OPTIMIZATION OF ACL INJURY PREVENTION: A STUDY OF MOTIVATION AND SELF-EFFICACY

by

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Introduction

Anterior cruciate ligament (ACL) injury is one of the most prevalent musculoskeletal injuries in sport and physical activity. Approximately 175,000 ACL injuries are reported each year in the United States, imposing a significant burden on both the individuals who incur them and society at large (Robey, 2014). It is estimated that ACL injuries are responsible for a cost of over $2 billion annually in the U.S. (Bogardus, 2013; Robey, 2014; Sugimoto et al., 2012; Sugimoto, Myer, Micheli, & Hewett, 2015). Additionally, these injuries result in short and long-term health consequences. In the short-term, individuals often experience decreased psychological well-being, a reduction in physical activity, and disruptions in daily and career-related undertakings (Chan, Derwin King Chung, Lee, Hagger, Mok, & Yung, 2017; Cupal, 1998). Furthermore, treatment often includes ACL reconstruction and many months of rehabilitation, making it both costly and time-consuming (Cupal, 1998; Yoo et al., 2010). The long-term complications of ACL injury include an increased risk of knee osteoarthritis and reinjury, which are prevalent even after ACL surgical reconstruction or therapy aimed at rehabilitation (Kiefer et al., 2015; Sugimoto et al., 2015; Yoo et al., 2010).

The high incidence and severity of anterior cruciate ligament injury have made it a popular topic for injury prevention research. This research has been effective in determining the mechanisms leading to ACL injury and, subsequently, the development of ACL injury prevention programs to alter these mechanisms. These programs have demonstrated the ability to substantially reduce ACL injury risk. However, the overall incidence of ACL injury remains high and continues to rise. One possible explanation for this occurrence is that preventive measures are not widely adopted by the target population or implemented in their routine. Another explanation could be sub-optimal adherence to the program protocol.

The current literature recognizes that lack of adherence is a significant barrier to achieving optimal long-term outcomes. However, there is a void in the research studying how to optimize adherence in an injury prevention program. The purpose of this study is to determine the impact of behavioral processes on an ACL injury prevention program. We hypothesize that participants who are autonomously motivated will demonstrate greater self-efficacy for program adherence, defined as the extent to which one feels they can adhere to the training protocol. This study is necessary to research how motivation influences adherence in an ACL injury prevention training program. This information would be beneficial to physical therapists, coaches, and athletic trainers as they try to improve participant adherence in injury prevention programs.

Literature Review

ACL injuries pose a major threat to competitive and recreational athletes across the globe, as they often result in long-term consequences regarding reinjury, loss in playing time, and development of subsequent health problems (Kiefer et al., 2015; Nessler, Denney, & Sampley, 2017; Sugimoto et al., 2015; Yoo et al., 2010). Research shows that approximately 20% of those who suffer from an ACL injury will reinjure their knee within two years and 79% will eventually develop knee osteoarthritis (Nessler et al., 2017). Despite this, limited research has been conducted on how to successfully implement an ACL injury prevention training program and maximize its effectiveness. While the mechanisms leading to ACL injury have been identified and injury prevention programs have reduced the likelihood of injury, widespread implementation and long-term risk reduction has yet to be achieved (Nessler et al., 2017). One possible limitation of program effectiveness is the inability to account for behavioral processes affecting adherence to preventive measures. The purpose of this literature review is to research theoretical application and training methods to increase adherence and improve the effectiveness of ACL injury prevention programs.

Mechanism of Injury

ACL injuries are most commonly reported in 15 to 25 year-old basketball, soccer, and volleyball athletes (Nessler et al., 2017). Female athletes are predisposed to injury of the anterior cruciate ligament due to anatomical, biomechanical, and hormonal differences. Thus, making them four to six times more likely to sustain an ACL injury than their male equivalents (Nessler et al., 2017). In the past few decades, female sport participation has risen, leading to an increase in ACL injuries and, as a result, greater interest in research surrounding the mechanism of injury (Steffen, Myklebust, Olsen, Holme, & Bahr, 2008).

Injury to the anterior cruciate ligament can be caused by contact or non-contact mechanisms. A direct contact injury results from collision with another athlete. Conversely, non-contact ACL injuries occur due to increased dynamic loading of the knee after a jump landing or loss of balance (Nessler et al., 2017). Research shows that 80% of all ACL injuries are non-contact in nature and the mechanisms leading to injury are therefore modifiable (Benjaminse, Welling, Otten, & Gokeler, 2015; Nessler et al., 2017; Renstrom et al., 2008). Various ACL injury prevention programs have demonstrated the ability to reduce ACL injury risk by improving landing techniques in jumping, cutting, or decelerating maneuvers (Renstrom et al., 2008). This can be accomplished by targeting factors such as increased knee abduction, decreased knee flexion angles, high vertical ground reaction force, and asymmetrical landing (Sugimoto et al., 2015). However, the incidence of ACL injury continues to be a leading problem amongst athletes and in orthopedic sports medicine (Chan et al., 2017). As such, many scholars have recognized the necessity for further research and understanding of both the prevention of ACL injuries and programs that maximize effectiveness.

