Barriers to Compliance in a Home-Based Anterior Cruciate Ligament Injury Prevention Program in Female High School Athletes

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ABSTRACT

Importance: Supervised injury prevention programs can decrease injuries in female high school athletes. Research regarding home-based injury prevention programs is limited.

Objective: To identify barriers to compliance with a home-based injury prevention program in rural Wisconsin female high school basketball players.

Design: Cross-sectional study including participants from 9 rural Wisconsin high schools. Participants were instructed in appropriate exercise form and DVD use in a group-based format. Participants were instructed to perform the home-based program 3 times per week for 8 weeks. Participants then completed a survey regarding their program compliance.

Setting: Exercise instruction and surveys were completed in the participant's high school gymnasium.

Participants: Female students in grades 9-12, who intended to play basketball, were invited to participate. Of the 175 eligible students, 66 enrolled in the study.

Intervention: The intervention consisted of a DVD-based injury prevention program.

Main Outcome: Our hypothesis—that compliance with a home-based injury prevention program would be low—was established prior to study commencement. Outcome measures consisted of self-reported responses by participants. Statistics are descriptive.

Results: Follow-up surveys were completed by 27 of 66 participants, with 50% reporting performing the injury prevention program 0-3 times per week. The reasons for low compliance included "I did not have time to do the program," followed by "I forgot to do the program."

Conclusions and Relevance: Wisconsin female high school basketball players demonstrated very low compliance with a home-based injury prevention program. This paper identifies barriers to compliance.

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INTRODUCTION

Sports-related lower extremity musculoskeletal injuries are common in females; 52% of female high school athletes in Wisconsin reported sustaining a sports-related injury that required them to modify or miss participation.[1] Among directly comparable high school sports (soccer, basketball, and baseball/softball), girls sustain more severe injuries than boys.[1] In the short term, this may result in less overall sport participation for females; the long-term consequences may include chronic pain, decreased function, and a decrease in lifetime physical activity.[2]

As compared to males, females are up to 8 times more likely to sustain a non-contact tear of the anterior cruciate ligament (ACL) in the knee.[3] These injuries often require surgery, lengthy rehabilitation, and result in an increased risk of degenerative arthritis.[3] However, recent studies have reported that utilization of a preseason and in-season injury prevention program can decrease the rate of ACL tears in females.[4] A program consisting of strengthening, jumping drills, and agility drills was effective in decreasing the incidence of ACL tears in high school female soccer players by 88%.[5] Other studies have reported similar findings.[4]

As with other injury prevention programs, these effective programs were supervised;[4,6,7] athletes who were highly compliant had a lower rate of ACL tears compared to participants with poor compliance.[8,9] However, few studies to date have used a home-based injury prevention program.[10] Because of differences in program design, lack of a control group, and a lack of tracking injury data,[10] it cannot be determined if a home-based program is effective in preventing ACL tears.

Table 1. Exercise Components and Progression of Home-Based, 8-Week Injury Prevention Program

Weeks 1-3		
	Number of Exercises/ Category[a]	**General Exercise Concepts**
Strength	5	Most exercises were double limb support, such as squats, stationary lunges, and bilateral heel raises. Most exercises focused on the sagittal plane.
Plyometric exercise	2	Jumps were 2-footed; most movement was in the sagittal plane, with small movements in the frontal plane.
Balance	2	Balance activities were single leg, primarily on the ground with small self-perturbations with the other lower extremity (or the upper extremity, like dribbling a basketball).
Weeks 4-6		
	Number of Exercises/ Category[a]	**General Exercise Concepts**
Strength	4	Strength exercises progressed to single leg (alternating lunges), and incorporated frontal (side raises standing on a labile surface[b]) and transverse plane movements (diagonal lunges).
Plyometric exercise	3	Jumps progressed to "take off 2, land 1" and jumping was performed in the frontal and transverse planes.
Balance	2	Single leg activities were performed on a labile surface,[b] while concurrently performing perturbation with the opposite lower extremity or the upper extremity.
Weeks 7-8		
	Number of Exercises/ Category[a]	**General Exercise Concepts**
Strength	3	Exercises were primarily in the frontal and transverse planes and involved stepping onto a labile surface,[b] oftentimes with upper body rotation.
Plyometric exercise	4	All jumps were single-footed and focused primarily on the frontal and transverse planes.
Balance	2	Balance exercises were dynamic (such as a single leg squat), and were performed on a labile surface,[b] and sometimes required the athlete to close her eyes to minimize visual input.

