermediate, Advanced, Expert. Other activity would include playing or practicing for sports, exercise, walking for more than 10 minutes at a time, and much more.

Week	Focus	Difficulty	Duration	Frequency	
4	Stabilization	Novice	35-45 min	3-4x	
Day 1	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Distance Running	Beginner	1	1	20 min
	Bird Dog	Novice	5	2	1 min 45 secs
	Curl-Up	Novice	7-10	2	40 secs
	Groin Flexibility	-	1	1	1 min
	Thigh Flexibility	-	1	1	1 min
	Cool-down	-	1	1	2-3 min
Day 2	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Pivot	Novice	10	2	3 mins 10 secs
	Planks	Novice	1	3	30 secs
	Rouger	Intermediate	5-10	3	40 secs
	Curl-Up	Intermediate	7-10	3	40 secs
	Squats	Intermediate	5	3	1 min
	Trunk Flexibility	-	1	3	45 secs
	Cool-down	-	1	1	2-3 min
Day 3	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Stairs	Novice	1	1	15 min
	Lunges	Intermediate	15	2	3 min
	Leg Raises	Intermediate	5	2	1 min
	Burpies	Novice	3-5	2	20 secs
	Side Plank	Novice	1	2	1 min
	Groin Flexibility	-	1	2	1 min
	Cool-down	-	1	1	2-3 min
Day 4*	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Distance Running	Novice	1	1	25 min
	Bird Dog	Novice	5	2	1 min 45 secs
	Curl-Up	Novice	7-10	2	40 secs
	Groin Flexibility	-	1	1	1 min
	Thigh Flexibility	-	1	1	1 min
	Cool-down	-	1	1	2-3 min

Notes:

Activity Tracker – Week 4

Day	Activity	Time	Difficulty
Sunday			
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			

Record any other physical activity you participated in during week 4 here. Estimate the difficulty level by using Beginner, Novice, Intermediate, Advanced, Expert. Other activity would include playing or practicing for sports, exercise, walking for more than 10 minutes at a time, and much more.

Week	Focus	Difficulty	Duration	Frequency	
5	Progression	Intermediate	35-45 min	3-4x	
Day 1	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Walking/Jogging	Novice	1	1	15 min
	Lunges	Intermediate	15	1	3 min
	Leg Raises	Novice	10	2	1 min
	Squats	Novice	10	2	1 min
	Groin Flexibility	-	1	2	1 min
	Curl-Up	Novice	7-10	2	40 secs
	Burpies	Intermediate	3-5	2	25 secs
	Cool-down	-	1	1	2-3 min
Day 2	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Stairs	Intermediate	1	1	10 min
	Rouger	Intermediate	5-10	3	40 secs
	Planks	Novice	1	3	30 secs
	Side Plank	Novice	1	3	1 min
	Trunk Flexibility	-	1	3	45 secs
	Squats	Novice	6	3	30 secs
	Cool-down	-	1	1	2-3 min
Day 3	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Distance Running	Intermediate	1	1	30 min
	Bird Dog	Intermediate	10	1	3 min 30 secs
	Groin Flexibility	-	1	1	1 min
	Thigh Flexibility	-	1	1	1 min
	Cool-down	-	1	1	2-3 min
Day 4*	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Walking/Jogging	Novice	1	1	15 min
	Lunges	Intermediate	15	1	3 min
	Leg Raises	Intermediate	5	2	1 min
	Squats	Intermediate	5	2	1 min
	Groin Flexibility	-	1	2	1 min
	Curl-Up	Novice	7-10	2	40 secs
	Burpies	Intermediate	3-5	2	25 secs
	Cool-down	-	1	1	2-3 min

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Activity Tracker – Week 5

Day	Activity	Time	Difficulty
Sunday			
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			

Record any other physical activity you participated in during week 5 here. Estimate the difficulty level by using Beginner, Novice, Intermediate, Advanced, Expert. Other activity would include playing or practicing for sports, exercise, walking for more than 10 minutes at a time, and much more.