ACL Injury Prevention Program Effectiveness

Sugimoto et al. (2015) identifies six evidence-based principles (age, biomechanics, exercise, feedback, dosage and adherence) to improve the success of injury prevention programs. Programs targeting 14-18 year-olds demonstrate the greatest success in reducing ACL injury risk (Sugimoto et al., 2015). These programs aim to reduce modifiable biomechanical risk factors, such as those mentioned above (e.g., increased knee abduction, etc.). This is best achieved when a variety of exercises (e.g., plyometric, strength, agility, flexibility and balance training) are incorporated along with instructional feedback (Padua et al., 2018; Sugimoto et al., 2012). The National Athletic Trainers' Association recommends the aforementioned use of multicomponent training, as no single exercise has proven to be efficacious (Padua et al., 2018). Several studies demonstrate an inverse dose-response relationship between neuromuscular training (NMT) volume and ACL injury rates, meaning the higher the training dosage, the lower the injury occurrence (Arundale et al., 2018; Padua et al., 2018; Sugimoto et al., 2012; Sugimoto et al., 2014; Sugimoto et al., 2015). The minimum dosage should be two or more days per week, for at least 20 minutes per session during the pre-season and in-season (Sugimoto et al., 2015). Finally, there must be high adherence, defined by intensity, frequency, and duration, to the training protocol in order to maximize program effectiveness (Sugimoto et al., 2012). There is strong evidence of program efficacy when implementing the above strategies; however, several inconsistencies in the current literature remain. These programs call for high adherence, however, little research has been done to investigate the best practices to improve adherence in these kinds of training programs.

Limitations in the Reporting of Adherence

Multicomponent ACL injury prevention training programs have achieved anywhere from a 39-82% ACL injury risk reduction (Gagnier, Morgenstern, & Chess, 2013; Grindstaff, Hammill, Tuzson, & Hertel, 2006; Hewett, Ford, & Myer, 2006; Nessler et al., 2017; Sadoghi, von Keudell, & Vavken, 2012; Sugimoto, Myer, McKeon, & Hewett, 2012; Taylor, Waxman, Richter, & Shultz, 2015; Yoo et al., 2010). The reason for the variation in outcomes between these programs could be due to inconsistencies in the reporting of program dosage and adherence. One systematic review and meta-analysis mentions adherence as a limitation to their findings, stating that the reviewed studies had adherence rates as low as 26% (Taylor, Waxman, Richter, & Shultz, 2015). This study did not take low adherence rates into account when measuring program dosage, skewing the results and making it difficult to determine program effectiveness. Steffen et al. (2008) observed no injury risk reduction from their program, concluding that it was likely due to low compliance. Another meta-analysis found that performing NMT for more than 30 minutes per week may result in a 68% reduction in ACL injury risk, while performing NMT for less than 15 minutes per week may result in a 44% risk reduction (Sugimoto et al., 2014). These studies emphasize the importance of training volume in ACL injury prevention programs and the consequences of not reporting adherence within these programs.

Another meta-analysis specifically studies adherence within ACL injury prevention programs. Sugimoto et al. (2012) identifies three levels of compliance: high (>66.6%), moderate (33.3-66.6%) and low (<33.3%). Compliance was calculated as attendance rate x completion rate. The results indicate that low compliance may correlate with a 4.9 times greater ACL injury risk, while moderate compliance may result in a 3.1 times greater injury risk than participants with high compliance to a NMT program. This research suggests that adherence rates need to be upward of 66% in order for an ACL injury prevention program to be effective in young physically active females (Sugimoto et al., 2012). Unfortunately, participant adherence is not reported in many ACL injury prevention programs, making it difficult to verify these findings.

As high adherence is essential in effective interventions, the lack of standardized reporting mechanisms is a setback for injury prevention programs. Adherence and compliance are frequently used interchangeably in injury prevention literature despite having different meanings (Owoeye, McKay, Verhagen, Evert A L M., & Emery, 2018). Compliance refers to the extent to which one follows a prescribed training protocol, essentially doing what one is told. Conversely, adherence refers to the extent that one follows a mutually agreed upon training protocol, implying that participants experience a sense of volition (Keats, Emery, & Finch, 2012).

The usage of these terms has significant implications for etiological explanations of program outcomes, specifically regarding the concept of autonomy in self-determination theory. In order to adequately understand the impact of adherence on ACL injury risk reduction, it is essential that the scientific community come to a consensus on whether to measure adherence or compliance and recognize their respective meanings. The term compliance is used in the majority of the ACL injury prevention literature (Hewett, Ford, & Myer, 2006). However, Owoeye et al. (2018) vouches for the use of the term adherence, as it is more practical for ACL injury prevention in everyday settings.

Theoretical Integration to Improve Motivation and Adherence

Adherence to prevention programs is influenced by a myriad of factors, especially motivation. Recently, ACL injury prevention research has applied social psychological theory, namely self-determination theory (SDT), to study how to maximize adherence and improve long-term effectiveness (Chan et al., 2017; Seeberg, 2016). Self-determination theory explains motivation as being either controlled or autonomously motivated (Chan, Derwin K. C. & Hagger, 2012). Autonomous motivation regulates intrinsic motivation (behaviors performed for inherent satisfaction and personal interest), integrated regulation (behaviors performed to fulfill one's psychological needs), and identified regulation (behaviors performed to fulfill a goal). Autonomous motivation is a key predictor of an individual's continued commitment to a prevention program. It is also associated with adaptive outcomes, namely increased sense of well-being and determination (Chan & Hagger, 2012). Conversely, controlled motivation regulates external motivation (behaviors completed to avoid punishment or social consequences) and introjected regulation (behaviors performed to avoid feelings of guilt and improve self-worth) (Chan & Hagger, 2012).

Self-determination theory also posits that there are three psychological needs: autonomy, competence and relatedness. Autonomy refers to a person's principle desire to make decisions concerning his or her own life. Competence refers to the psychological need to seek mastery experience, or feel effective in one's environment. Relatedness is the innate requirement for social support and connectedness (Seeberg, 2016). According to self-determination theory, these three factors are necessary to achieve autonomous motivation and improve performance.