[a] Although each exercise had more than one component (a strength and balance component, for example), the exercise was categorized according to the primary focus of the exercise.
[b] Thera-Band Stability Trainer

To date, an at-home, DVD-based injury prevention program to decrease knee injuries in female high school basketball players has not been performed. Although barriers to compliance with home-based exercises after ACL reconstruction have been identified, these factors—increased stress and negative mood[11]—relate directly to surgical reconstruction. It is unknown what barriers may be associated with a home-based knee injury prevention program. Therefore, the purpose of this study was to identify barriers associated with performing an at-home, DVD-based, lower extremity injury prevention program to reduce knee injuries in rural high school female athletes.

METHODS

Subjects

During the 2012-2013 school year, 9 high schools in Wisconsin were selected by convenience for study participation. Schools that contracted athletic training services from a local hospital that was a voting member of the Rural Wisconsin Health Cooperative (RWHC) were invited to participate. The high school was considered rural because the local hospital was a member of the RWHC. Within the 9 selected sschools, enrollment averaged 75 students per class. Females who had played basketball the previous year and all incoming freshman females were contacted and invited to participate. Females were excluded if they sustained a lower extremity surgery within the past year, had spinal surgery within the past 6 months, had an orthopedic condition that precluded them from exercising, or if they had utilized a formal rehabilitation program for a lower extremity orthopedic injury in the past 3 months. Of the 255 female athletes who were contacted, 175 planned to participate in basketball and were eligible for the study. Sixty-six individuals chose to participate in the study, which was approved by the Institutional Review Board at the University of Wisconsin-Madison.

DVD Exercise Program Content

The 8-week injury prevention program was designed by the authors, based upon existing, successful supervised injury prevention programs.[5] The DVD-based program was designed to progress the female athlete's strength, balance, and jumping and landing technique with minimal risk of injury. Each training session was approximately 15 minutes in length and was comprised of 3 components: strength training, plyometrics, and balance. The exercises progressed from Level 1(weeks 1-3), to Level 2 (weeks 4-6) to Level 3 (weeks 7-8) (Table 1). The DVD demonstrated both improper and proper exercise form and provided repetitions and sets of each exercise; the participant simply had to complete the exercise at the same rate as the age-appropriate model on the DVD. For each Level, there were three different exercise programs from which the athlete could choose for a total of 9 programs. This was done to encourage variety and minimize boredom. Lastly, a section was created that reviewed exercise form; the participant was encouraged to refer back to this section when necessary.

Exercise Program Instruction and Data Analysis

Once written parental consent and written subject assent was obtained, participants met with one of the authors (JTN) in a

group-based format at their local high school gymnasium. This meeting occurred 8 to 9 weeks prior to the onset of basketball season, in late August, for all 9 schools. At this meeting, participants were instructed in DVD use, provided necessary equipment (DVD, Thera-Band, and Thera-Band Stability Trainer) and instructed in use of the exercise log. The exercise sessions were led by an author (JTN) and the licensed athletic trainer from the respective school. Upon successful completion of the training session, which included return demonstration of the exercises, participants were instructed to perform the exercises at home 3x/week for the next 8 weeks. The participants were not contacted during the 8-week time period. Upon completion of the 8-week program, participants turned in their exercise log and equipment. They also completed a survey developed by the authors that questioned the participant's compliance, likes, and dislikes of the home-based program. Although local coaches were aware of the program, they had no knowledge of who was participating in the study. In addition, although the licensed athletic trainers were aware of which athletes were study participants and possibly saw the athletes at school as a fall sport participant, they did not offer encouragement or discuss the study with the athlete.

Descriptive statistics were used to characterize the sample. Frequencies were used to summarize participants' responses regarding grade, fall sports participation, completion of post-training surveys, frequency with which they performed the program, reasons for noncompliance, and user satisfaction and feedback from those who were compliant with the program.

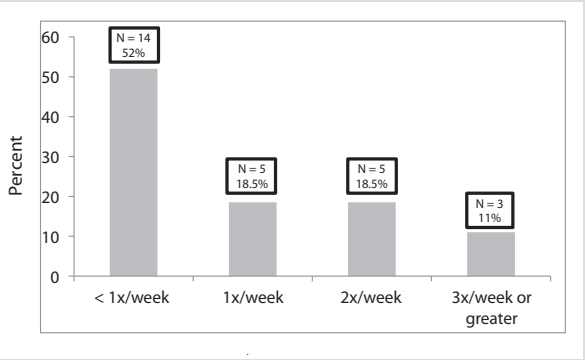
RESULTS

Of the 175 high school females who participated in basketball during the 2012-2013 season, 66 participated in the initial training session for a 38% participation rate. Eight weeks later, 27 of the 66 females (41%) present at the initial training session completed the compliance survey and provided feedback regarding the home-based injury prevention program.