Week	Focus	Difficulty	Duration	Frequency	
6	Stabilization	Intermediate	40-50 min	3-4x	
Day 1	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Pivot	Novice	10	3	3 mins 10 secs
	Rouger	Intermediate	5-10	3	40 secs
	Curl-Up	Intermediate	7-10	3	40 secs
	Squats	Novice	10	3	1 min
	Bird Dog	Intermediate	10	3	3 min 30 secs
	Groin Flexibility	-	1	3	1 min
	Cool-down	-	1	1	2-3 min
Day 2	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Stairs	Intermediate	1	2	10 min
	Rouger	Intermediate	5-10	3	40 secs
	Planks	Intermediate	1	3	30 secs
	Trunk Flexibility	-	1	3	45 secs
	Side Plank	Intermediate	1	3	1 min
	Squats	Intermediate	5	3	1 min
	Cool-down	-	1	1	2-3 min
Day 3	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Pivot	Intermediate	10	2	2 mins 20 secs
	Leg Raises	Novice	10	3	1 min
	Burpies	Intermediate	3-5	3	25 secs
	Thigh Flexibility	-	1	3	1 min
	Lunges	Intermediate	15	3	3 min
	Squats	Intermediate	5	3	1 min
	Cool-down	-	1	1	2-3 min
Day 4*	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Walking/Jogging	Intermediate	1	1	20 min
	Lawnmower	Advanced	5-10	3	45 secs
	Planks	Intermediate	1	3	30 secs
	Trunk Flexibility	-	1	3	45 secs
	Side Plank	Intermediate	1	3	1 min
	Squats	Novice	10	3	1 min
	Cool-down	-	1	1	2-3 min

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Activity Tracker – Week 6

Day	Activity	Time	Difficulty
Sunday			
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			

Record any other physical activity you participated in during week 6 here. Estimate the difficulty level by using Beginner, Novice, Intermediate, Advanced, Expert. Other activity would include playing or practicing for sports, exercise, walking for more than 10 minutes at a time, and much more.

Week	Focus	Difficulty	Duration	Frequency	
7	Progression	Advanced	35-45 min	2-3x	
Day 1	**Exercise**	**Difficulty**	**Repetitions**	**Sets**	**Time/Set**
	Warm up	-	1	1	3-5 min
	Stairs	Advanced	1	1	10 min
	Rouger	Advanced	5-10	2	45 secs
	Curl-Up	Advanced	7-10	2	40 secs
	Bird Dog	Advanced	5	2	1 min 45 secs
	Leg Raises	Advanced	10	2	2 min
	Cool-down	-	1	1	2-3 min
Day 2	**Exercise**	**Difficulty**	**Repetitions**	**Sets**	**Time/Set**
	Warm up	-	1	1	3-5 min
	Pivot	Advanced	15	3	3 mins 30 secs
	Squats	Advanced	6	3	30 secs
	Burpies	Advanced	3-5	3	30 secs
	Planks	Advanced	1	3	40 secs
	Side Plank	Advanced	1	3	1 min
	Lunges	Advanced	10	3	3 min 30 secs
	Cool-down	-	1	1	2-3 min
Day 3*	**Exercise**	**Difficulty**	**Repetitions**	**Sets**	**Time/Set**
	Warm up	-	1	1	3-5 min
	Walking/Jogging	Intermediate	1	1	20 min
	Bird Dog	Intermediate	10	2	3 min 30 secs
	Groin Flexibility	-	1	2	1 min
	Trunk Flexibility	-	1	2	45 secs
	Curl-Up	Intermediate	7-10	2	40 secs
	Thigh Flexibility	-	1	2	1 min
	Cool-down	-	1	1	2-3 min

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Notes:

Activity Tracker – Week 7

Day	Activity	Time	Difficulty
Sunday			
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			

Record any other physical activity you participated in during week 7 here. Estimate the difficulty level by using Beginner, Novice, Intermediate, Advanced, Expert. Other activity would include playing or practicing for sports, exercise, walking for more than 10 minutes at a time, and much more.