These constructs can be applied to ACL injury prevention to understand how to improve adherence and reduce the incidence of injury. Competence can be achieved in injury prevention programs by educating potential participants on the protocol and benefits of the program, as well as providing feedback throughout the program. Autonomy can be realized by recognizing the necessary commitment to the program and allowing participants to make a decision based on that knowledge. Relatedness can be achieved by building up the participant's support system or incorporating group or partner-based exercises. Autonomous motivation can be fostered through supporting the participant's personal goals and providing them with the resources and knowledge necessary to feel effective within the program (Chan & Hagger, 2012).

Application of self-determination theory in addition to the theory of planned behavior (TPB) has been successful at predicting intention in sports injury prevention and rehabilitation (Chan & Hagger, 2012). TPB addresses shortcomings in the SDT, such as an individual's decision-making process. Therefore, the theory of planned behavior is integrated to incorporate personal beliefs, attitudes, subjective norms, and perceived behavioral control (Chan & Hagger, 2012; Chan et al., 2017). The constructs of TPB could explain a person's behavioral intention to adhere to program requirements and predict future intention to engage in the learned behaviors (Chan & Hagger, 2012). The results of this study concluded that the quality of motivation from SDT may influence prevention and rehabilitation intentions by increasing attitude, perceived behavioral control, and beliefs (Chan & Hagger, 2012)

Dyad training

Dyad training has been shown to improve effectiveness and efficiency of prevention programs (Benjaminse et al., 2015). Dyad training in ACL injury prevention could enhance motor learning and sense of relatedness, while also taking strain off of coaching and athletic training staff. Dyad training usually consists of alternations between observation and performance between peer athletes (Karlinsky & Hodges, 2018). Alternating practice gives the observer a unique opportunity to cognitively assess proper movement technique and problem solve strategies for improving performance (Wulf, Shea, & Lewthwaite, 2010). This form of training can improve motor learning in ACL injury prevention programs and translate to better long-term prevention outcomes (Benjaminse et al., 2015).

Shea et al. (1999) found that dyads alternating between observational, physical, and dialogue practice performed superiorly to individual training in terms of delayed retention and transfer. This experiment found that the skills obtained through dyad training remained intact when the participants performed the tasks individually (Shea, Wulf, & Whltacre, 1999). This study conducted by Shea et al. (1999) shows that observational learning and dialogue between peer learners can have benefits for learning retention and training effectiveness. This could be applied in ACL injury prevention programs to improve the transfer of skills to game-like situations, where injury is most likely to occur.

Another study found that there was no difference in learning retention between the individual group and dyad group, despite the dyad receiving only half the amount of hands-on physical practice (Sanchez-Ku & Arthur, 2000). This study, called AIM, demonstrated that observing and/or interacting with a peer partner can halve the amount of physical practice time necessary for retention (Sanchez-Ku & Arthur, 2000). These findings indicate the potential for reducing barriers to ACL injury prevention program implementation, such as limited funds and equipment due to a lesser amount of hands-on time needed to generate results. (Hodges & Williams, 2012).

Research Questions

Do participants experience increased levels of motivation, adherence, and effort when training in a dyad versus individually? Does increased motivation, adherence, and effort translate to improved performance on retention and/or transfer tests?

Methods

Participants

The sample (*N*=4) consisted of recreationally active athletes (mean age [20.25 ± 1.26], 75% female) from North Carolina. Participants were excluded from the training study if they were under the age of 18 or over the age of 25, were experiencing or recovering from a lower-extremity injury at the time of testing, had a BMI >30 kg/m^2, or did not meet the criteria for being recreationally active (defined by participation in sport or high intensity exercise at least 3 days per week and/or 6 hours per week). The study received prior approval by the Institutional Review Board. Each participant read and signed a consent form before biomechanical and survey evaluation (see Appendix 1).

Measures

The first 9 questions in the survey asked about demographics, knee injury history, and current sports participation (See Appendix 3). Questions 1-5 asked for demographic information such as height, weight, age, ethnicity, and gender respectively. Question 6 gathered information on which sports and activities the subjects were currently involved in, for how many hours per week, and for how many days per week. Questions 7-8 asked if the subjects had previously injured their ACL or another part of their knee that caused them to lower their physical activity level. If yes was selected for question 7 or 8, the participants were asked when the injury occurred and what part of the knee was injured in question 9.

The survey also consisted of seven items assessing participants' self-efficacy in their ability to adhere to an 8-week injury prevention training program, despite barriers such as stress, scheduling conflicts, criticism, low mood, and lethargy. In order to measure self-efficacy for program adherence, a modified version of the Self-Efficacy for Exercise Scale (SEE) was utilized (see Appendix 3). This scale is both valid and reliable, with an internal consistency of 0.92, and has been used in a variety of exercise programs (Resnick & Jenkins, 2000). The responses were recorded on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). The mean score of the survey items was calculated for each participant.

The Behavioral Regulation in Sport Questionnaire (BRSQ) was utilized to measure self-determined forms of motivation (see Appendix 3). This questionnaire was developed to examine the tenets of self-determination theory in competitive athletes and demonstrates a good test-retest reliability, as well as internal consistency, and validity (Lonsdale, Hodge, & Rose, 2008). The survey consisted of 10 items measuring types of motivation and responses were recorded on a 7-point Likert scale. Five subscales were included in the survey: amotivation (n=1), external regulation (n=2), introjected regulation (n=2), identified regulation (n=3), and intrinsic motivation general (n=2). The sixth subscale in the BRSQ, integrated regulation, was excluded from this survey due to reports in the literature suggesting overlap with other subscales (Lonsdale et al., 2008). Each subscale was scored by taking the average score of all items included in the subscale. Subscale scores closer to 1 indicated that the type of motivation had little influence on the participant's drive to participate in the training program, while scores closer to 7 indicated a larger influence. The components of amotivation (e.g., "I am not sure why I am motivated to attend this training program"), external regulation (e.g., "I want to satisfy other people"), and introjected regulation (e.g., "I feel obligated to") were grouped together as "non-self-determined motivation." The components of identified regulation (e.g., "I value the benefits of this program") and intrinsic motivation general (e.g., "it looks fun") were grouped together as "self-determined motivation." The resulting groups were scored by taking the average score of the included subscales.