Of the 66 females who participated in the initial training session, the majority (40.90%) were in grade 9; the least were in grade 12 (13.64%). Likewise, the majority of participants who completed post-training compliance survey were also in grade 9 (48.15%), whereas only 7.41% of those in grade 12 completed the post-training surveys. Approximately 80% of the 66 females also participated in a fall sport, either volleyball (71.21%) or cross country (10.60%). Of those who completed the post-training surveys (n = 27), 21 (77.8%) participated in volleyball, while 1 (3.7%) participated in cross country. Five (18.5%) of those who completed the post-training surveys did not participate in a fall sport.

The females who completed the post-training survey (n = 27) were asked to report the frequency that they performed the program during weeks 1-4, as well as during weeks 5-8. The average

Figure. Frequency (%) Which Participants Reported Performing the Exercise Program for the 8-Week Period[a]



[a] The goal was to perform the exercises 3 times per week.

Table 2. Self-Reported Reasons for Lack of Completion of the Injury Prevention Program[a]

Statement	N (%)
I did not have time to complete the program at home.	21 (78)
I forgot to do the program.	12 (44)
I lost my equipment.	1 (4)
The program made me too sore in my muscles.	0 (0)
I didn't have space in my house to do the program.	0 (0)
I did not like the program.	0 (0)
I did not have home media equipment to do the program.	0 (0)

[a] Because participants could select more than 1 option, the percentage is >100%.

frequency with which they completed the program is outlined in the Figure. The majority (52%) reported performing the program < 1x/week during the 8-week period. When weeks 1-4 were compared to weeks 5-8, the frequency of participation was similar. In other words, there was not a significant increase or decrease in participation over the 8-week period. No attempt was made to contact the girls who did not complete the post-test survey (n = 39).

When asked why they did not complete the program as requested, 78% of the participants reported they "did not have time to complete the program," and 44% reported they "forgot to do the program." No participants reported that they were too sore in their muscles, had a lack of space in their home, or that they did not like the program as a reason for a lack of compliance (Table 2).

Of the 27 participants who completed post-training surveys, 7 (26%) completed the program, > 11 times (out of 24 total sessions), or at least 50% of the requested time. Six of these 7 participants thought that doing the program made their legs stronger, made their balance better, and would make them a better basketball player and thus would do the program again. Of the 20 participants (74%) who reported doing the program less than 50% of the time, most felt the DVD was easy to use and the exer-

Table 3. Feedback From Participants Who Completed the Program <50% of the Time Compared to Those Who Completed the Program >50% of the Time

Statement	Mean Likert Score[a]	
	< 50% (n = 20)	> 50% (n = 7)
The DVD was easy to use.	4.41	4.71
Exercises were easy to follow.	4.39	4.57
The exercise program was too long.	3.11	2.43
The exercise program was too short.	2.44	2.57
I got bored doing the exercises.	3.53	3.29
The equipment (bands, balance trainers) was easy to use.	3.94	4.57
I liked the music on the DVD.	3.39	1.43
I listened to my own music most of the time.	2.82	3.29
I think doing this program made my legs stronger.	3.53	4.43
I think doing this program made me jump better.	3.44	3.86
I think doing this program made my balance better.	3.56	4.14
I think I will be a better basketball player because I did this program.	3.50	3.86
If I had the chance, I would do this program again before basketball season.	3.47	3.57

[a] Likert scale: 5= strongly agree, 4 = agree, 3 = neutral, 2 = disagree, 1 = strongly disagree.

cises were easy to follow (Table 3). The group with low compliance also reported average lower Likert scores related to improved leg strength, improved balance, and improved jumping skills as compared to the group with higher compliance (Table 3).

DISCUSSION

This study identifies barriers to performing a home-based exercise program for lower extremity injury prevention in female high school basketball players in rural Wisconsin. The most commonly identified barriers included (1) a lack of time and (2) forgetting to do the program. None of the athletes identified muscle soreness, a lack of space, or a lack of home media equipment as a barrier to compliance.

The most common self-reported barrier to program compliance was a lack of time. In our present study, over 80% of the participants reported competing in a fall sport. Because of the demands of the fall sport, in addition to other extracurricular activities and homework, the participants may have been limited on time available to complete the program at the requested frequency. In addition, children from rural families devote 1 to 2 hours/day to farm work.[12] All of these factors may have contributed to the participants' reported lack of time to complete the program.

Another reason for lack of compliance was that the participants simply forgot to perform the program. We purposely chose not to provide participants with reminders because we wanted to determine how compliant girls would be without any external reminders. Although asking parents to provide regular reminders to improve compliance is likely not realistic, the coach of the sport in which the female is participating may be able to offer reminders at practice.