Week	Focus	Difficulty	Duration	Frequency	
8	Stabilization	Advanced	45-60 min	3-5x	
Day 1	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Distance Running	Advanced	1	1	30 min
	Bird Dog	Advanced	5	2	1 min 45 secs
	Curl-Up	Advanced	7-10	2	40 secs
	Groin Flexibility	-	1	2	1 min
	Thigh Flexibility	-	1	2	1 min
	Cool-down	-	1	1	2-3 min
Day 2	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Pivot	Advanced	15	3	3 mins 30 secs
	Planks	Advanced	1	3	40 secs
	Rouger	Expert	10-15	3	1 min
	Curl-Up	Advanced	7-10	3	40 secs
	Squats	Advanced	6	3	30 secs
	Trunk Flexibility	-	1	3	45 secs
	Cool-down	-	1	1	2-3 min
Day 3*	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Distance Running	Advanced	1	1	30 min
	Bird Dog	Advanced	5	2	1 min 45 secs
	Curl-Up	Advanced	7-10	2	40 secs
	Groin Flexibility	-	1	1	1 min
	Thigh Flexibility	-	1	1	1 min
	Cool-down	-	1	1	2-3 min
Day 4	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Stairs	Advanced	1	2	10 min
	Lunges	Expert	10	3	4 min
	Leg Raises	Expert	10	3	3 min 30 secs
	Burpies	Expert	5-10	3	1 min 15 secs
	Side Plank	Advanced	1	3	1 min
	Groin Flexibility	-	1	2	1 min
	Cool-down	-	1	1	2-3 min
Day 5*	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Pivot	Advanced	15	3	3 mins 30 secs
	Planks	Advanced	1	3	40 secs
	Rouger	Expert	10-15	3	1 min
	Curl-Up	Advanced	7-10	3	40 secs
	Squats	Advanced	6	3	30 secs
	Trunk Flexibility	-	1	3	45 secs
	Cool-down	-	1	1	2-3 min

Notes:

Activity Tracker – Week 8

Day	Activity	Time	Difficulty
Sunday			
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			

Record any other physical activity you participated in during week 8 here. Estimate the difficulty level by using Beginner, Novice, Intermediate, Advanced, Expert. Other activity would include playing or practicing for sports, exercise, walking for more than 10 minutes at a time, and much more.

Week	Focus	Difficulty	Duration	Frequency	
9	Stabilization	Advanced	45-60 min	3-5x[c]	
Day 1	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Walking/Jogging	Expert	1	1	15 min
	Lunges	Advanced	10	3	3 min 30 secs
	Leg Raises	Advanced	10	3	2 min
	Squats	Advanced	6	3	30 secs
	Groin Flexibility	-	1	3	1 min
	Curl-Up	Advanced	7-10	3	40 secs
	Burpies	Expert	3-5	3	1 min 15 secs
	Cool-down	-	1	1	2-3 min
Day 2	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Stairs	Advanced	1	3	10 min
	Rouger	Expert	10-15	3	1 min
	Planks	Intermediate	1	3	30 secs
	Side Plank	Intermediate	1	3	1 min
	Trunk Flexibility	-	1	3	45 secs
	Squats	Expert	10	3	1 min
	Cool-down	-	1	1	2-3 min
Day 3*	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Walking/Jogging	Expert	1	1	15 min
	Lunges	Advanced	10	2	3 min 30 secs
	Leg Raises	Advanced	10	2	2 min
	Groin Flexibility	-	1	2	1 min
	Curl-Up	Advanced	7-10	2	40 secs
	Burpies	Expert	3-5	2	1 min 15 secs
	Cool-down	-	1	1	2-3 min
Day 4	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Distance Running	Expert	1	1	50 min
	Bird Dog	Intermediate	10	1	3 min 30 secs
	Groin Flexibility	-	1	1	1 min
	Thigh Flexibility	-	1	1	1 min
	Cool-down	-	1	1	2-3 min
Day 5*	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Stairs	Advanced	1	2	10 min
	Rouger	Expert	10-15	3	1 min
	Planks	Intermediate	1	3	30 secs
	Side Plank	Intermediate	1	3	1 min
	Trunk Flexibility	-	1	2	1 min
	Squats	Expert	10	3	1 min
	Cool-down	-	1	1	2-3 min

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Activity Tracker – Week 9

Day	Activity	Time	Difficulty
Sunday			
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			

Record any other physical activity you participated in during week 9 here. Estimate the difficulty level by using Beginner, Novice, Intermediate, Advanced, Expert. Other activity would include playing or practicing for sports, exercise, walking for more than 10 minutes at a time, and much more.