Three items were developed to measure the importance of relatedness in a training program (See Appendix 3). Participants were asked to rate how strongly they agreed or disagreed with statements measuring the underpinnings of relatedness. The items all began with the stem "it is important to me that I…" and ended with "feel supported in an exercise program," "feel comfortable with the people I exercise with," or "have positive relationships with the people I train with." The items were scored on a 7-point Likert scale and the mean score of the three items was calculated to determine the importance of relationships in the prevention program.

Procedure

All participation in this study was voluntary. To recruit participants, flyers were posted around the East Carolina University campus (see Appendix 2). Interested participants contacted program coordinators for more information regarding the study. This study was part of a larger study which included 3D motion capture, EEG, and EMG. Subjects who agreed to participate came to the lab for biomechanical testing and survey evaluation, which took a total of approximately 2 hours to complete. The survey portion of the data collection took approximately 10 minutes and was administered using Qualtrics survey software. Following the initial evaluation, subjects were enrolled in an 8-week ACL injury prevention program.

Statistical Analysis

The survey responses were transferred into Statistical Package for Social Sciences (SPSS) software, where they were coded and analyzed. Descriptive statistics were used for the demographic information. An internal consistency analysis was performed on survey scales to determine Cronbach's alpha coefficient. The scale was considered to be reliable with strong internal consistency if Cronbach's alpha coefficient was greater than 0.70. Descriptive statistics were used to identify variability and patterns within and among the self-efficacy, motivation and relatedness scales.

Results

Demographics

A total of four participants were included in the study; none of the interested participants refused to participate and none were excluded from the study. Tables 1a and 1b present descriptive statistics of demographic, primary sport participation, and knee injury history.

Table 1a. Descriptive Statistics of Demographics (N=4)

Variable	Mean	Std. Deviation
Height (m)	62.37	1.68
Weight (kg)	1.69	0.10
BMI (kg/m2)	22.15	2.98
Age (years)	20.25	1.26

Table 1b. Descriptive Statistics of Demographics Cont. (N=4)

Variable	Sample Size	Percent
Gender		
Male	1	25
Female	3	75
Ethnicity		
White/European American	2	50
African American	2	50
Primary Sport/Activity		
Basketball	2	50
Dance	1	25
Other	1	25
Prior Knee Injury		
Yes – ACL	2	50
Yes – Meniscus	1	25
No	1	25

Internal Consistency

An internal consistency analysis was conducted for the 7 items measuring self-efficacy, each of the BRSQ subscales, and the 3 items measuring relatedness. A Cronbach's alpha coefficient of greater than 0.70 indicated good internal consistency or reliability. Table 2a displays Cronbach's alpha coefficients for the self-efficacy items. Two of the original SEE items were excluded due to low internal consistency and one item was excluded due to having zero variance (the original scale is denoted by SEE and the new 4-item scale is denoted by SEE*). Table 2b includes Cronbach's alpha coefficients for the BRSQ subscales of introjected regulation, identified regulation, and intrinsic motivation. Cronbach's alpha coefficient could not be calculated for amotivation because the subscale consists of only one item. Additionally, an internal consistency analysis could not be performed for the external regulation subscale or relatedness due to having too many items excluded for having zero variance.

Table 2. Reliability Statistics: Cronbach's alpha for SEE and SEE*

Subscale	Cronbach's Alpha
SEE	-0.126
SEE*	0.762
Introjected Regulation	0.974
Identified Regulation	1.0
Intrinsic Motivation	0.89

Notes: SEE consists of items 1-7. SEE* consists of items 2-5.

Descriptive Statistics: Self-Efficacy for Adherence, Motivation and Relatedness

Descriptive statistics for self-efficacy, the five BRSQ subscales, and relatedness were measured in Table 3. This table summarizes how strongly the total sample rated each variable. Each participant's mean score of the 4 items in the SEE* (questions 2-5 in the original SEE) were graphed in Figure 1. Descriptive statistics for each of the 7 items in the SEE were displayed in Table 4. Each participant's mean score for the five BRSQ subscales (amotivation, external regulation, introjected regulation, identified regulation, and intrinsic motivation) were graphed in Figure 2. The external regulation and introjected regulation subscales were averaged and graphed for each participant as the "non-self-determined motivation" subscale in Figure 3 (mean = 2.33, Std. Deviation = 0.58, minimum = 1.83, maximum = 3.17). The identified regulation and intrinsic motivation subgroups were averaged and graphed for each participant as the "self-determined motivation" subscale in Figure 3 (mean = 6.44, Std. Deviation = 0.66, minimum = 5.75, maximum = 7.00). For each of the following tables and figures there was a possible range of 1-7 for all variables.

Table 3. Mean Score, Standard Deviation, and Range for Self-Efficacy for Adherence, Motivation and Relatedness (N=4)

Variable	Mean	Std. Deviation	Minimum	Maximum
Self-Efficacy	5.5	0.43	5.0	6.00
Amotivation	1.75	0.50	1	2
External Regulation	2.88	1.31	1	4
Introjected Regulation	2.38	1.55	1	4.5
Identified Regulation	6.5	0.58	6	7
Intrinsic Motivation	6.38	0.75	5.5	7
Relatedness	6.00	0.38	5.67	6.33

Note: Self-efficacy descriptive statistics calculated using the 4-items in the SEE*.