Other studies have reported low compliance with home-based exercise programs in the high school population.[13] Even with face-to-face reminders, compliance with home programs has been reported to be as low as 40%. In the present study, we did not communicate with the athletes to encourage compliance. As our findings are similar to this study,[13] providing face-to-face communication alone may not improve compliance.

In contrast, compliance with a 6-week home-based wobble board training program was investigated. Participants received biweekly in-person assessments and progressions in addition to weekly telephone calls.[14] It appears that face-to-face interaction in combination with weekly reminders from a health care professional may be effective in increasing compliance. Unfortunately, in the real world setting outside of a structured research protocol, there may be limited contact with a researcher who can provide exercise reminders.[15] However, utilization of a health care professional who has daily contact with the athlete, such as a high school athlete trainer, may be able to provide reminders, leading to increased compliance.

Dissemination and implementation of effective injury prevention programs and subsequent compliance with these programs is essential to reducing the burden of sport-related injuries. A meta-analysis reported that higher compliance rates with prevention programs was associated with lower rates of ACL injury incidence.[9] Other studies have demonstrated similar findings.[16] As such, identifying barriers to implementation and compliance and creating strategies to overcome these barriers is paramount. Low levels of conflict, high levels of cohesion and organization, and good communication patterns have been associated with better regimen adherence.[17] As such, high school athletic trainers, who interact frequently with the athletes and coaching staffs, are ideal candidates to take a leadership role in this area. Athletic trainers are uniquely positioned to implement and supervise adherence to these ACL injury prevention programs.

Wisconsin basketball coaches surveyed about their use of injury prevention programs reported a lack of expertise as one reason for not implementing them.[18] Coaches also cite lack of time and space as barriers to perform injury prevention programs. Athletic trainers should be encouraged to take a more prominent role in advising coaching staffs how prevention programs can be implemented in a short, efficient manner requiring minimal equipment and space. In a study by LaBella et al,[19] coaches were instructed in how to lead a 20-minute neuromuscular warm-

up that was aimed at reducing lower extremity injuries in high school female athletes. Compared to a control group, the coach-led warm-up group of female athletes had less noncontact lower extremity injuries as compared to the control group.[19]

Studies have shown that enhancing long-term adherence requires individualization and should take into account the patient's age, lifestyle, motivation, interest, and usual methods of enforcement.[20] This requires that the interventions must be tailored to an individual's needs to succeed. In our study, we designed an injury prevention program specifically for female high school basketball players: The background of the DVD was basketball-based and the drills utilized a basketball and/or basketball-specific drills whenever possible. At each level, there were 3 different individual programs; as such, we felt we provided the participant with a variety of exercises routines from which to choose. In addition, the models in the video were young females of average height and weight. Feedback from the most compliant participants was overwhelmingly positive; dislike of or difficulty using the DVD or performing the exercises did not appear to be barriers for these individuals. Compared to the most compliant participants, the individuals who performed the exercises < 50% of the time tended to agree more with the statement "The exercise program was too long" (mean Likert score 3.11 vs 2.43) (Table 3). Although each program was approximately 15 minutes in length, this may have been a barrier to program completion for some girls. Boredom rates with the home program appeared similar between the 2 groups. Boredom with doing the exercises at home alone may be a barrier to use of home-based programs. This further suggests the need to implement programs in a supervised, school-based setting where adolescents spend a significant amount of their extracurricular (and athletic and social) time.

One limitation of this study includes the small sample size. Of the 175 athletes who were eligible to participate, only 66 participated in the introductory meeting, and only 27 completed the follow-up survey. Obtaining parental consent and student assent during the summer months, when school is not in session, proved very challenging. Of the 66 that were provided equipment and requested to complete the home program, only 27 returned for the follow-up survey. We elected to schedule the follow-up meeting immediately before or after a volleyball practice, as many study participants also competed in volleyball. However, volleyball practice sometimes got moved to a different time, or athletes had outside responsibilities immediately after volleyball practice, such as work or duties at home, which precluded them from completing the follow-up survey. Other limitations include the lack of generalizability to other sports, and the small sample size from each school, making between-school comparisons impractical.

CONCLUSION

This study identifies barriers to compliance with home-based injury prevention programs in female high school athletes. The main reason for poor compliance was a lack of time, followed by failing to remember to do the program. Other studies have identified that higher compliance is associated with a decrease in injury rate. Due to multiple barriers to compliance with home-based prevention programs, school districts may wish to consider the utilization of other professionals, such as coaches or licensed athlete trainers, to properly implement an injury prevention program.

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