Week	Focus	Difficulty	Duration	Frequency	
10	Progression	Expert	45-60 min	3-5x	
Day 1	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Pivot	Advanced	15	3	3 min 30 secs
	Rouger	Expert	10-15	3	1 min
	Curl-Up	Advanced	7-10	3	40 secs
	Squats	Expert	10	3	1 min
	Bird Dog	Expert	10	3	3 min 30 secs
	Groin Flexibility	-	1	2	1 min
	Cool-down	-	1	1	2-3 min
Day 2*	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Walking/Jogging	Expert	1	1	15 min
	Rouger	Expert	10-15	3	1 min
	Planks	Expert	1	3	1 min
	Trunk Flexibility	-	1	3	45 secs
	Side Plank	Expert	1	3	1 min
	Squats	Expert	10	3	1 min
	Cool-down	-	1	1	2-3 min
Day 3	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Stairs	Expert	1	2	15 min
	Rouger	Expert	10-15	3	1 min
	Planks	Expert	1	3	1 min
	Trunk Flexibility	-	1	3	45 secs
	Side Plank	Expert	1	3	1 min
	Squats	Expert	10	3	1 min
	Cool-down	-	1	1	2-3 min
Day 4*	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Walking/Jogging	Expert	1	1	15 min
	Rouger	Expert	10-15	3	1 min
	Planks	Expert	1	3	1 min
	Trunk Flexibility	-	1	3	45 secs
	Squats	Expert	10	3	1 min
	Cool-down	-	1	1	2-3 min
Day 5	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Pivot	Advanced	15	2	3 min 30 secs
	Leg Raises	Expert	10	3	3 min 30 secs
	Burpies	Expert	5-10	3	1 min 15 secs
	Thigh Flexibility	-	1	3	1 min
	Lunges	Expert	10	3	3 min 30 secs
	Squats	Expert	10	3	1 min
	Cool-down	-	1	1	2-3 min

Notes:____________________________________

Activity Tracker – Week 10

Day	Activity	Time	Difficulty
Sunday			
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			

Record any other physical activity you participated in during week 10 here. Estimate the difficulty level by using Beginner, Novice, Intermediate, Advanced, Expert. Other activity would include playing or practicing for sports, exercise, walking for more than 10 minutes at a time, and much more.

Week	Focus	Difficulty	Duration	Frequency	
11	Peak	Expert	40-50 min	3x	
Day 1	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Stairs	Expert	1	2	15 min
	Rouger	Expert	10-15	2	1 min
	Curl-Up	Expert	10-15	2	1 min
	Bird Dog	Expert	10	2	3 min 30 secs
	Leg Raises	Expert	10	2	3 min 30 secs
	Cool-down	-	1	1	2-3 min
Day 2	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Pivot	Expert	10	3	2 mins
	Squats	Expert	10	3	1 min
	Burpies	Expert	5-10	3	1 min 15 secs
	Planks	Expert	1	3	1 min
	Side Plank	Expert	1	3	1 min
	Lunges	Expert	15	3	4 min
	Cool-down	-	1	1	2-3 min
Day 3	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Walking/Jogging	Advanced	1	1	10 min
	Bird Dog	Intermediate	10	2	3 min 30 secs
	Groin Flexibility	-	1	2	1 min
	Trunk Flexibility	-	1	2	45 secs
	Curl-Up	Intermediate	7-10	2	40 secs
	Thigh Flexibility	-	1	2	1 min
	Cool-down	-	1	1	2-3 min

Notes:

Notes:

Activity Tracker – Week 11

Day	Activity	Time	Difficulty
Sunday			
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			

Record any other physical activity you participated in during week 11 here. Estimate the difficulty level by using Beginner, Novice, Intermediate, Advanced, Expert. Other activity would include playing or practicing for sports, exercise, walking for more than 10 minutes at a time, and much more.