Figure 1. Mean SEE* Score for Each Participant

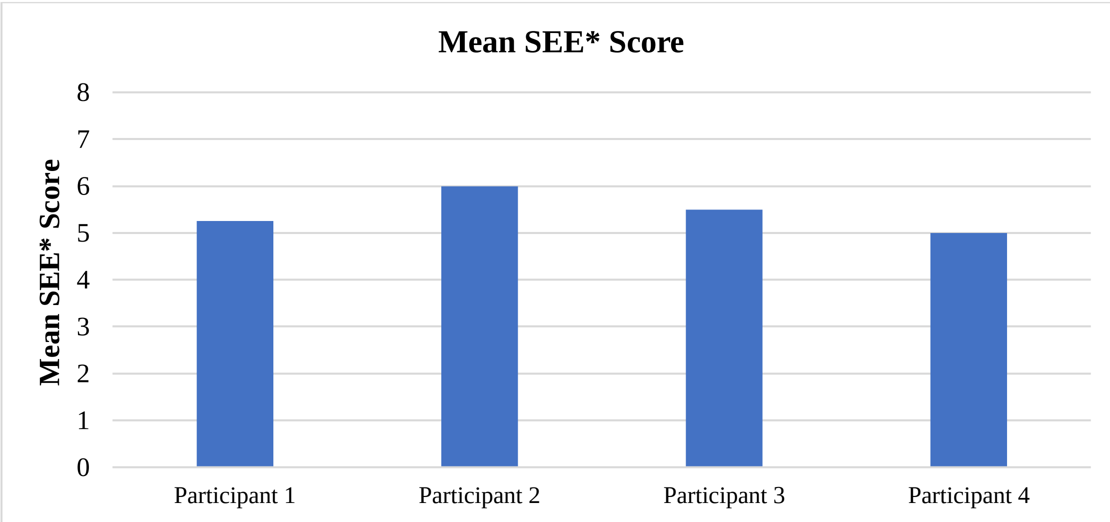


Table 4. Mean and Standard Deviation of the 7-items in the SEE.

Statement	Mean	SD
I am confident that I can participate in this program consistently three times per week for the next 8 weeks.	6.25	0.50
I am confident that I can make time for this program no matter how busy my day.	5.25	0.50
I am confident that I can motivate myself to attend no matter how tired I may feel.	5.50	0.58
I am confident that I can motivate myself to attend no matter how stressed I feel.	5.50	0.58
I am confident that I can motivate myself to attend even when I'd rather be doing something else.	5.50	0.58
I am confident that I can motivate myself to attend even if my friends criticize me for it.	6.25	0.50
I am confident that I can motivate myself to attend even when I am feeling down.	6.00	0.00

Figure 2. Mean BRSQ Subscale Score for Each Participant

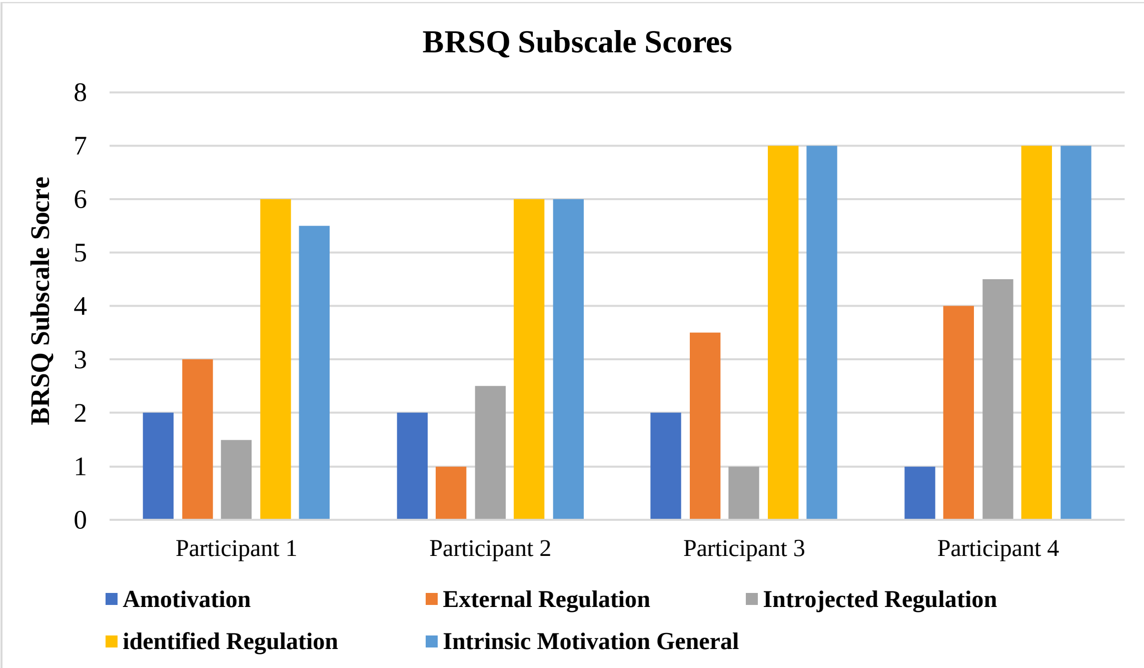
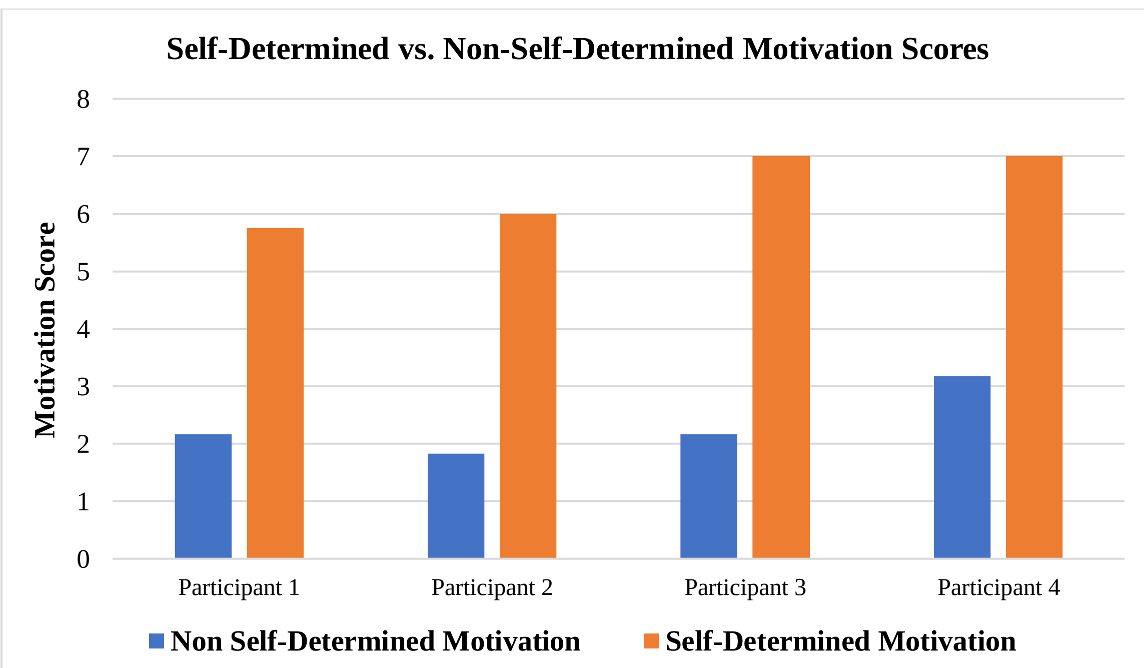


Figure 3. Self-Determined versus Non-Self-Determined Motivation Scores for Each Participant



Discussion

Due to the COVID-19 Pandemic, all activities related to this study were suspended as of 3/12/20. This study was lab based and required face-to-face contact, rendering further data collection unsafe. As a result, participation in the study was low and the training portion of the study could not be completed. No data was collected concerning dyad training and its impact on participant's levels of motivation, adherence, and effort. It also could not be determined whether increased motivation, adherence, and effort translated to improved performance on retention or transfer tests. Ultimately, this study was significantly impacted by COVID-19 and the proposed research questions could not be answered. The focus of this discussion will instead aim to explore the results of the pre-test analysis and offer suggestions for future exploration.

The current study does not support the hypothesis that participants who are autonomously motivated will demonstrate greater self-efficacy for program adherence. No statistically significant correlations were found between SDT subscales, self-efficacy for adherence, or relatedness in the study. Correlations may have been found if the sample size was larger or data was collected over the course of the training program. Results of other studies have found that higher non-self-determined motivation at pre-test predicted higher self-efficacy at 6 months, which actually led to cessation of physical activity at 12 months (Maibach, Flora, & Nass, 1991).

Generally, the study participant's motivation appeared to stem from self-determined factors, indicated by the high mean score for the self-determined motivation group versus non-self-determined. This result is supported by previous research, which has found that participation in voluntary activities is associated with high self-determined motivation and low non-self-determined motivation (Lonsdale et al., 2008). One interesting finding in the present study was that participants who had a history of knee injury tended to score higher on the external regulation subscale.

Overall, participant’s self-efficacy in their ability to adhere to the program was relatively high at pretest. Self-efficacy has been associated with future adherence in various programs. One study found that self-efficacy for exercise was the only predictive factor of exercise maintenance adherence. Similarly, Medina-Mirapeix et al. (2009) found that self-efficacy was predictive of adherence, in terms of both frequency and duration, to a home exercise program. Unfortunately, no data was collected in the present study to corroborate these findings since the training portion could not be completed.

Another interesting finding from the self-efficacy scale items was that when participants were asked about their confidence in their ability to attend training three times per week for the next 8 weeks, they reported the highest scores. However, participant self-efficacy significantly decreased upon being asked about potential barriers they may face. The participants were least confident in their ability to attend training when considering the barrier of having a busy day, indicated by the lowest mean score of the self-efficacy items. This finding was consistent with previous research, which implicates time as a primary barrier to adherence (Picha, 2018).

Limitations and Future Research

One strength of this study was that the different subscales of motivation were examined in addition to a “self-determined motivation” subscale and a “non-self-determined motivation” subscale. Using both methods allowed for a more general analysis of motivational quality in addition to specific observations about the subscales. However, the integrated regulation subscale was not studied, which could have skewed results. Additionally, the BRSQ was adapted for use in this study. The BRSQ was not made for use in an injury prevention program. Future research should focus on the development of a proper measurement tool for self-efficacy, motivational quality, and adherence in the context of injury prevention.

As previously mentioned, another significant limitation of this study was the small sample size. Given that only four participants were enrolled in the study, the types of statistical analyses that could be run and the overall findings of the study were significantly limited. The results found may not be generalizable to the target population of recreationally active athletes. The primary barrier to recruiting participants was the time commitment associated with the training portion of the program. Potential participants were unsure if they could make time for training three times per week. Future studies should aim to recruit participants who are currently active in team sports, including intramural, club, or competitive sports.