Week	Focus	Difficulty	Duration	Frequency	
12	Maintenance	Advanced	40-50 min	2-3x	
Day 1	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Stairs	Advanced	1	2	10 min
	Rouger	Expert	10-15	2	1 min
	Planks	Advanced	1	2	40 secs
	Side Plank	Advanced	1	2	1 min
	Trunk Flexibility	-	1	2	45 secs
	Squats	Expert	10	2	1 min
	Cool-down	-	1	1	2-3 min
Day 2	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Distance Running	Advanced	1	1	30 min
	Bird Dog	Advanced	10	2	3 min 30 secs
	Curl-Up	Advanced	7-10	2	40 secs
	Groin Flexibility	-	1	1	1 min
	Thigh Flexibility	-	1	1	1 min
	Cool-down	-	1	1	2-3 min
Day 3*	Exercise	Difficulty	Repetitions	Sets	Time/Set
	Warm up	-	1	1	3-5 min
	Stairs	Advanced	1	2	10 min
	Rouger	Expert	10-15	2	1 min
	Planks	Advanced	1	2	40 secs
	Side Plank	Advanced	1	2	1 min
	Trunk Flexibility	-	1	2	45 secs
	Squats	Expert	10	2	1 min
	Cool-down	-	1	1	2-3 min

Notes:____

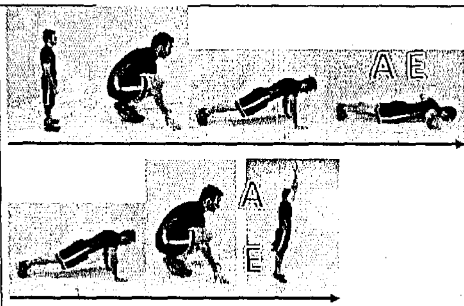
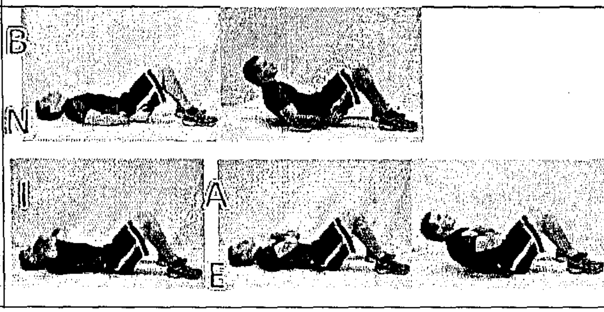
Notes:

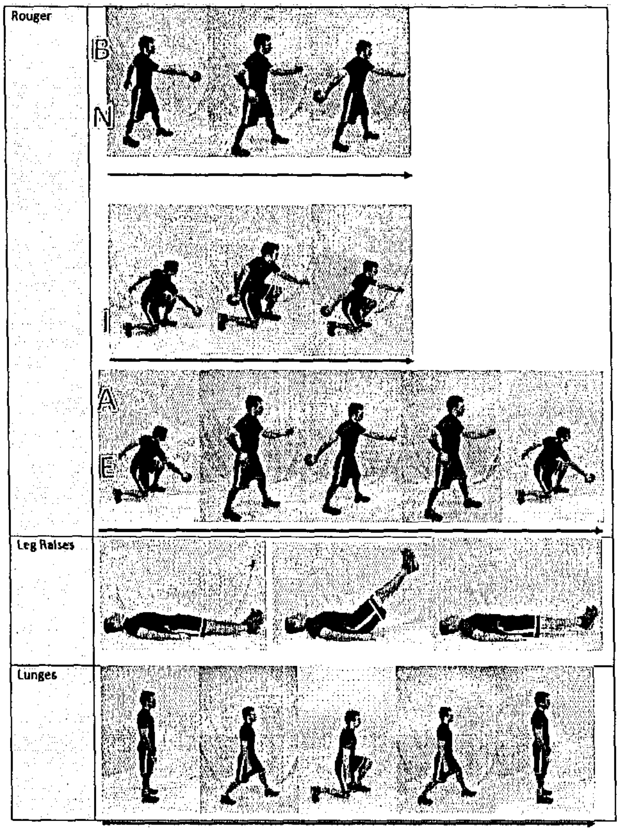
Activity Tracker – Week 12

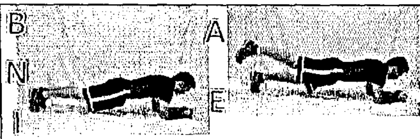
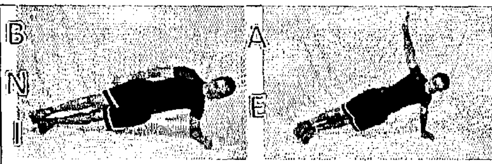
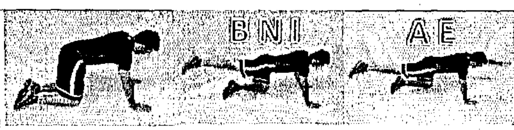
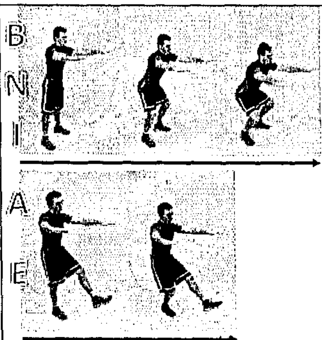
Day	Activity	Time	Difficulty
Sunday			
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			

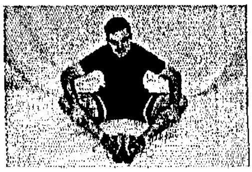
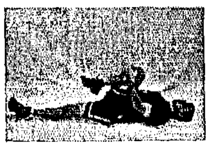
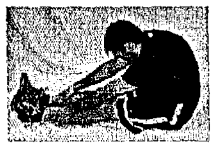
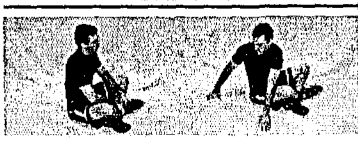
Record any other physical activity you participated in during week 12 here. Estimate the difficulty level by using Beginner, Novice, Intermediate, Advanced, Expert. Other activity would include playing or practicing for sports, exercise, walking for more than 10 minutes at a time, and much more.

IMAGES

Pivot	
Burpies	
Curl-up	


Rouger
B
N
I
A
E
Leg Raises
Lunges

Plank	
Side-Plank	
Bird Dog	
Squats	

Groin Flexibility	 
Thigh Flexibility	  
Trunk Flexibility	 

Fitness Appraisal (to be completed before exercise program begins)

Your Name________________________

Gender (M or F):_____ Age:_____ Height (cm):_____ Weight (kg):_______

Last written PAR-Q+ (date):___/___/_____

Healthy Physical Activity Participation: Score______ Rating* ______

BMI (kg/m^2):_______ Rating* _____ Waist Circumference (cm)*:_________ Rating*______

Wall Sit time (seconds):______ Predicted work capacity*:_____

Rockport 1 mile walk: Time (minutes):______ Heart Rate (bpm):_____ Predicted VO_2max*:______

Grip Strength (kg)*:

	Trial 1	Trial 2	Max
Right			
Left			

Combined score:_____ Rating:_____

Maximum number of consecutive push-ups:______ Rating*:_____

Sit and Reach*: Trial 1:_____ Trial 2:_____ Max:_____ Rating:_____

Partial-curl ups*(max 25):_____ Rating:_____

Composite Musculoskeletal fitness*: Score:_____ Rating:_____

Back Extension*: Time (seconds):_____

(*) Must be completed with a personal trainer present.

Completion Date:___________________________

Completed By:___________________________

Fitness Appraisal (to be completed at the conclusion of the exercise program)

Your Name________________________

Gender (M or F):_____ Age:_____ Height (cm):_____ Weight (kg):_______

Last written PAR-Q+ (date):___/___/_____

Healthy Physical Activity Participation: Score______ Rating* ______

BMI (kg/m^2):_______ Rating*_____ Waist Circumference (cm)*:_________ Rating*______

Wall Sit time (seconds):______ Predicted work capacity*:_____

Rockport 1 mile walk: Time (minutes):______ Heart Rate (bpm):_____ Predicted VO_2max*:______

Grip Strength (kg)*:

	Trial 1	Trial 2	Max
Right			
Left			

Combined score:_____ Rating:_____

Maximum number of consecutive push-ups:______ Rating*:_____

Sit and Reach*: Trial 1:_____ Trial 2:_____ Max:_____ Rating:_____

Partial-curl ups*(max 25):_____ Rating:_____

Composite Musculoskeletal fitness*: Score:_____ Rating:_____

Back Extension*: Time (seconds):_____

(*) Must be completed with a personal trainer present.

Completion Date:____________________________

Completed By:______________________________