Another limitation of this study was the subjective nature of the data collection. All measures were self-reported in the surveys and were therefore subject to potential inaccuracies. The results were also limited to data from the pretest surveys alone. Future research on this topic should employ a longitudinal research design to identify the patterns of occurrence for the variables of SDT motivation and self-efficacy and determine their effect on adherence to an ACL injury prevention program. It is known that self-efficacy changes over time in response to different situations, including vicarious experience and role modeling (Picha, 2018). Future research should identify effective interventions for improving self-efficacy and self-determined motivation in ACL injury prevention programs. Dyad training is a relatively understudied topic in injury prevention literature and could be a promising method for future exploration. Identifying factors and interventions that improve adherence in ACL injury prevention programs is a crucial step toward optimizing their effectiveness and ultimately reducing the occurrence of ACL injuries.

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Appendix 1: Informed Consent

Informed Consent to Participate in Research

Information to consider before taking part in research that has no more than minimal risk.

Title of Research Study: Influence of jump-landing training on lower-extremity biomechanics

Principal Investigator: Nicholas Murray (Person in Charge of this Study)
Institution, Department or Division: Department of Kinesiology
Address: 166 Minges Coliseum, Greenville, NC 27858
Telephone #: (252) 737-2977

Researchers at East Carolina University (ECU) study issues related to society, health problems, environmental problems, behavior problems and the human condition. To do this, we need the help of volunteers who are willing to take part in research.

Why am I being invited to take part in this research?

The purpose of this study is to evaluate the effect that an eight-week jump-landing training program has on lower-extremity biomechanics in distracted landing-tasks. You are being invited to take part in this research because you are a healthy adult between 18-25 years of age, have no current lower-extremity injuries, do not wear a brace that prohibits full range of motion, and participate in a team sport at least 3 days/week and/or 6 hours/week. The decision to take part in this research is yours to make. By doing this research, we hope to learn how jump-landing training can influence biomechanics during distracted landing.

If you volunteer to take part in this research, you will be one of about 40 people to do so.

Are there reasons I should not take part in this research?

There are minimal risks associated with this study, however, you should not participate if you are currently experiencing or recovering from a lower-extremity injury that prohibits full range of motion in a joint or your ability to complete a series of jump-landing tasks. You can choose not to participate at any time prior to or during the study.

What other choices do I have if I do not take part in this research?

You can choose not to participate.

Where is the research going to take place and how long will it last?

The research will be conducted at East Carolina University in Greenville, North Carolina. You will need to come to the Human Movement Analysis Lab located on the first floor of the Laupus Library building located on the ECU Health Science Campus two times during the study. The pre and post testing sessions will last approximately 1-1.5 hours each. For the training sessions, you will be asked to arrive at the ECU Student Recreation Center on main campus or the ECU Health Science Recreation Center. Training sessions will occur 3 days/week for eight weeks and are expected to last 30 minutes.

What will I be asked to do?
You will be asked to do the following: complete a maximum jump height task and four jump-landing conditions for pre and post training data collections. For the maximum jump height trial, you will step onto the force plate and jump as high as you can.
The four jump conditions include:

- Focused jump: no distraction present, jump up and focus on landing.
- Distracted jump: you will jump up on the force plate and grab a suspended ball.
- Moving target jump: you will step onto the force plate and jump to catch a ball released from a ball-release apparatus.
- Walking jump: you will start off the force plate, take a step onto the force plate, and jump up as you take that one step.

During the pre and post training sessions, a non-invasive EEG cap will be used to record brain activity. Once the cap is in place and properly aligned, the scalp under each electrode will be prepared by first gently abrading the skin using the wooden end of a standard cotton swab with pumice and Vitamin E to reduce impedance to the electrode, and then inserting a conductive gel with a 16-gauge blunt needle. Eye movements will be recorded with electrodes placed above and below the left eye to capture electrooculographic (EOG) activity.
Non-invasive Electromyography (EMG) electrodes will be placed over the motor points of the gastrocnemius lateralis and tibialis anterior to monitor ankle flexion and extension, and rectus femoris and biceps femoris.

For the training program, you will be asked to train individually or with a partner. Prior to training, you will complete a survey containing questions about individual and paired training. Every participant will complete the same routine of agility, balance, and plyometric exercises. Certain plyometric exercises will contain distraction tasks. You will receive verbal or video bandwidth feedback throughout the training program based on your recruitment period (spring/summer 2020 or fall 2020). Verbal feedback are the traditional verbal cues that coaches and/or experts provide to athletes to help improve or alter a movement. Video bandwidth feedback provides a computer generated model of correct movement patterns and allows you to see how closely your movements align with the model, thus, reducing the need for verbal feedback from the study staff.

What might I experience if I take part in the research?
There is a minimal risk of injurt with an athletic movement. Any risks that may occur with this research are no more than what you would experience in your normal team sport activities or typical training session. We don't know if you will benefit from taking part in this study. There may not be any personal benefit to you but the information gained by doing this research may help others in the future.

Will I be paid for taking part in this research?
We will not be able to pay you for the time you volunteer while being in this study.

Will it cost me to take part in this research?
It will not cost you any money to be part of the research.

How will you keep the information you collect about me secure? How long will you keep it?

Your data will be stored on a secured server. You will be assigned an ID number and that will be used to identify any of your data files. The data will not contain any information that can be used to identify you. Data will be kept for a minimum of 3 years following the completion of this study.

What if I decide I don't want to continue in this research?

You can stop at any time after it has already started. There will be no consequences if you stop and you will not be criticized. You will not lose any benefits that you normally receive.

Who should I contact if I have questions?

The people conducting this study will be able to answer any questions concerning this research, now or in the future. You may contact the Principal Investigator at (252) 737-2977 (Monday-Friday, between 9:00-5:00)

If you have questions about your rights as someone taking part in research, you may call the Office of Research Integrity & Compliance (ORIC) at phone number 252-744-2914 (days, 8:00 am-5:00 pm). If you would like to report a complaint or concern about this research study, you may call the Director of the ORIC, at 252-744-1971.

Is there anything else I should know?

Identifiers might be removed from the identifiable private information or identifiable biospecimens and, after such removal, the information or biospecimens could be used for future research studies or distributed to another investigator for future research studies without additional informed consent from you or your Legally Authorized Representative (LAR). However, there still may be a chance that someone could figure out the information is about you.

I have decided I want to take part in this research. What should I do now?

The person obtaining informed consent will ask you to read the following and if you agree, you should sign this form:

- I have read (or had read to me) all of the above information.
- I have had an opportunity to ask questions about things in this research I did not understand and have received satisfactory answers.
- I know that I can stop taking part in this study at any time.
- By signing this informed consent form, I am not giving up any of my rights.
- I have been given a copy of this consent document, and it is mine to keep.

____

Participant's Name (PRINT) **Signature** **Date**

Person Obtaining Informed Consent: I have conducted the initial informed consent process. I have orally reviewed the contents of the consent document with the person who has signed above, and answered all of the person's questions about the research.

____

Person Obtaining Consent (PRINT) **Signature** **Date**

Appendix 2: Flyer for Participant Recruitment

Jump Landing Research Study

Human Movement Analysis Laboratory
Health Sciences Building at East Carolina University

What will you be doing?

Participating in three 30-45 minute jump landing training sessions per week for 8 weeks.
Complete a pre and post training landing evaluation.

Who Qualifies?

Recreationally active individuals who are 18-25 years old and who participate in team sports at least 3 days a week or for 6 hours per week. Examples inlcude: basketball, soccer, volleyball, football, gymnastics, cheerleading, or dancing.

Why should you participate?

By participating, you will gain insight into your jump landing technique and evaluation of risk factors for injury that may or may not be present!

Interested? Contact Dylan Sampson at: sampsond16@students.ecu.edu

Made with PosterMyWall.com

Appendix 3: Pre-Test Survey

Instructions: The following questions will give you the opportunity to tell us about yourself. Read each statement carefully to answer to the best of your ability. There are no right or wrong answers.

1. What is your height?

____ feet _____ inches

2. How much do you weigh?

_______ lbs

3. How old are you?

_______ years old

4. What is your ethnicity?

_____ African American _____ Asian/Asian American
_____ Latino/a _____ White/European American
_____ Arab/Middle Eastern _____ Other

5. What is your gender?

Male Female Prefer not to answer

6. We are interested in your general sporting background experience. Think of the sports or activities (ex: basketball, soccer, gymnastics, cheerleading, dance, etc) that you are currently involved in and answer the questions below.

Sport / Activity	**Approximately how many hours per week do you participate in this sport?**	**Approximately how many days per week do you participate in this sport?**
1.		
2.		
3.		

7. Have you ever injured your ACL?

_____ Yes _____ No

8. Have you ever had a knee injury that caused you to lower your physical activity level?

_____ Yes _____ No

9. If you answered yes to question 7 or 8, can you briefly explain when the injury occurred and what part of your knee was injured?

____

____

____

____

Instructions: The following statements are about your confidence in your ability to attend this program. Read each statement carefully and bubble an answer based on how strongly you agree or disagree with the statement. There are no right or wrong answers.

Please honestly rate how strongly you agree or disagree with the following statements at this moment in time...

	Strongly Disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
I am confident that I can participate in this program consistently three times per week for the next 8 weeks.	○	○	○	○	○	○	○

I am confident that I can make time for this program no matter how busy my day.	○	○	○	○	○	○	○
I am confident that I can motivate myself to attend no matter how tired I may feel.	○	○	○	○	○	○	○
I am confident that I can motivate myself to attend no matter how stressed I feel.	○	○	○	○	○	○	○
I am confident that I can motivate myself to attend even when I'd rather be doing something else.	○	○	○	○	○	○	○
I am confident that I can motivate myself to attend even if my friends criticize me for it.	○	○	○	○	○	○	○
I am confident that I can motivate myself to attend even when I am feeling down.	○	○	○	○	○	○	○

Instructions: The following statements are about <u>why you are motivated to attend</u> this injury prevention program. Read each statement carefully and bubble an answer based on how strongly you agree or disagree with the statement. There are no right or wrong answers.

Please honestly rate <u>how strongly you agree or disagree with the following statements</u> at this moment in time...

	Strongly Disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
I am not sure why I'm motivated to attend this training program	○	○	○	○	○	○	○
I am motivated to attend this training program because I want to satisfy other people	○	○	○	○	○	○	○
I am motivated to attend this training program because I feel pressured to from others	○	○	○	○	○	○	○
I am motivated to attend this training program because I would feel guilty if I didn't attend	○	○	○	○	○	○	○

I am motivated to attend this training program because I feel obligated to	○	○	○	○	○	○	○
I am motivated to attend this training program because preventing injury is important to me	○	○	○	○	○	○	○
I am motivated to attend this training program because I value the benefits of this program	○	○	○	○	○	○	○
I am motivated to attend this training program because I want to learn proper form and technique	○	○	○	○	○	○	○
I am motivated to attend this training program because it looks fun	○	○	○	○	○	○	○
I am motivated to attend this training program because I think I will enjoy it	○	○	○	○	○	○	○

Instructions: The following statements are about the importance of relationships in an exercise program. Read each statement carefully and bubble an answer based on how strongly you agree or disagree with the statement. There are no right or wrong answers.

Please honestly rate how strongly you agree or disagree with the following statements at this moment in time...

	Strongly Disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
It is important to me that I feel supported in an exercise program	○	○	○	○	○	○	○
It is important to me that I feel comfortable with the people I exercise with	○	○	○	○	○	○	○
It is important to me that I have positive relationships with the people I train with	○	○	○	○	○	○	○